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MISSING

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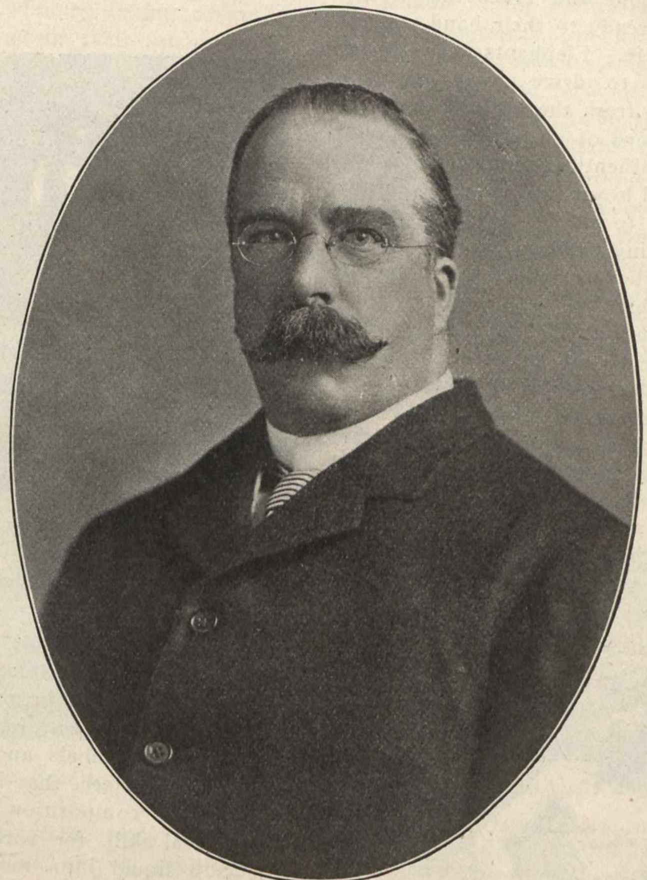
We judge ourselves by what we feel capable of doing;
but the world judges us by what we have already done."
—*Longfellow.*



FREDERIC NICHOLLS.

Herbert Spencer says—in his "Study of Sociology":—

"If you want roughly to estimate any one's mental calibre, you cannot do it better than by observing the ratio of generalities to personalities in his talk—how far simple truths about individuals are replaced by truths abstracted from numerous experiences of men and things, and when you have thus measured many, you find but a scattered few likely to take anything more than a biographical view of human affairs."

Judged by this standard, the subject of our first biographical sketch ranks high among the intellectual forces of the day. Among Canadian Captains of Industry, Mr. Nicholls has not a peer for broad generalization and comprehensive grasp of business affairs. That the business men of Canada have confidence in his judgment and *executive ability* is manifest; for he is President, Vice-President, or Director, of thirty of the largest manufacturing and commercial concerns in the Dominion: Vice-President and General-Manager The Canadian General Electric Co.; Vice-President Canada Foundry Co.; Vice-President Dominion Iron & Steel Co., Vice-President and Managing-Director of the Electrical Development Co. of Ontario, Ltd.; Director Canadian Bank of Commerce; President The Canadian Shipbuilding Company, etc.; together with directorate interests in Cuba, Brazil, Argentina, etc.

Although not a specialist in Civil, Mechanical, or Electrical Engineering—as such, Mr. Nicholls is entitled to the place of honor in our gallery of men who have "*done things*;" for the remarkable development of Electrical enterprise in Canada, culminating in the colossal works now being built at Niagara Falls, is due more to him than to any other man; whilst the immense general Engineering plant of The Canada Foundry Company—probably the best designed and equipped in the Dominion, and which will be fully described and illustrated in our August number,—is the work of his hands. His mind is now turned towards Marine Engineering, and the development of the shipbuilding interests of the country.

"Some are born great, some achieve greatness, and some have greatness thrust upon them."—*Shakespeare.*

Frederic Nicholls was born in England, November 23rd, 1856. Educated at Stuttgart, Wurtemburg. He crossed the Atlantic for Canada in 1874. When the philosophic historian comes to write the industrial history of Canada, the name of Frederic Nicholls will have an important place; as one who, by his fine business tact, unique executive ability, and indomitable energy—supplemented by a high code of ethics, helped mightily to develop the resources and shape the destinies of the greatest colony in the British Empire.

"The result of careful experiment is the voice of Nature speaking truth, the interpretation of it is the work of fallible humanity."

—*J. E. Stead.*

DESCRIPTIVE METALLURGY OF IRON AND STEEL.

BY

SAMUEL GROVES.

Introductory.

In the primitive ages, when our ancestors dwelt in caves, they hunted the buffalo and the bear with bow and arrow and spear, tipped with *sharpened* flints and stones. It was this unique faculty of being able to *invent and form* tools and weapons of defence that "gave man dominion over the fowls of the air, the fish of the sea, and everything that creepeth on the face of the earth." Moreover, this capacity to give new shape and form to existing materials, makes an absolute line of demarkation between man and the lower animals. Monkeys will throw down cocoa nuts from the trees, then pick up a stone and crack the shells; but they always take something ready to their hand—never make a hammer, hatchet, or knife. Elephants tear down branches from the forest trees to drive away the tormenting flies, or to protect them from the burning rays of the tropical sun; but whoever heard of an elephant making an umbrella? There is not an authenticated instance in the history of the world, of an animal lower than man, inventing and making a tool or implement to aid his natural powers. By instinct,—" a propensity existing prior to experience and independent of instruction," the beaver builds his dam, the bee his honeycomb, and the robin his nest, just as they did at the earliest dawn of civilization. The cave, tent, cabin, cottage, house, and palace indicate the progress made by the human race. By man's unique power of *invention* the desert has been made to blossom as the rose.

The earliest records of prehistoric times show palæolithic man dwelling in hillside caverns, supplementing his natural powers by making stone arrow heads and spear points to

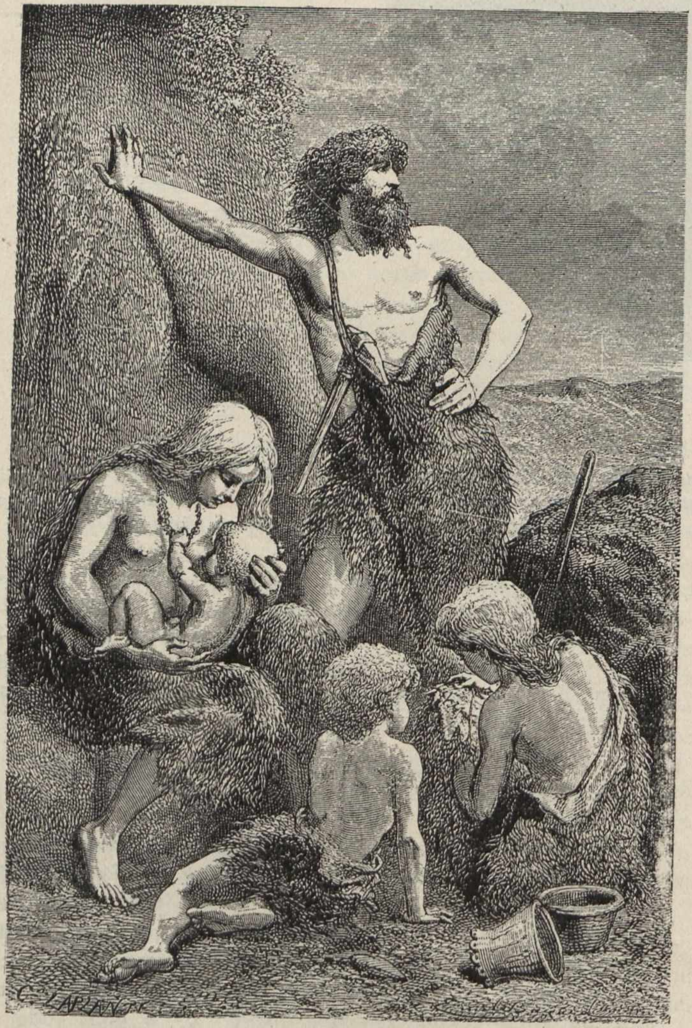


Fig. 1—A Family of the Stone Age.

protect him from the great carnivora, or to kill wild deer for food, and shaping stone hatchets, knives and hammers for cutting up the flesh and breaking the bones. Hence this first period of man's existence has been called the

Stone Age.

Then came the discovery of copper, which was hammered into ornaments and various articles of domestic use, but was too soft for fine-edged tools and weapons of defence. It was found, however, that by mixing the ores of oxidized copper and tin together, and melting them over a hot charcoal fire, a new metallic alloy resulted, which could be poured as a liquid into moulds, making castings of all shapes and sizes, having any degree of hardness; in fact, a mixture of two parts copper and one of tin makes an alloy so hard that it cannot be cut by ordinary tool steel. It was further discovered that if the bronze was made

Fig. 2—A Founder's Workshop during the Bronze Period.

red hot, then suddenly plunged into cold water, it become comparatively soft and ductile, and could be hammered into any shape, but if made red hot again, and allowed to cool *slowly*, would once more regain its original hardness. The native workers of bronze in India still take advantage of this diverse process, for it is the very way in which they make their cymbals and tomtoms to-day.

We thus see, that in bronze, Neolithic man discovered a metallic composition admirably adapted to his nascent industrial skill, for without much trouble they could pour it as a liquid into moulds having the form of hatchets, poniards, swords, agricultural implements and mechanical appliances of all kinds.

In this way began the art of founding in metals. At what precise date and in which part of the globe this simple but important invention was made is enveloped in mystery. The earliest written record is found in Genesis 4:22, where Tubal Cain is described as *"an instructor of every artificer in brass and iron,"* while tradition declares that bronze was first introduced into Central Europe by Phœnician traders about 1500 B.C.

This Epoch, or second period in the story of mankind, is known as the

Bronze Age.

But although bronze was a great advance over stone as a means of aiding the natural powers of primeval man, yet, as organized communities took the place of the patriarchal family and tribe, and the wants of the social organism became necessarily more varied and complex, it was found that copper and tin, and the bronze alloy made therefrom, were not elastic and hard enough, and the supply of their ores not plentiful enough to meet the increasing demands of the newly-formed societies. And since "Necessity is the mother of invention," and the art of metallurgy had made great progress during this Epoch, as the unearthed prehistoric relics of the period show, it is not surprising that Tubal Cain, or some other skilful founder in "brass," tried the experiment of smelting in a hot charcoal furnace the red oxides of iron which they found in abundance cropping out of the hillsides, and succeeded in easily producing lumps of metal, unalloyed, which could be hammered into knives, hatchets, scythes, plowshares, etc., for domestic use or cultivation of their lands in the "piping times of peace;" and swords, spears, armor, etc., for use in the chase, or stirring times of war and conquest.

With the advent of Iron, began a new era in the social evolution of mankind, known as the

Iron Age.

As in the case of bronze, so in the case of iron, the exact time and place of the discovery is unknown; but archæological remains, gold trinkets, bronze coins, ivory ornaments, iron swords, scythes, etc., together with rudely-built smelting furnaces, found in the hillsides and prehistoric tombs of Hallstadt, Austria, and Jura mountains of Switzerland, clearly prove that 2,000 B.C. a Gallic race inhabited these regions of central Europe, who, by taking advantage of the discovery of iron, and trading their manufactures with the Phœnicians, enjoyed material comforts and luxuries, and developed skill and taste in the cultivation of the arts of life, far in advance of the rugged nomadic tribes and people by whom they were surrounded, bearing out the famous dictum of Thenard, the Chemist, that we may judge of the state of civilization of any nation, by the degree of perfection at which it has arrived in the workmanship of Iron.

Fig. 3—Primitive Furnace for Smelting Iron.

The method by which these men of the early Iron Age extracted metallic iron from mineral ore, is graphically illustrated in Fig. 3. This picture was drawn from a model in relief, prepared in 1866 by a learned Swiss Engineer, M. Quiquerez, and designed from many specimens found in Hallstadt, Austria, and in the Bernese Jura. The furnace consisted of a cavity in the hillside, covered in with a concave wall about nine feet high, plastered with fire clay, and surmounted with a conical chimney. Steps made of rough stone were arranged on each side of the mound to enable the workman to climb on top in order to charge with ore and fuel. On the right hand side is a heap of charcoal for fuel, while on the left is a store of ironstone, enclosed in a pen formed of long, wooden logs. In the foreground is a heap of scoria, hammer slag and scale, dropped as debris in the process of hammering the crude metal. A workman is pulling a cake of iron out of the ashes; another is hammering on the anvil a piece of spongy iron, just taken from the furnace. In all these researches, no trace was found of the use of bellows, natural draft only being used at this period; hence, there is no proof that *founding in iron* existed in Prehistoric times. To fuse iron ore, and reduce it to a liquid condition, requires a temperature of some 2,200° F., and this high temperature is not attainable in the natural draft furnace described. In these ancient furnaces, the iron in the mineral ore was only reduced to a red-hot spongy state, and dropped down among the ashes in the form of pasty lumps of malleable iron, weighing from twelve to sixteen pounds, which were worked on the anvil by artisans skilled in the craft of Tubal Cain.

So far we have followed the footprints of primitive man up through the mists of antiquity, guided only by the evidence furnished in roughly chipped flints and stones, cunningly worked bronze tools and ornaments, rudely formed iron weapons, implements, etc., found in deep caverns, embedded in solidified mud or under alluvial deposits of past geological ages.

It is not until 1050 B.C. that we cross the threshold of history, and enter the domain of scientific fact. The first historic record is found in Solomon's famous message to Hiram, King of Tyre (2 Chron. 2:7), where he requests the Phœnician monarch to assist him in building the Temple of Jerusalem, in the golden age of Judea. Said he:

> *"Send me now, therefore, a man cunning to work in gold, and in silver, and in brass and iron."*

The next instance is found in Homer's Iliad, written about 850 B.C.:

> *"And the Greeks bought wine for shining steel, and some for sounding brass."—(Book VII.)*

And where the Trojan captive spy, Dolon, tries to bribe the Greeks:

> . . . . *"He, weeping, offered*
> *A wealthy ransom for his life, and told them he had brass,*
> *Much gold, and iron, that fit for many labors was, from*
> *Which rich heaps his father would a wondrous portion*
> *Give."—(Book X.)*

From this time forward, the material progress and civilization of the human race, especially in Europe, was greatly accelerated, and largely through the use of Iron, which has felicitously been called the "King of Metals."

(Continued.)

ON COMMERCIAL MILLING.

(Special correspondent.)

Commercial milling is generally understood to mean that which enables the work to be produced most quickly and economically, at the same time with a degree of accuracy that best adapts it to following operations and final assembling.

In this connection it is well to bear in mind, that while desirable to know how much work a machine can produce, it is many a time essential to know with what degree of accuracy the work can be commercially manufactured.

The rates of speed and feed need not necessarily be the limit of the capacity of the machine; but such feeds and speeds should be selected as will best produce the work commercially.

The Brown & Sharpe Mfg. Co., from whose shops the following examples of commercial milling were obtained, is probably one of the most widely known and best equipped to furnish information relating to the subject in hand. As an example of the completeness of the facilities these shops contain for studying the requirements of commercial milling, we were informed that nearly 400 milling machines are kept in almost constant operation on all varieties of work and it is apparent that the advantages to be derived from such a wide experience in every line covering milling operations, is exceptional. This experience we understand is placed at the disposal of those desiring information as to the most economical method to adopt; if sample pieces or sketches are sent, information is gladly given.

The illustrations show some of the milling operations on the body and slide of a milling machine vise, and the writer perceived that the pieces were practically ready for assembling when received from the machine; the amount of hand-fitting required, being surprisingly small.

Depth of cut, 3-32"; surface speed 109 feet per minute; table feed, 10¼" per minute.

Total width of cut, top and sides, 9½"; length, 12". Cutters—2 inserted tooth side milling, 9½" diameter; teeth of high speed steel; 1 milling, with nicked teeth, 3" diameter, 6⅛" long, tool steel.

This is a good example of the combination of tool steel cutters with cutters of high speed steel, as it will be noted,

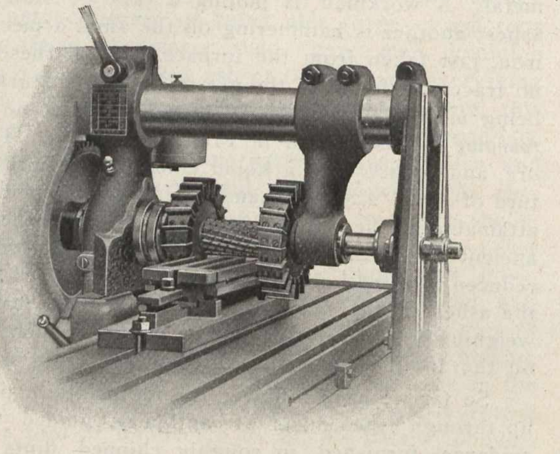


Fig. 1.—Rough Milling the bottom and sides of a Vise Bed.

that while the side mills are running at a comparatively high speed, the speed of the milling cutter is about right for tool steel.

There are two cuts in this operation: Roughing—depth of cut, ⅛"; surface speed, 50 feet per minute; table feed 5" per minute. Finishing—depth of cut .010"; surface speed 172 feet per minute; table feed, 3¼" per minute. Width of cut, 8½"; length, 6".

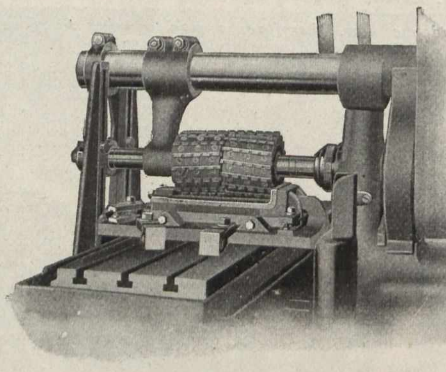


Fig. 2.—Milling the top of a Vise Bed.

The cutter used is an interlocking milling cutter with inserted teeth, nicked, tool steel; diameter, 6"; length, 8½".

Depth of cut, .020"; surface speed, 156 feet per minute; table feed, 5⅝" per minute. Cut, top and sides, width, 12 1-16"; length, 12". Cutters—2 inserted tooth side milling, 9½" diameter, teeth of high speed steel; 1 milling with spiral teeth, 3" diameter, tool steel.

There are also two cuts in this operation as follows:—

Roughing.—Depth of cut, 1-16"; surface speed, 105 feet per minute; table feed, 7⅜" per minute. Finishing.—Depth of cut, .010"; surface speed 89 feet per minute; table feed, 3 5-16" per minute.

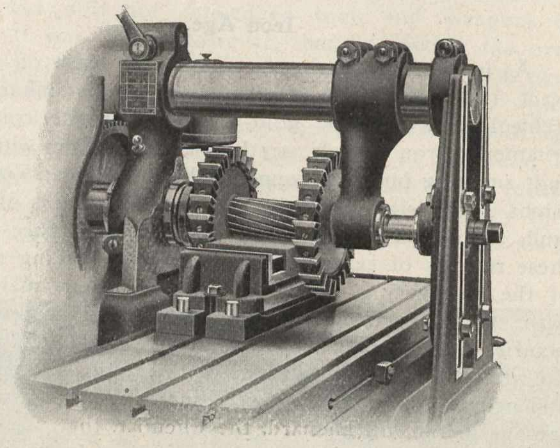


Fig. 3.—Finish Milling the top and sides of a Vise.

Total width of cut, 8"; length, 4⅛".

Cutters—4 side milling, 6" diameter. Roughing cutters, high speed steel; Finishing, tool steel.

Attention might be called to one feature in connection with this operation, namely, that the cutters have sharp

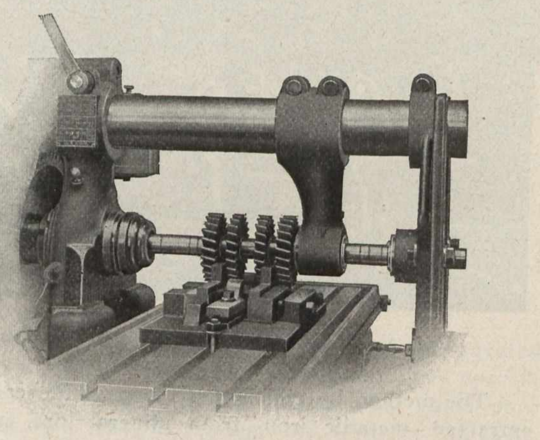


Fig. 4.—Milling the bottom of a Vise Slide.

corners and to insure accuracy of the finished product, they must necessarily be run at a speed that will maintain the sharpness of the corners. If run at a higher speed, the corners would soon become rounded and impair the efficiency of the cutters.

ROBB-ARMSTRONG CORLISS ENGINES

SLOW AND MEDIUM SPEED.

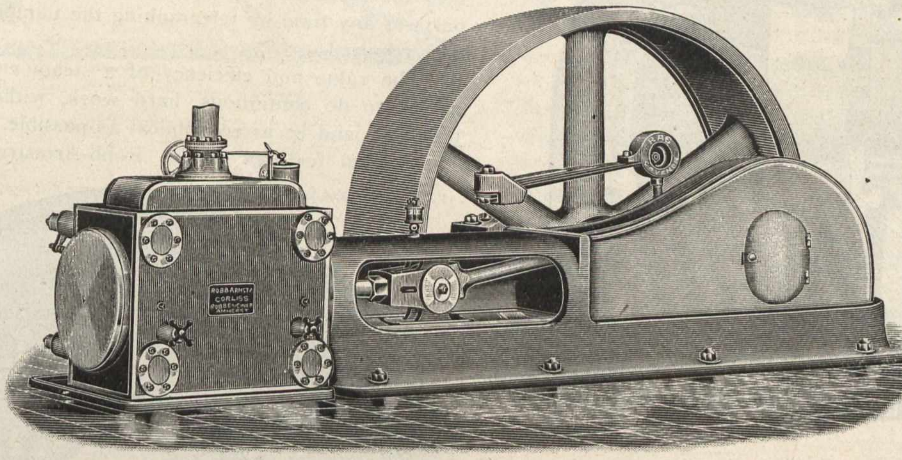
The Robb-Armstrong Corliss engine is designed on the lines of standard Corliss engines of the modern, heavy duty type, the stroke being rather short, giving a compact frame, free from the vibration, which always takes place in the older design of long stroke, girder frame. As shown by the cut, the frame is supported the whole length on the foundation; the crosshead guides and main bearing seats being bored in a special machine at one operation, making them in perfect alignment. The length of stroke is so proportioned that the revolutions of the engines may be anywhere from 90 to 150, and the speeds of pistons and reciprocating parts do not exceed 450 to 600 feet per minute, which is very desirable for use in factories, saw-mills, etc., where continuous service is required with the minimum amount of attention.

The special feature of this type of engine is the Armstrong-Corliss valve gear, which is much more simple in construction than the ordinary releasing gear, and will operate successfully at any speed up to 200 revolutions per minute.

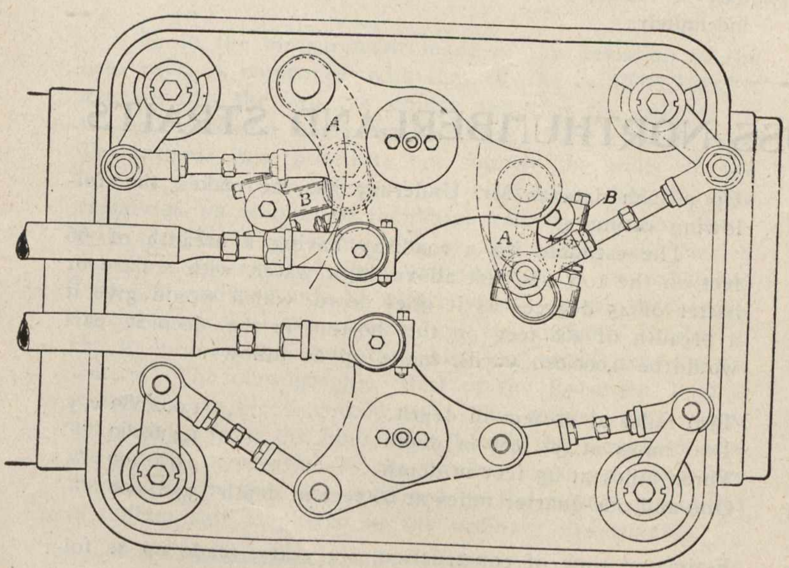
The valve gear, shown in the outline sketch, is the invention of Mr. E. J. Armstrong, M.E., the essential feature of it being that there are no springs, dash pots, or disengaging parts, which are usual in the ordinary Corliss valve gear. By the introduction of two small links, A and B, between the wrist plate and bell cranks, the steam valves are caused to open and close quickly, and remain stationary during the remainder of the stroke, the action being almost precisely the same as with the releasing gear invented by George H. Corliss, the advantage being that as this valve gear is positively driven, and does not depend on springs or dash pots for closing, it may be operated at much higher speed than the releasing valve gear.

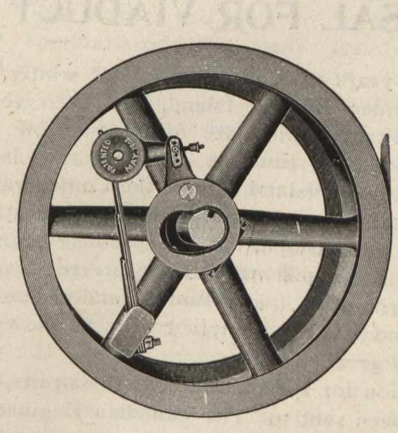
and as there are only about half as many pieces and wearing surfaces, and no latches or detachable parts, the gear runs very smoothly without noise or friction. The valves are of the usual Corliss rotative type, triple ported, of the latest design, giving very short travel and quick opening. The exhaust valves are driven from a wrist plate in the usual way.

The automatic cut-off is obtained by means of a shaft governor, located in the driving wheel of the engine, so arranged that the position of the eccentric is varied, changing the cut-off of the valves directly. This method of governing is much more positive, quicker in action and gives a closer regulation than the indirect method of governing used in connection with the releasing valve gear.



In the Robb-Armstrong-Sweet governor, the centrifugal weight is carried directly by the spring, so that the heavy strain, due to centrifugal force, is not brought on the suspension pin, which merely carries the eccentric, and is not subject to any strain or friction, except that due to the driving of the valve gear. The centrifugal weight may be very heavy without bringing undue strain on the spring, because a large part of its centrifugal force is carried by end pull on a flat lead spring, so that inertia of the weight will be sufficient to prevent disturbance by the reciprocating motion of the valve gear, and the weight is so placed that it gets the effect of inertia for quick regulation. The governor system is in gravity balance in all positions, because the eccentric is made to balance the centrifugal weight, the principle of balancing being the same as that invented by Professor John E. Sweet, and used in the



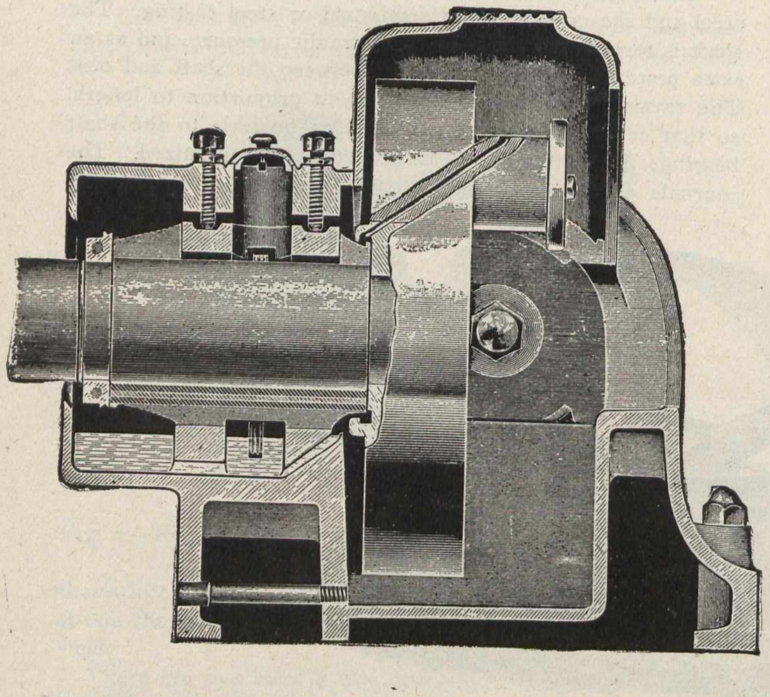


"Straight Line" governor. The result is an extremely simple and powerful governor, in which there is not enough friction to prevent it from changing position almost instantly to meet sudden changes of load, and there is no possibility of racing when properly adjusted. By means of a simple adjustment of the link connecting the eccentric and centrifugal weight, the governor weight may be adjusted to any degree of sensitiveness or close regulation. Only an engineer who has had experience with various types of governors can properly appreciate the ease and certainty with which the necessary adjustments are made on this one, and the absolute integrity with which they are maintained. No other governor compares with it in these all essential qualities.

The crank shaft is made of the best quality of mild, forged steel and the crank disk of semi-steel or steel casting. The shaft is forced into the disk by hydraulic pressure, and as an extra precaution, a key is inserted between the shaft and disk. The crank pin is large in diameter in proportion to length, so that centre of thrust is as close as possible to the shaft bearing; hence, springing of the crank is minimized. The journals of the crank shaft and crank pin are carefully ground to gauge, and lapped to perfect surface. The crank pin is oiled continuously by the waste oil from the shaft bearing, and also from the sight feed valve on the main bearing cap, the oil being caught in an annular recess at the back of the crank disk and conveyed to the crank pin, by centrifugal force, through the oil hole shown in the sectional cut of the main bearing and crank.

The shaft bearings consist of interchangeable, removable shells lined with genuine babbitt, made of pure copper, tin and antimony compressed into the outer cast-iron shells and carefully bored and scraped to gauge. The shells are in halves, turned on the outside to fit seats in the frame of the engine, held to place and adjustable by wedges, as shown in the illustration. The adjustment is made by screws from the outside of the cap; by loosening the centre screws which hold the top wedge, and tightening the side screws, which lift the side wedges and close in the shell, or, vice versa. The adjustment of the shells may be made by hand while the engine is running, which enables the engineer to feel the tightness, and prevents getting the bearing too tight. By this arrangement, the shell is closed in evenly all around, keeping the contact of the bearing surfaces even and equal as wear takes place, which is not the case in the ordinary four-part box. As the strain on the bearing is on the bottom and sides only, the top part of the shell is open and does not touch the shaft, which prevents heating, and allows the oil to be well distributed over bearing. The bearing shells are interchangeable, and may be replaced at any time without delay, restoring the alignment of the crank shaft. The shaft bearings have ring oiling in addition to the regular system of oiling, as described.

The connecting rod is a solid steel forging, the cross-head end being solid—without straps, and the crank end either solid or of the marine type, the bearing surfaces being lined



with genuine babbitt, compressed into place, bored out and carefully scraped to gauge. The connecting rod boxes are interchangeable, so that they may be replaced at any time.

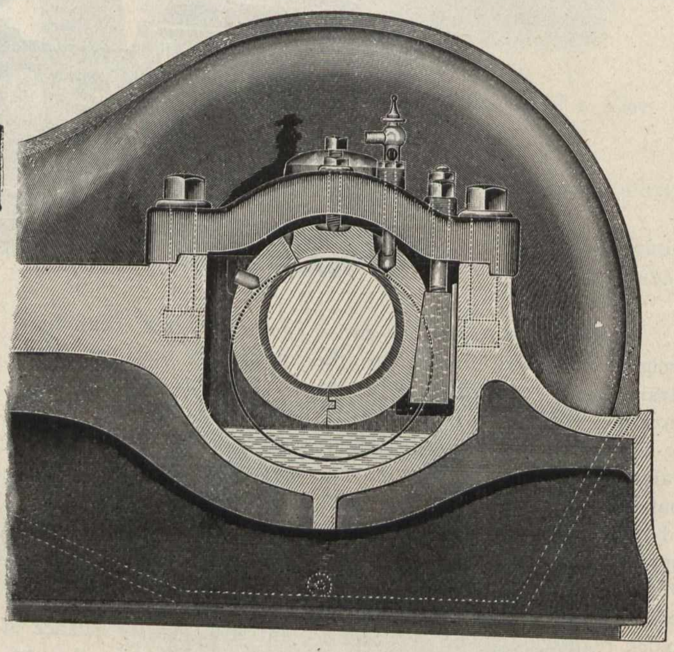
The crosshead is of the ordinary type, made of steel with an adjustable bottom shoe, which is lined with babbitt.

Large oil pockets are provided at each end of the guide, into which the crosshead shoe dips, so that it practically floats in oil.

A regular and copious supply of lubricant to all working parts of an engine is perhaps more essential than any other detail to its successful and satisfactory working, as well as to its length of life. The continuous oiling of all the bearings of the Robb-Armstrong engine is provided for by a large reservoir placed on a pedestal above the engine, and the oil is piped to every bearing with a sight feed valve for each, which may be adjusted once for all; the engine oiling system being started or stopped by opening or shutting a single valve at reservoir. As stated previously, the main bearings have ring oiling in addition to the sight drop, and the crank pin is also supplied in two ways. The oil is all returned to the crank pit, where it may be drawn off and filtered, or allowed to drain to a separator and filter attached to the engine. The frame and crank, as well as the eccentric are entirely enclosed by sheet metal casings, which prevent the oil being thrown outside the engine. The cylinders are provided with positive feed lubricators.

The Robb-Armstrong engines are designed with the special object of being made in quantities by the interchangeable system. The drawings, gauges, templates and manufacturing plant are especially adapted for it, and a large stock of duplicate parts always kept on hand. Every part of each engine is numbered, corresponding with drawings, which are placed in their files for reference, so that the customer may obtain duplicate parts at any time by telegraphing the number of the engine and part required.

The value and efficiency of a steam engine depends on its ability to do continuous, hard work, without undue wear or breakage, and be as economical as possible in the use of steam. The special features of the Robb-Armstrong Corliss engines



are the improved valve gear, extreme simplicity in the number and arrangement of parts, and the fact that every wearing part may be replaced, thus keeping the engine in perfect condition indefinitely.

PROPOSAL FOR VIADUCT ACROSS NORTHUMBERLAND STRAITS

For many years past, the question of winter communication with Prince Edward Island, has been very serious for the inhabitants, who are often cut off from the mainland weeks at a time, as was the case last winter. When Prince Edward Island entered the Confederation, it was on the understanding that constant communication should be kept up with the island, but this promise has never been fulfilled, and the demand made at the present session of the Dominion Parliament for a tunnel under the Straits of Northumberland was not complied with, as the expense was considered too great.

A suggestion for a viaduct across the straits,—instead of a tunnel, has been sent to "The Canadian Engineer" by J. C. Underhay, C.E. A section of the formation underlying the straits is given herewith, and Mr. Underhay estimates that a viaduct between Cape Traverse, P.E.I., and Cape Tormentine, N.B., can be built in six years at a cost of only $3,000,000; as against $10,000,000,—the estimated cost of the tunnel.

The upper stratum of the bed of the strait consists of fifty to eighty feet of shale clay, with, however, frequent outcrops of rock, which would make a tunnel expensive, but the character of the bottom is not known in detail. Upon such data as Mr. Underhay has, he makes the following estimate:

"The estimate for a roadway having a breadth of 66 feet on the top, six feet above high water, with a flare or batter of 45 degrees as it goes down, which would give it a breadth of 268 feet on the bottom in the deepest part would be 9,000,000 yards, made up as follows:

Two miles at 27 feet in depth..............	1,002,080 c. y.
Two miles at 36 feet in depth..............	1,436,160 "
Three miles at 45 feet in depth..............	2,930,400 "
One and one-quarter miles at 96 feet in depth	3,581,600 "

Estimated time of construction, six years, made up as follows:

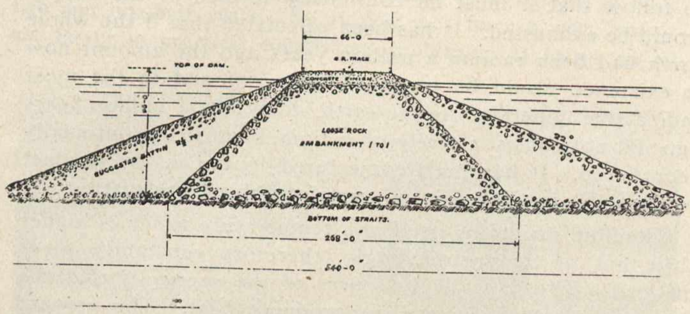
100 scows, with four men to each scow, 170 days each year, 20 yds. per day; for each scow	2,040,000 yds.
12 cars, 1,200 days, at 300 yds. per day........	4,320,000 "
12 cars, 960 nights, at 240 yds. per car........	2,592,000 "

At an estimated cost of $3,000,000, made up as follows:

Loading and unloading cars and quarrying stone:

35 men to each car, 1,200 days, at $2 each per day..	$1,006,000
35 men to each car, 960 nights, at $2 per night....	806,200
400 men, hauling with scows, 1,020 days, at $2 each	816,000
Superintending and train hands..................	50,000
Engines, cars, rails and track-laying............	300,000
100 scows, $20,000; incidentals, $1,800...........	21,800

A total cost of $3,000,000.



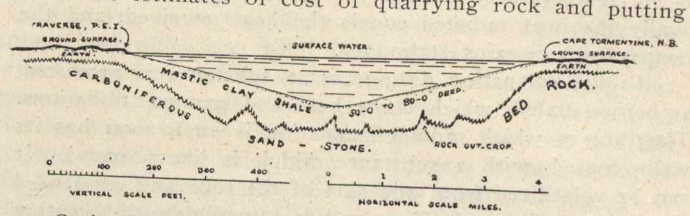
Cross Section of Proposed Embankment Across Northumberland Straits: together with Suggested Batter, as Designed by J. C. Underhay, C. E.

About 700,000 yards of this work would be above water, and would best have a concrete finish at an extra cost of $1 per yard. The foregoing calculations have been made assuming, as we are warranted in doing, that there is plenty of stone at each cape (Cape Tormentine, on New Brunswick side, and Cape Traverse, on Prince Edward Island side), and along the shores; and that cars could be so constructed and adapted to the work as to unload themselves with little help or loss of time. It would take about 350 acres at a depth of twelve feet to supply the stone to be put down by the cars.

Method of Construction.—Having full faith in the practicability and durability of the embankment, constructed of rough stone, dumped from the cars at each end of the work and from scows in the middle, which would roll out to about the angle mentioned, with a concrete finish above water. The work would require no expensive machinery nor skilled labor, and the money spent in a rough embankment of this kind would go into the pockets of the local men on each side of the Straits willing to do a fair day's work for a fair day's pay, while a costly masonry embankment would probably cost more than even a tunnel, with the same disadvantage of the greater part of the expenditure being for costly machinery and imported labor. Though no precedent exists for such a gigantic embankment, nor has any tunnel been bored where such conditions exist, nevertheless the history of the world teaches us how slow the public mind is to accept any new theory. As the work on the embankment progressed each year it would facilitate the communication between the Capes by narrowing the gap. The first season's work would narrow it by more than a mile on each side, besides about 1,870 yards in the middle."

J. A. Macdonald, a student member of the Canadian Society of Civil Engineers, of Hermanville, P.E.I., in forwarding Mr. Underhay's sketch, says:

"The writer considers a flare of 45 deg. insufficient, and suggests a batter or flare of 22 deg., or about 2½ to 1. This would increase the cost considerably. The writer also considers the estimates of cost of quarrying rock and putting



Section (Approximate) of Northumberland Straits: Between Cape Traverse, P E.I.; and Cape Tormentine, N.B. Designed by J. C. Underhay, C. E.

it in place too low by 100 per cent., maybe more, and that the cost of the embankment would be not less than $10,000,000, instead of $3,000,000 or $4,000,000. The writer also thinks that with a batter of 2½ to 1 the embankment scheme is more practical than a tunnel."

RADIUM AND ITS CONNECTION WITH CHEMICAL AND PHYSICAL PROBLEMS.

By John Waddell, B.A., D.Sc., School of Mining, Kingston.

(Concluded.)

From the measurement made of the deviation of the beta rays, as compared with that of the cathode rays, it appears that the two are similar, but that the velocity of the beta radiation is greater than that of the cathode rays. The cathode rays penetrate but slightly the walls of the tube in which they are produced electrically, but the beta radiations, on account of their high velocity, are very penetrative. This gives some idea of the energy with which beta rays are emitted, since cathode rays in an exhausted bulb are produced only by very powerful electric discharges. In the same way the gamma rays are probably similar to the Roentgen rays, but they also are much more penetrative. The photographic effect of the Roentgen bulb is mainly due to the Roentgen rays. The cathode rays escape but slightly from the bulb, and, though the Roentgen rays are not so penetrative as the gamma rays, yet there are more of them than are produced by the minute quantities of radium salt employed in the ordinary experiments.

Some radioactive substances give out alpha radiations only, but where beta radiations are emitted they are always accompanied by gamma radiations, and, just as Roentgen rays are produced by the stoppage of cathode rays, so it seems that the gamma rays are produced in the formation of beta radiations; that is, a sudden change of velocity of the particles gives a wave motion in the ether, just as a stone thrown violently upward through the surface of water by an explosion sets up waves similar to those produced by its fall.

The energy of the alpha radiations is very great, and when a particle strikes certain substances, such as zinc sulphide a change is produced that is accompanied by a flash of light. These flashes can by a proper arrangement, such as in the spinthariscope, be made plainly visible. It is calculated that a gram of radium loses in every second more than 100,000,000,000 alpha particles, so that in the spinthariscope the zinc sulphide screen is heavily bombarded.

If a compound of radium is heated or if it is dissolved, and air is passed over the hot substance or through the solution, a gas is carried off which is very radioactive. The quantity of gas is so small that it cannot be detected by the ordinary physical or chemical means, but it can be liquefied, and its rate of diffusion through another gas can be determined. This is owing to its effect on phosphorescent substances. If air containing the gas, which is called the radium emanation, passes through a tube containing zinc sulphide, the latter glows. If the tube is made very cold in any part, the emanation liquefies, and the zinc sulphide beyond that point ceases to glow. Though the emanation is a gas, it is not absorbed by liquids that absorb most gases. Moreover, it is not acted on by chemical reagents, it does not attack heated calcium, or magnesium, and is, in fact, like the group of gases, of which argon is the most conspicuous member.

As already said, the radium emanation is strongly radioactive—it gives out alpha radiations only. This is shown by the fact that if air containing the emanation is enclosed in a tube with thin walls, no radioactive effect is obtained outside the tube, though beta and gamma radiations could easily penetrate the walls, which would be, however, impervious to alpha radiations. This is the state of affairs immediately after the emanation is introduced into the tube, and for some time afterwards, but in the course of several hours beta and gamma radiations are given out. It can be proved that meanwhile the quantity of emanation diminishes and another substance is produced, which substance gives out the beta and gamma radiations. The radium from which the emanation has been withdrawn has thereby lost most of its radioactive power, but this power returns after some time, and it returns just at the same rate as the emanation loses its radioactivity. In four days, the emanation loses half its power; in four weeks, practically all of it. On the other hand, in four days the radium regains half of its radioactivity; in four weeks, the whole. This can be explained on the assumption that radium is all the time producing emanation, which is all the time being decomposed. When a certain amount of emanation has accumulated in the radium, it disappears as rapidly as it is formed. An illustration is afforded by the case of a piece of iron heated in a flame. At first the iron gets hotter, but as its temperature increases, it gives out more heat, till finally the heat radiated equals the heat received, and the temperature remains stationary.

As the emanation disappears, a substance is produced, as before stated, which emits beta and gamma radiations. The tube in which radium emanation is kept, soon has its walls coated with a substance which is like a metal. It can be volatilized from one part of the tube and condensed on another. It can be dissolved in some acids, the solution becoming thereby radioactive. This substance loses its radioactivity rapidly, falling to half the original in twenty-eight minutes. Just as radium produces the emanation, so the emanation produces the other substance, which also decomposes, producing some other substance or substances.

After the emanation has been kept for a few days in a tube it is found that helium makes its appearance. This is shown by the spectroscope, it being found that though when the emanation is introduced into the tube no spectrum of helium can be obtained it becomes visible within a few days. This seems to be a case of transmutation of an element, and, although we have not been able to change lead into gold, it appears that transmutations quite as wonderful go on spontaneously.

As radium changes into something else it would seem to follow that it must be continually formed or the supply would be exhausted. It has been calculated that if the whole earth had been radium a million years ago the amount now in existence would be no more than is found in the most radioactive minerals. As the earth, doubtless, a million years ago did not consist entirely of radium, it must be continually reproduced. It has been conjectured that it is the product of uranium, but there is no certainty about the matter.

Radium maintains itself at a temperature which is higher than that of its surroundings; therefore constantly gives off heat. The most likely source of the energy is that the decomposition of the radium produces heat. The amount of heat thus produced is very many times as great as could be produced by the most vigorous chemical action in the same quantity of material.

For a long time there has been a dispute between physicists and geologists about the length of time during which the earth has existed in approximately its present condition. Geologists have required longer time than physicists were willing to grant. Physicists have calculated from the rate of cooling of the earth. But they assumed a cooling where there was no supply of heat within the earth itself, but if decompositions are taking place similar to that of radium, heat may have been thus produced and the time of cooling of the earth correspondingly lengthened. It will be seen that the problems connected with radium have a very important bearing on many problems regarding the character of matter and supplies of energy.

FORMATION OF ANCHOR ICE, AND PRECISE TEMPERATURE MEASUREMENTS.*

By Howard T. Barnes, McGill University, Montreal.

(Continued.)

Often the dark patches or absorption bands extend for a long distance through the spectrum.

Tyndall showed that the long rays from copper heated 100 degrees are all stopped by water. Rubens and Aschkinass have shown that there is a dark band (an absorption band) in the heat spectrum of water, and therefore there may exist heat rays beyond this absorption band for the longer waves which will penetrate the water. There is nothing to prevent our making that assumption. I will admit that it is yet to be proved that such exists, but that such could exist seems entirely plausible. Take the bed of a river which is at the freezing point radiating heat off into space. The waves of heat which will pass off will be very long and they very probably consist of waves beyond the absorption band discovered by Rubens and Aschkinass.

Having run over the various points in connection with heat transmission, I want to dwell for a short time on the physical properties of ice and water. Let us take ice first and briefly review its characteristic properties. We know that ice is very plastic; it can be molded into various shapes. We have examples of ice which has been pressed between heavy molds to form perfect spheres; and ice that is pressed in a cylinder may be forced out of a narrow opening. Ice, however, does not exhibit the characteristic properties of viscosity. This was pointed out by Tyndall. An illustration of this is the glacier action. A glacier in moving from a narrow passage to a wide passage cracks instead of adapting itself to the wider passage. A glacier moving down over a very gentle slope will crack on lines at right angles, showing that ice is exceedingly brittle. Therefore, we cannot say that ice possesses viscosity to any great extent, although it can be molded under pressure and made to run under pressure. Now the phenomena which enable it to give under pressure are probably due to another physical property of ice, namely, regelation. We know that pressure sufficiently great will melt ice. One hundred and fifty atmospheres pressure will lower the freezing point of water and ice 1 deg. Cent. It does this by squeezing some of the ice back into water; the temperature is lowered by the melting of the ice and the absorption of the heat. Regelation accounts for a great many ice phenomena of nature. A very beautiful example of regelation is Bottomley's experiment. It is a block of ice being cut through by a wire attached to a weight. I dare say many of you have seen the experiment. The pressure of the wire at the point of contact melts the ice. The water runs around the wire and finds itself freed from the pressure and at a temperature lower than its freezing point; it freezes again above the wire. In this way the wire slowly creeps through the ice leaving it as strong after the wire passes as it was before. By means of pressure we can freeze blocks of ice together—two pieces of ice brought together and pressed will stick together. A slight film of water is formed on the touching surface and immediately the pressure is relieved the water in contact with the ice surface finds itself below the normal freezing temperature at once solidifies, cementing the two blocks together.

There is another property which ice possesses and which

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*A paper presented at tht monthly reunion in New York City, in March, 1905, and at the Scranton meeting (June, 1905), of the American Society of Mechanical Engineers.

has quite recently been measured. That is, it possesses the power of growing by itself; ice in contact with water exactly at the freezing point apparently goes on growing. You have all observed the beautiful growth of a crystal of alum or a crystal of sugar in a saturated solution of the alum or sugar, and how it gradually increases in size. Apparently ice does the same thing, only very slowly. As I shall explain to you presently water possesses ice in solution. The rate of growth of the ice crystals has been measured. If we allow the natural rate of growth to go on it would form an inch in about two and one-half years. So it does not form a very important factor in practical engineering problems. It forms an im-

Fig. 1.—Observation Shanty, Lachine, where Temperature Measurements were Made of the Water.

portant factor, however, in this respect, that it helps to cement ice crystals together. It was Faraday who first showed that if we had some cracked ice floating in a vessel by taking one of the pieces of ice and bringing it in contact with another piece of ice, it would stick to it; no pressure required, merely contact; and would draw it along. So he was able to get a whole train of six or eight pieces of ice in a vessel all being led by the first piece. This process of growth shows why these particles cemented themselves together when touched; for at the point of contact we have two ice surfaces with zero water between. The ice would be growing all the time and hence the two pieces in contact would at once adhere. A pressure is, therefore, not required to cause ice to freeze together.

Now of the physical properties of water we have the most important, i.e., maximum density. We then have the facts that water is opaque to heat rays and that it allows only a few of the heat rays to pass through. We have a further and quite an important physical property, that below 40 degrees Cent. or about 97 degrees Fahr. water commences to form ice; this ice remaining in the solution until the freezing point is reached. The proportion of ice increasing as the temperature falls and at the freezing point we have actually a saturated solution of ice and water. It explains to us the maximum density of water and the minimum specific heat.

The curve showing the variation of the specific heat of water drops very rapidly from 0 degrees Cent. and passes through a minimum at 40 degrees. Now that is apparently due to the fact that besides the heat absorbed in the natural expansion of the water we have the heat absorbed in transforming those ice molecules into water molecules. That is as the temperature rises, the amount of heat that would be absorbed by the ice becomes less and less. At 40 degrees Cent. we have an exact balancing. From 40 degrees upwards we have the water existing as a pure liquid.

Now I think I have taken up the chief points in regard to the physical properties of ice and water with the exception of the great change in volume that takes place when water freezes, which has such an important influence in river ice formation. There is an increase of about 9 per cent. in volume, and this is exceedingly important inasmuch as the ice as soon as it is formed comes to the surface or remains on the surface. Take, for example, a sheet of quiet water which is cooled lower and lower by the advent of winter weather. The surface becomes cool; the cooler layers fall to the bottom until 4 degrees is reached. Then the warmer layers stay at the bottom and the cooler layers remain on top. As soon as the surface gets to the freezing point ice forms. This ice spreads over the surface, usually from the banks towards the centre, and gradually increases in thickness by conduction.

To the convection of air currents we probably owe the fact that the ice spreads from the edges to the centre, because the water heats the air and it therefore rises from the centre and colder air sweeps in from the banks to the middle. We therefore have the water along the edges always in contact with colder air than at the centre. It has been considered that conduction plays probably the most important part in this phenomenon. But the conduction of heat through the banks of the river is slow indeed. It is so slow as to be practically negligible.

Let us consider what goes on in the case of a river which is flowing too rapidly to form a surface of ice? Naturally we will have instead of the flat surface ice, ice of finer quality formed. Each little piece of ice produced by the cooling of air on the surface is carried down by the currents and submerged, rising to the top again as the currents carry it above. Not forming the protecting layer of ice, the flowing river loses a very much greater amount of heat and the fine ice is produced by agitation in very great quantities. This is to be expected if we stop for a moment to consider river ice formation. How is this heat taken away from the water? We have the three governing processes at work. Conduction is probably negligible; convection by means of air currents and radiation from the water which is warm compared to the air above it.

Now you know that these fine crystals of ice which are formed and which are called frazil crystals, are swept down with the current and are carried by the current for long distances from open water under the surface ice. It was one of the discoveries of the Flood Commission of Montreal that this ice was found many miles below the bordage ice at the foot of the Lachine Rapids, where the greater portion of this ice is formed. An inspection of the many diagrams of the Flood Commission for various sections of the St. Lawrence river below Montreal, shows immense accumulation of frazil or what the engineers have called also sponge ice. It was found on examining this ice that it was very spongy. In determining the depth of the ice a leaded weight could be lowered through by slight pressure from above, and it was found that this ice accumulated under the surface ice to depths ranging from 30 to 35 feet. That it acted as a filter to the water which penetrated it was shown by the accumulation of a great deal of matter from the water, just as a sponge acccumulates slime from water. The great bulk of this ice which they found was manufactured in the Lachine Rapids, and in the reaches of open water extending about six miles from the ice sheet on Lake St. Louis. They found in many places below the rapids that there was more ice than water. The percentage of this ice became less as they obtained their suctions further and further below, until finally, some twelve miles below, the frazil was exceedingly

Fig. 2.—Attendant about to Place Thermometer in Water.

scarce. In general, wherever an open river flows unprotected, quantities of this frazil ice are formed by radiation and by convection of air currents and wind agitation. These crystals of ice vary in size, depending upon the agitation of the water. The more rapid the agitation, the finer they are, and the further they travel the larger they grow.

There is another form of open water ice which we must consider, and which is primarily the subject of this paper, namely, anchor ice. Anchor ice and frazil ice are often mistaken for the same thing; as a matter of fact we must distinctly draw a line between the two. Frazil ice is ice formed in the water itself by surface agitation and other causes. Anchor ice is ice that grows on the bed of the river, on the rocks, on anything in the bed of the river to which ice may be attached.

There is still a difference of opinion as to how this anchor ice grows; how it first forms; but I think when we consider the amount of heat which is lost from the surface of a river by radiation and the fact that much of this heat can penetrate through the water that we must admit that radiation plays an important part. When we consider further that this anchor ice is formed only at night when the radiation from the earth is a maximum, that as a rule it never grows under a bridge or under any object which would reflect the heat rays back again into the water, and when we consider that anchor ice apparently grows more rapidly on dark rocks than on light rocks then we must admit there is strong suspicion that radiation plays an important part in its formation. That anchor ice is built up as well by the freezing to the bottom of frazil crystals goes without saying. It could not do otherwise. These surface currents carry down the fine pieces of ice, which passing across the layer of anchor ice, which may have formed there by radiation, become attached, and we have then great thicknesses built up in a single night. Anchor ice is formed partly by radiation and partly by the sticking to the bottom of these frazil crystals. Anchor ice, during a severe spell of weather, when it is cloudy by day and clear by night, attains a thickness of

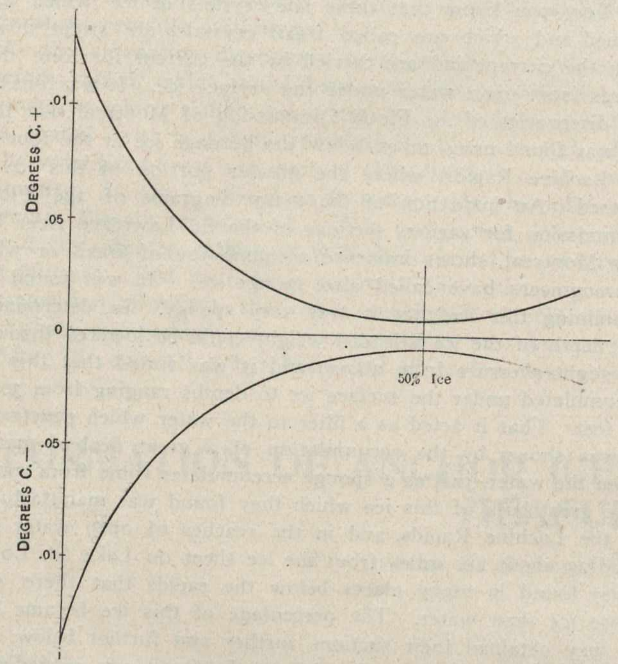


Fig. 3.—Freezing Temperature Diagram.

several feet, such that a pole or a stick placed on the ice will sink into it to considerable depths. When the sun rises it has been noted for a long time that these masses rise to the surface. The boatmen are very chary about going across an open channel when the sun is bright, for these masses come up in great quantities. As soon as the sun gets at a sufficient angle so that its rays penetrate the water, they pass through the water, and ice, warm the bed of the river and warm the water in contact with the ice. The ice rises with a characteristic hissing noise several feet above the water, and then falls back turning white as the water drains out of it. It floats low in the water because it is saturated and waterlogged just as sawdust will float lower in the water than an equal mass of solid wood. The fact that these anchor ice masses float lower in the water than a similar weight of packed ice would, has given rise to the opinion that anchor ice was ice denser than normal and therefore held down by its own weight. There is no evidence whatever to show that ice of a greater density than normal exists, and we therefore disregard that idea as being entirely untenable. Ice at one particular density is formed and only one. The reason of anchor ice being fastened to the bottom is that it is actually frozen there. As evidence of its buoyancy, large masses of rock are sometimes brought up with the anchor ice and carried down the river. Anchor ice will carry large boulders which fill up the channel of the river, and that is one thing the Montreal Harbor Commissioners have to contend with in the harbor there. They have annually to remove a large amount of rock and boulder carried down by the anchor ice. This anchor ice when it comes up becomes disintegrated and is carried down with the currents, thus aiding the frazil in causing the damming up of the channel.

Now it was the problem set me by the Harbor Commissioners to determine, if possible, what were the relations between the temperature of the water, if any, and the formation of anchor ice on the bottom, and the peculiar agglomeration of frazil crystals that takes place during very cold weather. It is a great difficulty that the engineer has to contend with in clear water with wind agitation that these little harmless particles grow in size very rapidly, and form hard masses to which other crystals immediately adhere. Under certain atmospheric conditions ice agglomerates very rapidly, and objects placed in the water become rapidly coated with ice. It is a common phenomena that if one lowers a bit of iron or metal into the water when the water is in this state that the iron will freeze at once to the bottom or to whatever ice it comes in contact with. Mr. Keefer, who has done so much in studying ice formation, has observed in going across the St. Lawrence river during an exceedingly cold day when the water was very dull, and appeared to be completely laden with frazil crystals, that he could feel the resistance to the motion of his paddle as they attached themselves to it, sticking out at right angles like long needles.

We designed a suitable form of resistance thermometer and undertook in the winter of 1896 to determine, if possible, any variation in temperature from the freezing point under the surface ice. Accordingly, a shanty was provided for the instruments in a suitable spot opposite Montreal, and in February of that year the instruments were taken out and observations commenced. We wanted to know how much the river differed from the freezing point. The method of observation which was adopted was a differential one, determining the temperature of the river by a difference from a carefully prepared mixture of ice and water. A very sensitive galvanometer was used, and any changes were at once detected by either a change in the galvanometer or a change in a suitable measuring wire. The wire having a scale, as I mentioned before, of eight inches to the degree centigrade. Now, the difficulties encountered were very great, and I may say, although about five weeks were occupied in these measurements, only half a dozen measurements could be obtained, for troubles arose from the breaking of the thermometer; troubles arose from the breaking of the galvanometer owing to the roughness of the shanty, and other troubles arose from the varying magnetic field due to the heating apparatus.

The results of these observations have been published, and it was found during the entire time, with a variation of air temperature from 28 below to 40 above, the river under the surface ice never varied as much as one one-hundredth of a degree from the freezing point. During the entire time of the observation no deviation as much as that could be measured, and as a rule the variations were within a few thousandths of a degree. A severe spell of cold weather would cause a slight drop in temperature, and vice versa.

The tube of the thermometer passed out through the shanty to the river, from a shelf where rested the galvanometer and measuring instruments, which I may say were of priceless value, as they were unique of their kind. The bulb of the thermometer was encased in lead six inches long connected with wires encased in lead 100 feet long, which passed up into the shanty. First of all an exact balance was taken between the resistance of the two bulbs when both were immersed in the ice and water mixture in the shanty. The watchman then carried the bulb directly out and put it into the river, and after a few moments another balance was obtained. It was possible to obtain at once a change in reading giving by reduction of the temperature.

The following winter, observations were made at the Lachine Rapids, because it was considered that possibly the water under the ice opposite the city came to the freezing point because it flowed so far under the surface sheet of ice. The shanty provided was smaller again than the one we had before, and there we had further difficulties. It was placed on the coffer dam of the Lachine Hydraulic Company, then under construction, and just at this point the water was running at a very high velocity. This sheet of water is entirely open, and flows rapidly from a point about five miles above the dam, and sweeps around this curve with a tremendous velocity and a great deal of surface agitation.

Fig. 1 shows the position of the observation shanty. Tht dam is seen extending out to the corner where the shanty was placed; the river runs down here to the rapids proper, which is just at this point.

Fig. 2 shows the agitation of the water as it passes down around the ice which grew out from the edge of the dam. The watchman with the thermometer in his hands is seen prepared to put it in the water. This was a good spot to observe the river temperatures, because from this point, say five miles, the river being a mile wide and fairly shallow, the water was cooled for that distance by air currents. Therefore one would expect that if water ever got cooled much below the freezing point it would have a chance in this case. The water was only a few feet deep near the dam, but became rapidly deeper as we got out. The thermometer tube could be bent and placed at quite a distance under the ice edge so as to be protected from radiation. Measurements were carried out for about six weeks in this position, and we got slightly greater variations than under the surface ice the winter before, but as far as the lowering of temperature was concerned it could be limited within one one-hundredth of a degree Centigrade; and the greatest lowering of temperature observed during a very severe day was six thousandths of a degree. Photographs taken of the agitated water on a mild day and on a cold day show distinctly a difference. On the mild day the water looks softer and less stiff, but on the severe day it looks harder, as though the spray was at once frozen and fell back as ice. Great masses of anchor ice would rise near me and go floating down past the shanty. They look like a great mass of solid ice, but if one should attempt to test their soundness one would go right through. We have witnessed many hundreds of these rising to the surface after the sun gets up.

Table I shows the results obtained in these measurements, with water temperatures, clearness of sky, wind and miles per hour between the rapidly flowing current and the quiet back water just below the point of the dam. As the current was swept around the dam, some of the water came back and formed an eddy.

On the third, the sky was clear and the weather was fine.

On the fifth we have +32 degrees and —3 degrees; wind much lighter; and a temperature above freezing of 0.02 of a degree. The reason of that is the great deal of sunshine, 88 per cent.

The seventh was a rainy day. We obtained quite a rise in temperature, nearly 0.02 degree above freezing.

On the following day it was raining also. We find the influence of the rain making itself felt in the river.

TABLE I.

Date	Air Temp Fahrenheit Degrees Max.	Air Temp Fahrenheit Degrees Min.	Sunshine in per cent. if possible	Sky	Wind in Miles per hour	Difference from Freezing Point in Degree Centigrade Current	Difference from Freezing Point in Degree Centigrade Quiet Water
Feb. 3rd.	+20	+10	89	Clear....	28.6	0	....
" 5th.	+32	—3	88	"	9.7	....	+0.0215
" 7th.	+38	+27	00	Raining..	13.1	+0.0197	+0.0182
" 8th.	+34	+28	00	" ..	16.3	+0.0547	+0.0415
" 11th.	+18	—3	94	Clear....	6.5	+0.0137	+0.0151
" 12th.	+11	—2	00	Stormy..	21.1	—0.0065	—0.0068
" 13th.	+17	0	100	Clear....	15.1	....	+0.0186
" 15th.	+33	+24	67	Clear to cloudy.	17.6	+0.0280	+0.0423
Mar. 1st.	+22	—10	25	Clear to cloudy.	16.8	....	0.

During these two days of rain the river was fairly well cleared out of floating ice; very little ice could be seen. On the twelfth, a very stormy day, with a high wind, 21.1 miles an hour, no sunshine, and a mean temperature of about 7 degrees, we found a lowering of the temperature of six to seven thousandths of a degree, and the measurements corresponded very closely for the current and quiet water.

During this day the river was filled with fine particles of frazil, and a great deal of ice was formed. I might say that as one of these measurements was being made the thermometer bulb was resting on the ice on the bottom, and when I came to remove it I found it frozen solid there, and it was with great difficulty that I was able to remove it without injury.

The next observation on the thirteenth was made with a clear sky; as you see here again the temperature is above zero.

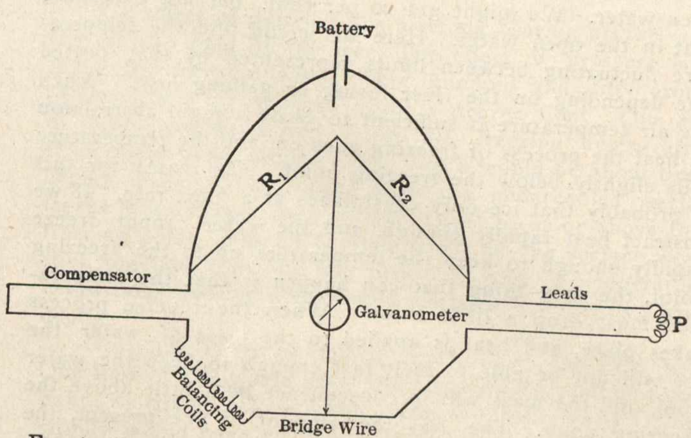


FIG. 4.—DIAGRAM OF PLATINUM THERMOMETER CONNECTIONS.

The next observation on the fifteenth was similar, with a fairly high temperature; 33 degrees maximum and 24 degrees minimum. We get the influence of the sun again.

This table illustrates one thing very clearly, that the margin between the disintegration of the ice and the formation of the ice is exceedingly narrow. That it is only a few thousandths of a degree. These high temperatures are all influenced by the sun's rays being absorbed in the water.

Table II is reproduced to show the effect of the sun's rays in the water.

TABLE II.

Date	Sunshine in %	Locality	Difference from 0° C.	Air Temp.
Feb. 13th.	100	5 ft. from surface (bottom).	+.0186	+16° Fahr.
"	100	1 ft.from surface.	+.0474	"
"	100	8 in. from surface	+.0741	"
"	100	Shallow current.	+.0461	"
15th.	67	3 ft. from surface.	+.0423	30° Sky clear.
"	67	8 in. from surface.	+.0819	" "
"	67	Just under edge ice.	+.0292	" "
"	67	Deep current....	+.0280	" "
"	67	Bottom of back water, sun clouded.	+.0112	" Cloudy.

On the 13th of February, five feet from the surface, we got a measurement 0.0186 degrees Cent., the air temperature being 16 degrees Fahr.; at two feet it was 0.0474 degrees Cent., although the air just above it was at 16 degrees Fahr. On the fifteenth similar measurements were made. During the time of that measurement, which is the same locality as before, the deep current and quiet water, three feet from the surface, were both 0.0423 degrees. The sun clouded over, and the effect was at once seen in that the temperature had dropped from 0.0423 degrees Cent. to 0.0112 degrees Cent. Now, if the sun had remained cloudy and the air cool the water would have dropped to the freezing point and a little below. The great influence which the sun has in warming the water is illustrated by the fact that anchor ice never forms and river ice never has any serious effects while the sun is shining.

Fig. 3 is a diagram which illustrates the narrow margin of temperature with which we have to deal in river ice formation. The horizontal axis represents the per cent. of ice in the water. On the vertical scale we will put the difference of temperature, plus above and minus below. Starting from the point representing pure water and carrying off a fixed and definite amount of heat per second, we would find that the temperature of the water would drop to about

0.0104 degrees, and ice would immediately commence to form. As the percentage of ice became larger the temperature approaches the true zero degrees Cent. Conversely, suppose we start with 50 degrees of ice, and continuously apply heat to melt the ice, the temperature will rise a little above the freezing point, and as the percentage of ice grows less the temperature rises higher. In the river the condition would be represented by the dotted region. That is, we would never get beyond a certain percentage of ice in the open water. We might get 20 per cent., but not exceeding that in the open water. Here we would find the temperature fluctuating between limits represented by that dotted line depending on the river losing or gaining heat. When the air temperature is sufficient to cause a rapid abstraction of heat the process of freezing goes on, and the temperature falls slightly below the freezing point. The reason for this is probably that ice only crystallizes at a fixed rate. If we abstract heat rapidly enough, and the water cannot freeze rapidly enough to keep the temperature up to the freezing point, the only thing that can happen is that the temperature must drop a little below. When the reverse process takes place, and heat is applied to the mass of water, the ice will not be able to melt fast enough to keep the water cool, and the mass will in consequence be a little above the freezing point. The less the amount of ice present, the more the temperature will rise or the lower the temperature will fall for any given rate of gain or abstraction of heat.

I hope I have made it clear from the diagram that what we have always considered to be a fixed and definite temperature, namely, zero Centigrade, or 32 degree Fahr., is really not absolutely fixed. It varies a little one way or the other, depending upon whether the mixture is receiving heat rapidly or losing it rapidly.

I have made measurements of these differences up to 20 per cent. of ice, and the method I adopted was a simple one. I took a quantity of water and cooled it rapidly by bubbling liquid air through it. This liquid air carried off a definite and regular supply of heat from the water, and the agitation of the water caused fine crystals of ice to form, looking in every way like frazil crystals. Just before they formed the water sank to —0.014 degrees. As soon as the ice began to form the temperature rose rapidly. On adding fine crystals of pure snow to the water to increase the percentage of ice the temperature rose nearer to the freezing point, —0.006 degrees Cent.

Now, as to the rate at which surface ice will form, I would say that we were intending to try some experiments this winter to determine the answer to that question. I have recently examined into the data on the matter, and I think a very simple formula based on mathematical calculation can be obtained to represent the rate at which ice will thicken; and I should like this to be tested experimentally some time, and so put on a firm basis. But we can write this expression here as connecting the time T at which ice will grow with the thickness. We find that

$$T = \frac{Lsd}{K\theta}\left(1 + \frac{d}{2}\right)$$

where $L =$ latent heat in calories (8.0); $s =$ density of ice (0.9166); K is thermal conductivity (0.0057 cal. per square centimeter per sec. per deg. diff.); $\theta =$ temperature difference between ice at 32 degrees and the air temperature; d is the thickness of the ice sheet in centimeters, which will grow in a time T seconds.

This gives the thickness of the surface sheet with water temperature at 32 and air temperature 3 degrees below zero Fahr. as 3 feet in 44 days. Starting with water without any ice on it at all it gives a thickness of ice of 3 inches in eight hours. I think in most places this would represent fairly closely the rate of the growth.

I wish now to say something in regard to the measurement of temperature with these electrical thermometers. I have worked for a great many years with them, and I may say that they are capable of the greatest possible refinement. I have here a number of differential thermometers which I used in my experiments and in verifying my conclusions in regard to the natural growth of ice, I used a pair of these differential thermometers reading temperatures to 0.0001 degrees Cent.

An examination of these thermometers will show that they consist of a coil of platinum wire. Their limit of accuracy depends upon the limit which we can measure resistance. When we come to measure hundredths of a degree the mercury thermometer becomes troublesome; when we come to measure thousandths of a degree the mercury thermometer is almost impossible; when we come to measure ten thousandths of a degree we cannot use the mercury thermometer at all. To measure ten thousandths of a degree with platinum thermometers difficulties are, of course, met with. Some observers claim to have obtained measurements to a millionth of a degree. I do not attach much weight to that, because I do not think anybody knows what a millionth of a degree means.

The diagram of connections for the platinum thermometer is shown here (Fig. 4). Two ratio coils, R_1, R_2, one arm with the coil attached, P, together with the necessary leads, a fourth arm containing the compensating leads and balancing resistance, forms the Wheatstone bridge arrangement. The compensating leads are equal in length to the thermometer leads and run side by side with them.

In the differential arrangement, Fig. 5, we have a double set of connections. The compensating leads of thermometer A are connected in series with thermometer B, and the compensating leads for thermometer B are connected in series with thermometer A. Thermometers A and B, forming the differential pair, are connected to opposite arms of the bridge. There is a bridge wire on which small variations

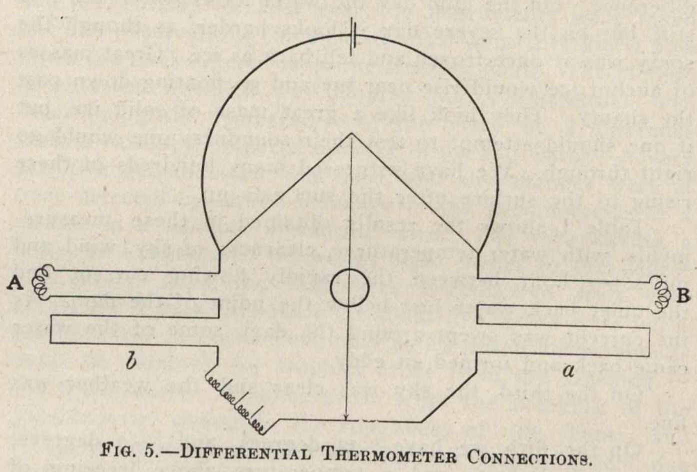


FIG. 5.—DIFFERENTIAL THERMOMETER CONNECTIONS.

can be measured, and if the reading goes beyond the bridge wire compensated resistances may be introduced. In this system we have everything compensated for. We must not have any coil that is going to vary with temperature at all. The coils that are to balance the change of resistance in the thermometer must be compensated. The box which I used was one that had been carefully compensated. There are only two of these in existence. One is owned by Professor Calendar, of London, and the other by myself. Professor Calendar made his and I made mine. I was over a year in making the box, and each coil was separately compensated and placed in the box; and there are a number of such coils, so that took a great deal of time.

The principle of the compensating lead was introduced by Professor Calendar, and renders the readings independent of the length of wire. I am successfully operating a thermometer placed nearly a mile from the place of observation.

Of course the details of construction were worked out carefully, such as placing the coils in lead tubing; everything worked fairly satisfactorily. A very sensitive galvanometer is required. For less accurate work the telephone can be used to replace the galvanometer.

Variations of resistance which determine the temperature are measured on a scale made in any convenient form. The battery is located as shown in the diagram, as is also the galvanometer circuit, or telephone which may be used in place of the galvanometer.

These scales can be graduated in any way that we wish, and they may be made to read with any degree of accuracy.

We can get a degree ten centimeters long or a degree one-tenth inch long. It does not make any difference. The bulb is connected with the wire, which is connected to a direct reading scale connected with a contact piece that slips along the wire. There is nothing to break the circuit for the use of the telephone except the interrupted contact.

The wire of a platinum coil is about 0.006 to 0.007 of an inch in diameter. The wire for the bridge may vary from sixteen thousandths to twenty-five thousandths, or even only ten thousandths of an inch. It depends on the condition.

Evaporation would have quite a considerable influence on the loss of heat and consequent formation of ice, but it is probable that it is small compared to the other agencies at work. At night we have a clear sky, practically free from water vapor, and, therefore, the heat is almost unabsorbed. That is, it passes through the layers of air without any reflection back again. On a cloudy night the rays are reflected back into the water. General calculations can only be made under given conditions. The average heat we receive from the sun is about 0.05 calorie per square centimeter per second.

We know about what the surface of a black body will radiate or how much heat will be given off. Such surface radiation is about 0.0003 calorie per square centimeter per second per degree difference of temperature.

That seems very small, but if you consider what the radiation is from the large surface of a river it seems much greater.

Suppose we make a calculation of how much heat would be radiated at 32 degrees Fahr. to air 0 degrees Fahr. We would find if we applied our calculations that about four and one-half pounds of ice would be formed per square yard per hour. Now, if we consider the radiation from the water surface at night into space at absolute zero, then we would get 80 pounds per square yard per hour formed. So you see how very much greater the radiation would be on a clear night, and what a large proportion of ice would be formed. That is merely by radiation. Of course, these calculations are based on assumptions which very seldom hold rigidly in actual conditions. From the river bottom there would be a smaller proportion of ice formed. We would get an inch of solid ice formed in about six or six and one-half hours.

The effect of pressure has a strong bearing on the question of the state of the ice. The effect of pressure is to lower the freezing point. One hundred and fifty atmospheres lower the freezing point 1 degree Cent. One foot of water-pressure would lower the freezing temperature, then, about 0.0022 degree Cent., which would be about 0.0004 degree Fahr. This means that the undercooled surface layers if submerged deep enough would be at or above their freezing point. The ice crystals which on the surface would stick together from the fact that they were at temperatures below their freezing point would not stick together at a great depth.

Now, the effect of falling water is to generate heat. One foot of fall would raise the temperature 0.00131 degree Fahr., or 0.0007 degree Cent. You see that water falling rapidly would have an important influence in counteracting the slight undercooling. But it would have to fall rapidly to counteract the cooling effect of air at or below the zero point. In the case of water flowing several feet in several hours this effect of heating by fall would be negligible. But if it was falling rapidly over, say, a head of a natural fall it would have an important influence. But it would be much smaller than calculation on account of the amount of mixed air and the exact influences could only be determined by measurement.

ESSENTIAL ELEMENTS IN THE DESIGN OF DAMS.

JOHN S. FIELDING.

(Continued.)

Referring to Fig. 24, the value of the inclination of ac will vary as the area of the triangle abc, which will vary as ab, and with

$$Pr = h^2 \times 31.25 = bc^2 \times 31.25.$$

$$wt = \frac{ab \times bc \times 140}{2}$$

$$\text{Adhesion} = \frac{65}{100}\left\{\frac{ab \times bc \times 140}{2}\right\} = 45.5\ (ab \times bc).$$

For a S. S. F. of 1½, the adhesion will require to be

$$3\left\{\frac{h^2 \times 31.25}{2}\right\} = 46.875\ h^2$$

$$\text{Then ab will} = \frac{46.875\ bc}{45.5} = 1.03\ bc.$$

$$\text{For a S. S. F. of 2, ab will} = \frac{62.5\ bc}{45.5} = 1.373\ bc$$

$$\text{For a S. S. F. of 2½, ab will} = \frac{78.125\ bc}{45.5} = 1.717\ bc.$$

$$\text{For a S. S. F. of 3, ab will} = \frac{93.75}{45.5} = 2.06\ bc.$$

Referring to Fig. 25,

With $Pr. = h^2 \times 31.25$ or $bc \times 31.25$.

$$Wt. = \frac{ab \times bc \times 140}{2} + \frac{ad \times dc \times 62.5}{2}$$

$$\text{Adhesion} = \frac{65}{100}\ Wt. = 65.8125\ (ab \times bc).$$

For a S. S. F.	of 1½	ab	should	equal	.712 bc.
"	"	of 2	"	"	"	.9494 bc.
"	"	of 2½	"	"	"	1.1875 bc.
"	"	of 3	"	"	"	1.4124 bc.

For a rectangular section as Fig. 26, these values will be:

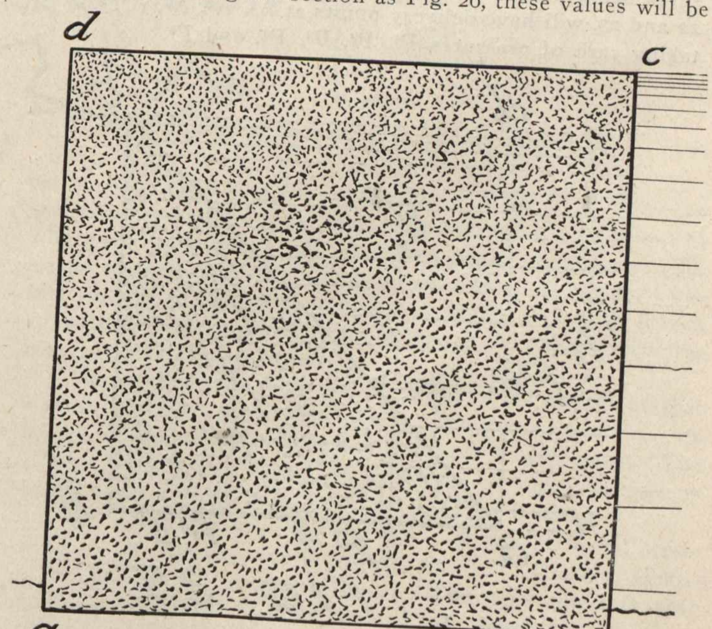


FIG. 26

For S. S. F.	of 1½	ab	should	equal	.5151 bc
"	"	of 2	"	"	"	.686 bc.
"	"	of 2½	"	"	"	.858 bc.
"	"	of 3	"	"	"	1.03 bc.

The fear of making this paper too lengthy impels the omission of the analysis of the variation of the O. S. F., for the foregoing sections. They are easily found, however, by the insertion of above values of ab and bc in the analysis given on page 181, or they may be taken as a simple pro-

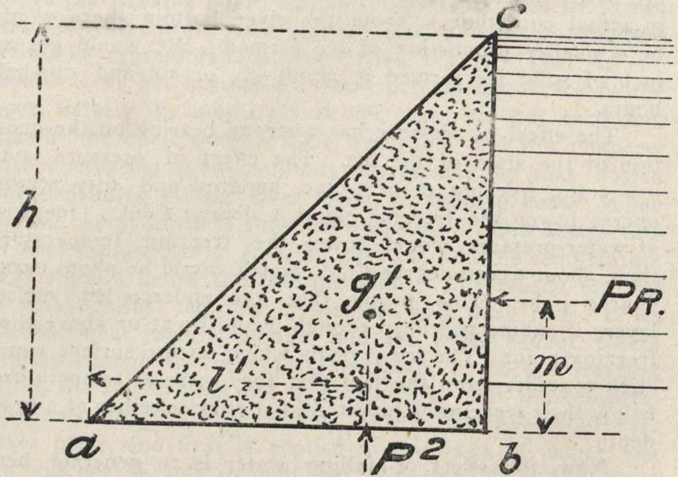


FIG. 24

portion of the varying length of ab used in conjunction with the values of O. S. F. of 4.48 and 4.23, given on page 181. O. S. F. for Fig. 26 with ab = bc will be 6.72.

Then for Fig. 24 O. S. F. would equal $\dfrac{4.48 \times a^1b^1}{ab}$

Then for Fig. 25 O. S. F. would equal $\dfrac{4.23 \times a^1b^1}{ab}$

Then for Fig. 26 O. S. F. would equal $\dfrac{6.72 \times a^1b^1}{ab}$

Whilst giving the foregoing information, for the sake of comparison of the two types of section represented by Figs. 24 and 25, it is not meant to recommend either as ideal sections for a dam, and at the same time the investigation is incomplete without subjecting section Fig. 25 to an analysis similar to that already given to Fig. 22 and Fig. 23, on pages 138 and 139 as follows, viz.:

Referring to Fig. 27. we have the lower portion represented by anb, and the upper portion by ncb. The pressures being assumed to act in 45° lines as assumed in Figs. 22 and 23, will have delivery points at A^1, A^2, A^3, A^4, and A^5, taking care of pressures P^1, P^2, P^3, P^4, and P^5.

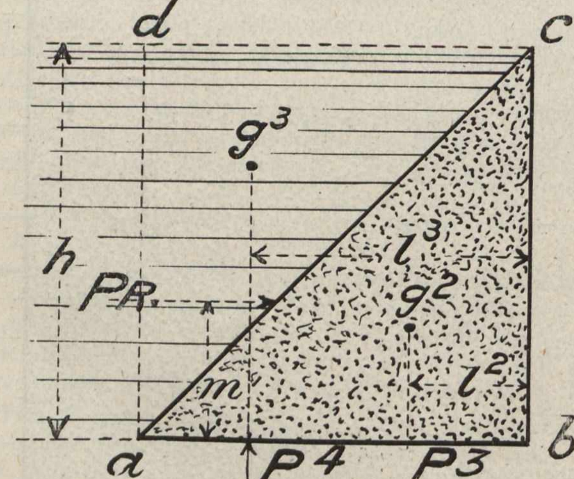


FIG. 25

We can make similar assumptions for decrement of length of col. A^1—P^1, A^5—P^5, to those made on page 138 giving the line an^1.

It will be seen, however, that these values are not cumulative towards the top as we had in Fig. 22, and do not tend to a maximum movement of the crest C from its original position vertically over b.

The security of the portion anb seems to be ample, since it has, independent of nd^1cb, its own weight and the weight of water in the figure add^1n.

The pressures above the line nb must act under different conditions to the pressures below n or nb. Below nb they act directly to ample adhesion on the sub-base at A^1—A^5.

It would seem that ncb must first of all try for shearing strength along the line nb, then try for a fulcrum point at b of sufficient area, then rely upon its weight of mass at g^1 by lever-arm l^1, and its weight of water pressure at g^2 by lever-arm l^2.

Whilst exercising these functions in the line of self-preservation, ncb would not in any degree decrease the strength of anb, even as against sliding, since any wts from g^1 and g^2 that may be lifted off of anb would be deposited again at b, and deposited vertically so as not to set up any horizontal tensile stresses, nor in fact any components whatever.

Any weakness in the adhesion at A^1, A^2, A^3, or A^4, can only set up compressive forces pushing forward horizontally to the excess of adhesion, that would have been deposited at b by the action of the mass ncb and its lever-arms.

This is all in correct line for security, since it places the margin of adhesive strength ahead of the pressure.

ncb would also have a farther factor of strength against overturning in the tensile strength of the fibres $T^1T^2T^x$.

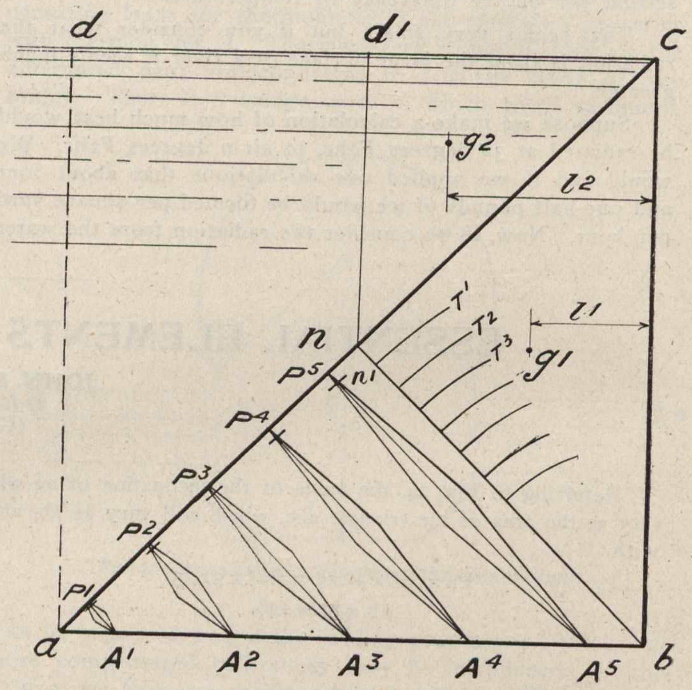


FIG. 27

acting in conjunction with lever arms from their centre to some point b.

Another feature of Fig. 25 is that a much greater depth of flood would be required to eliminate the safety-factors than would be required for Fig. 24.

Case (1).—The horizontal pressure with water-level even with crest would equal $20^2 \times 31.25 = 12{,}500$ lbs., and the adhesion $\dfrac{65}{100}\left(10 \times 62.5 \times 20\right) = \dfrac{65}{100}(12{,}500)$ lbs.

Case (2).—The horizontal pressure with one foot of flood would equal $(21^2 - 1^2)\ 31.25 = 441 - 1 = 440 \times 31.25 = 13{,}750$ lbs.

The adhesion $\dfrac{65}{100}\left(\dfrac{21+1}{2} \times 62.5 \times 20\right) = \dfrac{65}{100}(137{,}507$ lbs.

It can thus be shown that the horizontal pressure per square foot increases as the flood increases in the same ratio as the vertical pressure on the base increases; the adhesion, being dependent upon the assumed maximum coefficient of friction upon the sub-base, will increase in similar degree, but will always be lagging behind the increase in pressure as the coefficient is to 100, or with coefficient of .65, as 65 is to 100.

When this shortage equals the excess strength given to the dam, then the safety factor will be eliminated. In the case of a vertical-faced dam the safety-factor would be eliminated much sooner, viz.; when the increase in pressure from flood equalled the excess strength.

Now, if the length of base of such a dam exceeds the height in the proportion of 100 to 65, then the increase in the adhesion will equal the increase in horizontal pressure from flood, of any height.

Such a dam would have a base 1.538 times the height, giving an angle of inclination of 49°—5[1] for angle dac, Fig. 25.

We could then assume 100 feet of flood over a 20-foot dam, and would have as follows, viz.:—

$$\text{Horizontal pressure} = (120^2 - 100^2)\ 31.25 = 137{,}500 \text{ lbs.}$$

$$\text{Vertical pressure} = \frac{120 + 100}{2} \times 62.5\ (20 \times 1.538) = 211{,}475 \text{ lbs.}$$

$$\text{Adhesion} = \frac{65}{100} = \text{vertical pressure} = 137{,}500 \text{ lbs.}$$

Figures have been given for a vertical-faced dam on page 90, showing floods of 2.80 ft., 4.50 ft., and 8.28 ft., eliminating safety-factors (S. S F.) of 1.3, 1.5, and 2.0 respectively, so that this analysis shows Fig. 25 to have a decided advantage in this respect also.

(To be Continued).

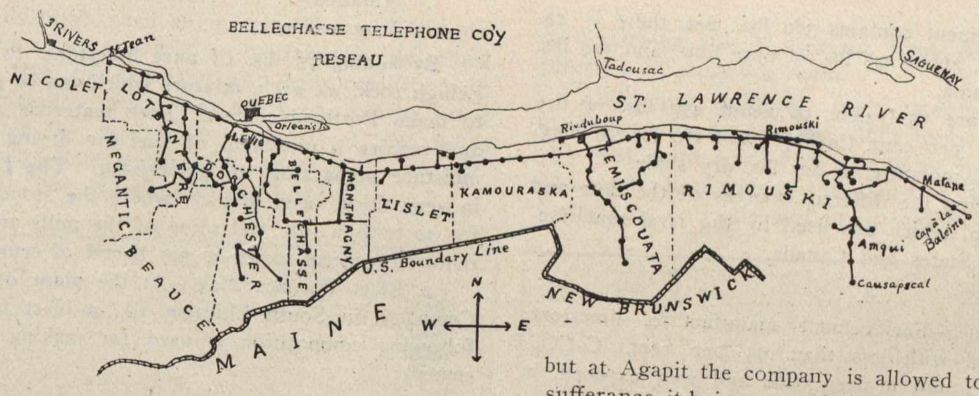
THE BELLECHASSE TELEPHONE COMPANY.

Seven years ago, Dr. J. F. Demers was practising medicine in Ste. Octave de Metis, in Matane County, Quebec. In connection with his professional duties he found that he needed telephone communication with a neighboring parish, and so he built a private line. The same year he wanted connection with a fellow-practitioner who lived in Ste. Flavie, and he and some others got together and organized a company to construct the line. They obtained incorporation with an authorized capital of $2,500, the corporation being known as the Metis Telephone Co. By the end of the first year, it was found that the money was all spent, but the company was doing a nice business, so the capital was increased to $7,500, and lines were built to Matane and Rimouski. At Rimouski there was a local exchange of 33 subscribers, operated by the Bell Telephone Co., which was bought by the Metis Co. for $2,000. About the same time the company built from Rimouski to Bic, a distance of ten miles, and they had thoughts of extending to Levis, but the necessary capital was not to hand. They discovered, however, that there was a company in Bellechasse County which had all the powers and authorized capital desired, but a poor equipment, so they were approached and their charter purchased, the name, Bellechasse Telephone Co., being now assumed by throughout the county. The business among farmers was started just last year, but it is expected that within three or four years 50 per cent. of the farmers will take telephones at this rate. The other rates are arranged according to the privileges afforded. Thus, $20 is charged in towns where the instruments are of long-distance construction and the service is continuous. $25 is the rate for a large concern which would call for frequent service.

The lines are constructed of copper, 346 pounds to the mile. The instruments are purchased in the United States, none suitable being manufactured in Canada. Exchanges are manual. There are between 65 and 70 switchboards, the largest accommodating 200 subscribers. The attendants are paid on a co-operative plan, receiving 10 per cent. on subscribers and 20 per cent. on tolls.

Long-distance rates are very low compared with Bell standards. For instance, between Levis and Rivière du Loup the Bell rate is 60 cents for three minutes' conversation, while the Bellechasse rate is 25 cents for five minutes.

Connection is had with the stations of the Intercolonial Railway and with those of the Quebec Central. The Grand Trunk refused to allow a telephone in their station at Levis,



Dr. Demers' corporation. This was in 1900, and was about the time that the enterprising manager retired from the medical profession to devote himself exclusively to the telephone business. The company extended the fifty miles of single wire which comprised the old company's line, and connections were extended to Levis and the surrounding country, as well as eastward to the lines of the original Metis Co.

From these beginnings has sprung the system shown in the accompanying map. The main trunk line extends from Cap à la Baleine, in Matane County, on the east of St. Jean des Chaillons, in Lotbinière County, on the west. Lateral lines run southerly, as shown, towards the New Brunswick and Maine boundaries, the total length of pole line being about 1,200 miles. There are at present 1,300 subscribers in the system, and the subscribers' directory shows telephones in eighty-eight localities. Excepting Levis, Montmagny, Riviere du Loup, and Rimouski, the system is practically rural. The population of the territory covered is about 350,000. Rates are from $12 to $25. Farmers' telephones are constructed along the pole line in four party groups at an annual rental of $12, this giving connections

but at Agapit the company is allowed to instal a telephone on sufferance, it being agreed that the telephone is to be removed whenever the Grand Trunk so orders, which, it is understood, means whenever the Bell Company so orders. No attempt has been made to get business connections with the Bell lines, though an offer was made by the Bell Company in 1900, which the company could not entertain.

The company has been so successful in its operations that a seven per cent. dividend has been paid every year since its inception, and this year fourteen per cent. is anticipated. The charter authorizes a capital of $1,000,000, of which $200,000 is paid up. The company has no debts and no bonds.

The officers of the company are: Georges Demers, president; A. B. Depuis, vice-president; Dr. J. F. Demers, secretary-treasurer and general manager. The other directors are: Georges Tanguay, M.P.P.; Rev. J. H. Frechette, Narcisse Rioux, John McWilliams, J. H. Ross, M.D.; Edouard Couture, and Etienne Dussault.

Dr. Demers says the telephone business is more profitable than medicine, and the fact that he is connected with not only one, but four, telephone companies, seems to indicate that he has gone into his new line in earnest. Besides being manager of the Bellechasse Co., he holds a similar position in the St.

Maurice Telephone Co., operating between Three Rivers and Shawinigan, and the Portneuf Telephone Co., besides being the authorized agent of the Beauce Telephone Co.

As to the ideal telephone management, Dr. Demers agrees with many others, who have studied the question, in strongly advocating the Government ownership and operation of long-distance lines, with local control systems. Government control of rates he does not believe would meet the situation, as this might discourage the building of new lines. Under Government ownership, however, a new line could be opened up just as a post office is opened, regardless of the revenue to be obtained from that particular office, but for the general convenience, with the assurance that the investment will pay for itself in the long run. From his experience, Dr. Demers says farmers appreciate the telephone, and they should have this convenience at a rate of $12 or less. Government ownership of the trunk lines should greatly stimulate the telephone business, especially in the country, as subscribers would then be assured of connection with the whole country, rather than with a few counties.

THE PORTLAND CEMENT INDUSTRY IN CANADA.

JAMES WALKER AND MORRIS M. GREEN.

Second Article.

When Canadian cement manufacturers are undersold by American rivals in their own market, as has happened recently in Hamilton, they must naturally reflect deeply as to the why and wherefore. People in the United States are not making cement for amusement, and if they secure Canadian trade, it might be inferred that their action was based on a cheaper cost of production. We shall, therefore, in this article, call attention to certain conditions affecting the cost of Portland cement in both countries. Portland cement, chemically speaking, is a double silicate of alumina and lime, of approximately the following composition.

	Per Cent.
Silica	20 to 23
Alumina	6 to 10
Lime	60 to 65

We will take the following as a fair illustration of an American cement:

	Per Cent.
Silica	22
Alumina and iron	9.4
Lime	64.50

As a barrel of cement contains 380 lbs., net, there is required to produce this, about 245 lbs. of pure lime, and 120 lbs. of dry silica and alumina.

These quantities are equivalent to about 450 lbs. of dry limestone or marl (95 per cent. $CaCO_3$), and 150 lbs. of clay, containing 20 per cent. moisture, or 125 lbs. dry shale.

We will now discuss the different sources of the lime and the alumina and silica, which are used by the rival manufacturers in the United States and Canada.

A.

1. Pure Limestone.—For cement manufacture, limestone is not generally used with less than 95 per cent. $CaCO_3$. Where the stone is found in deep beds and well exposed, it may be quarried in lumps of 6-in. size for about 40c. a ton. Limestone does not contain over 2 per cent. of moisture, ordinarily, and, while it must be dried preparatory to fine grinding, the cost is insignificant.

2. Pure Marl.—Marl of 95% $CaCO_3$, or better, is found in abundance in the United States and Canada. Its relative merits and demerits may be expressed as follows:

Merits.—1. Granular form, requiring less pulverizing than stone.

2. Cheap excavating cost. At the Omega Cement Co.'s plant, Jonesville, Mich., a cubic yard, or 3,000 lbs. of wet marl, averaging 60 per cent. moisture, can be dredged and taken to the 500-barrel cement mill, close at hand, for 6c. a cub. yard. As one cub. yard makes 2½ barrels of cement, we may safely allow 3c. a barrel for excavating cost.

Demerits.—1. Large percentage of moisture, owing to its presence under water in lakes or in low ground, where its porous nature leads to absorption of water. The dryest marl we have ever seen contained 40 per cent. moisture. As will be shown later on, this excess moisture leads to extra cost for fuel, also necessitates extra capital for extra machinery, thereby saddling fixed charges upon cost of cement.

2. Liability to organic impurities, also difficulty of determining where good marl ends and bad begins, with sub-aqueous deposits that are out of sight and not easily examined.

B.

Sources of Silica and Alumina.—1. Shale.—This is generally considered preferable to clay, owing to its lack of moisture. It is also apt to be more homogeneous and less liable to contamination by pebbles and grit.

2. Clay.—Clay usually contains 20 per cent. moisture. This leads to expense in drying, also renders it a sticky, unwieldy material to manipulate.

C.

1. Lehigh Cement Rock.—In the Lehigh Valley region of Pennsylvania, occur large deposits of an argillaceous limestone, which have made it the greatest cement-manufacturing district in the world, both as regards extent and cheapness of production.

The rock is of the following composition:

	Per Cent.
Calcium carbonate	70.10
Silica	15.05
Alumina	9.02
Iron oxide	1.27

By adding 75 lbs. of pure limestone to 500 lbs. of this Lehigh rock, we get a mixture which can be ground and burned to make Portland cement. Both materials are practically dry and require a minimum of fuel for drying their content of moisture preparatory to pulverizing. The Lehigh rock occurs in very thick, open breasts, where the stone can be taken out for 30 cents a ton, and some of the mills are immensely large, reducing general expenses per barrel of cement to a minimum.

2. Blast Furnace Slag.—At the plant of the Illinois Steel Company, in South Chicago, Ill., a blast furnace slag of the following composition is used for making excellent Portland cement:

Dry Slag:

	Per Cent.
SiO_2	34
Al_2O_3	12 to 13
CaO	48
MgO	3

The granulated slag contains 20 per cent. moisture.

For a barrel of cement, there are needed 200 lbs. of limestone and 350 lbs. of undried slag. After drying the slag, we need only 280 lbs. of dry slag granulated and 200 pounds of limestone, or a total of 480 pounds only of material per barrel of cement. Of this 480 pounds, 280 pounds occur as material already granulated, therefore implying a saving in pulverizing.

The following table will show the relative consumption of coal per barrel of cement in rotary kilns, using dry and wet feeds; also the output of the kiln in barrels of cement:

	Lbs. Coal per Bbl. of Cement.	Output of Kiln per Diem.
Dry mix,	120	200
Slurry, 40 per cent. moisture	160	125
Slurry, 60 per cent.	200	100

In a dry process kiln, enough waste heat passes off to dry 30 per cent. moisture in the feed. With careful work, some marls when mixed with dried pulverized clay, will give a slurry containing not over 40 per cent. moisture, which can be pumped into a kiln.

At its best, however, it can be seen that a marl cement plant takes 25 per cent. more kiln fuel and has only 62½ per cent. of the capacity per kiln of a cement plant using a dry mixture of limestone and shale. In a dry process kiln, the waste gases pass off at a temperature of 1,900 deg. F. One American plant passes such hot gases from two kilns into a waste heat boiler. In this boiler the gases generate 300-h.p., being reduced to 600 deg. F., thence passing through an economizer by induced draft, and heating feed-water to boilers. The boilers are supplemented by coal with hand firing.

These two kilns each turn out 250 barrels per diem, using 120 lbs. of coal per barrel.

As the motive power allowed for cement mills is usually 1-h.p. per diem for each barrel of output, equivalent to 70 lbs. of coal, it is evident that this method of saving waste allows cement to be made with 30 pounds of boiler coal and 120 lbs. kiln coal. The following table shows coal required for drying raw materials, for kilns, and for boilers, using different materials:

	Drying Fuel. Lbs.	Kiln Fuel. Lbs.	Boiler. Fuel. Lbs.	Total. Lbs.	Remarks.
Limestone and shale	5	120	70	195	Waste heat not recovered.
Limestone and shale	5	120	30	155	Waste heat recovered.
Limestone and clay..	10	120	70	200	Waste heat not recovered.
Limestone and clay..	10	120	30	160	Waste heat recovered.
Marl and clay slurry, 60% moisture	5	200	70	275	Waste heat not recovered.
Marl and clay slurry, 40% moisture	5	160	70	235	Waste heat recovered.

Equipment and Process of Canadian Cement Plants.

The cement industry in Canada originated with marl and clay as raw materials. Some of the plants installed drying plants for the marl. This, while it increased the capacity of the rotary kilns, led to a very high consumption of coal, as well as large outlay of machinery and labor for drying the marl.

Some of these Canadian marl plants also freight their marl from a deposit to a mill. Paying freight on the water in the marl is an expensive business. Also clay is hauled some distance to the mills. Clay cannot be excavated cheaply in small quantities; adding freight on 150 pounds per barrel of cement increases the cost. There being no coal in Canada between Nova Scotia and the Rockies, Ontario cement mills must import American coal, paying a tariff upon it. Many of the Ontario mills have been placed in rural districts, remote from their best market, and at the mercy of a single railroad line.

It can be said that most Canadian mills use too much coal, for which they pay much higher prices than their American competitors.

Their mills are too small to make cement economically, and are handicapped by long hauls to markets. It is unfortunate that the Canadian cement industry did not originate with large mills using limestone, instead of the present large number of small mills using marl. It is gratifying to note that one large mill using limestone has recently been built, also that blast furnace slag will be used for Portland cement manufacture in Nova Scotia. With proper management the latter cannot fail to be a success and a source of pride to Canadians.

NEW BOILER WORKS OF GOLDIE & McCULLOCH CO., Limited, GALT, ONT.

Among the old-established engineering firms of Canada, none have earned a better right to be laudably described as "enterprising" than the company who have recently built a fine new boiler-making plant near the banks of the River Grand, just outside the north-east boundary of the rising town of Galt, whose 9,000 inhabitants speak of it with pardonable pride, as "The Manchester of Ontario."

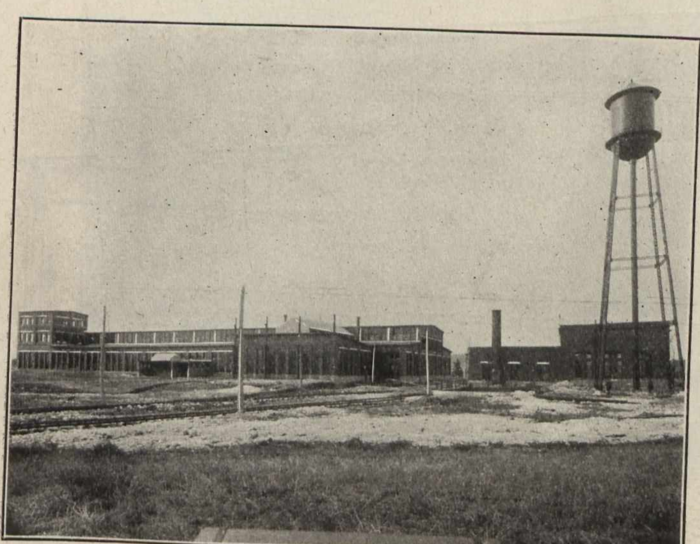


Fig. 1—General Side View of Plant.

After a personal visit to the new works, and close inspection of every department, we can say deliberately, that if their advertising fearlessness and business-seeking energy is equal to their wise policy of specialization and capacity for adapting means to ends, as manifested in the design and equipment of the well-planned shops we now have pleasure in describing and illustrating, then assuredly, a prosperous future is in store for them.

In keeping with the best modern practice, they have located, as far as possible, their tools and appliances under one roof, with a view of taking in rough material at one end, and discharging the finished article at the other. Everything is made and fitted in logical order.

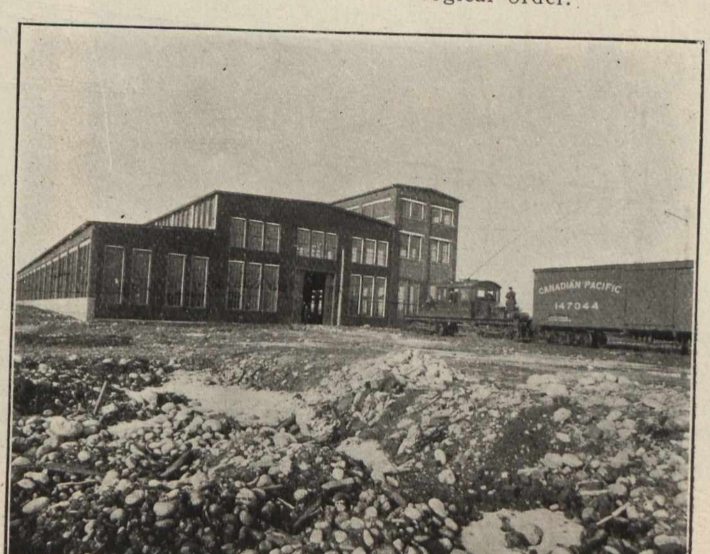


Fig. 2—End View of Plant.

The main building is 308 feet long, consisting of a middle bay, 60 feet wide, and two wings 30 feet wide, making a total width of 120 ft., and which, along with the Power House, were erected by G. B. Loomis & Sons, Montreal. Standing in the 14-ft. doorway, we get a perspective view of the interior, which is certainly pleasing to the trained eye of the travelled engineer. A better lighted shop it would be difficult to imagine; in fact, the lack of definition in the photographic views is due to the almost excessive light, which streams into the building through sides, ends and roof; while the air of orderly arrangement, up-to-date tools, large and small, and general commodiousness, impresses one with a sense of entire adaptability and completeness.

trucks. And we found installed within the stores two powerful hydraulic machines, viz., a splitting shear for one-inch plates on one side, and a compound bar and angle shear on the other, both made by R. D. Wood, of Philadelphia.

The provision of these machines is a typical example of the foresight and economy which characterizes the whole plant; for plates, bars, and angles can be delivered to the workmen of the precise lengths called for by requisition, thus saving the double handling of material, and localizing

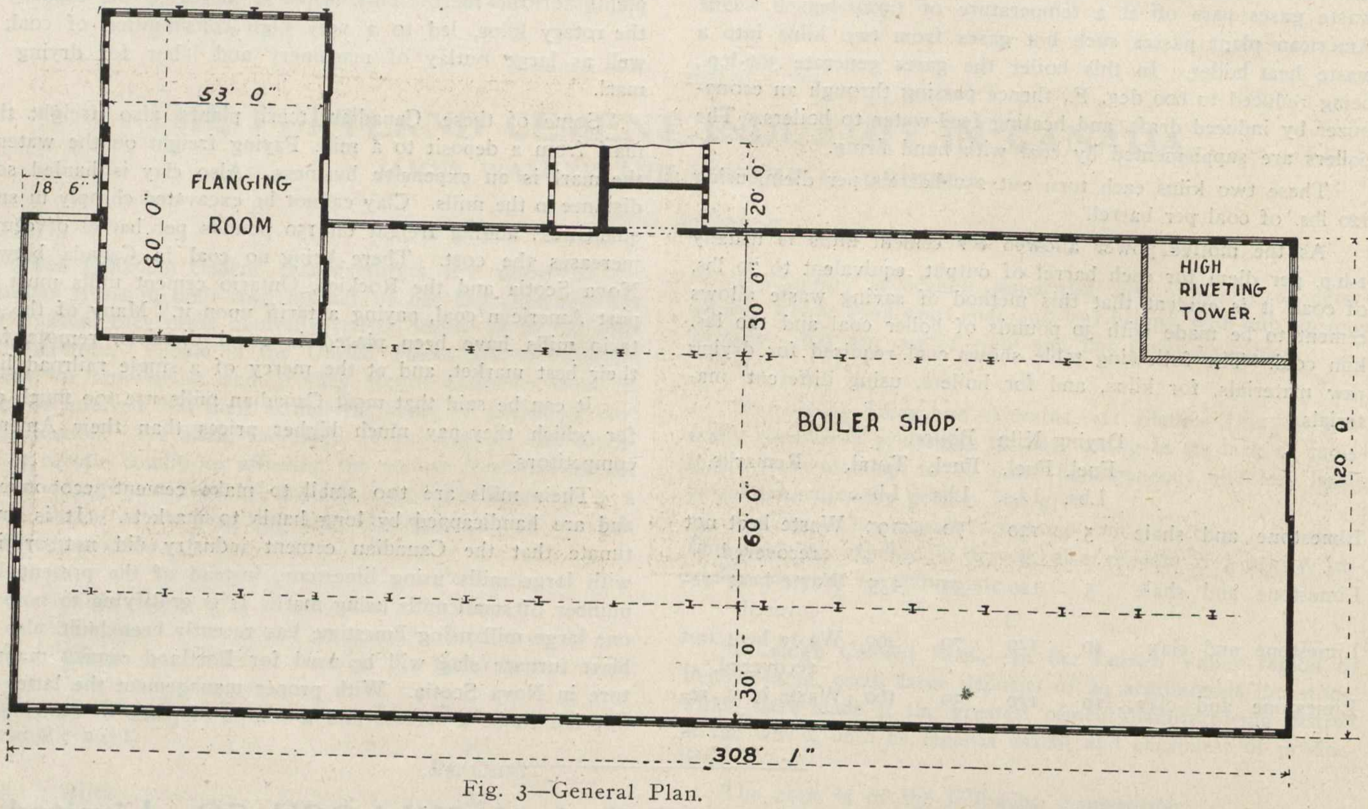


Fig. 3—General Plan.

A standard double railroad track runs through the centre of the shop, above which travels a 30-ton "Morgan" electric crane, having 25 feet lift, so that a boiler can be picked up at one end and carried over 300 feet to the other. In the north-east bay are four, and in the south-west bay are five, hand-power cranes, each fitted with three-ton Yale & Towne "Triplex" hoisting blocks; and these travel the whole length, whilst the conveyance of material from the semi-detached forge at the north corner is effected by

the scrap. This conveniently arranged Stores Department is undoubtedly a model of its kind.

In the south-west wing is a large, side, plate planing machine, 26 feet long, made by J. Bertram & Sons, Dundas, Ont. On this modern tool anything can be planed up to five inches thick. It is electrically driven. In close proximity are three useful hydraulic machines, made by R. D. Wood Co., Philadelphia, viz., vertical punch, vertical shear, and horizontal plate and bar punch; maximum capa-

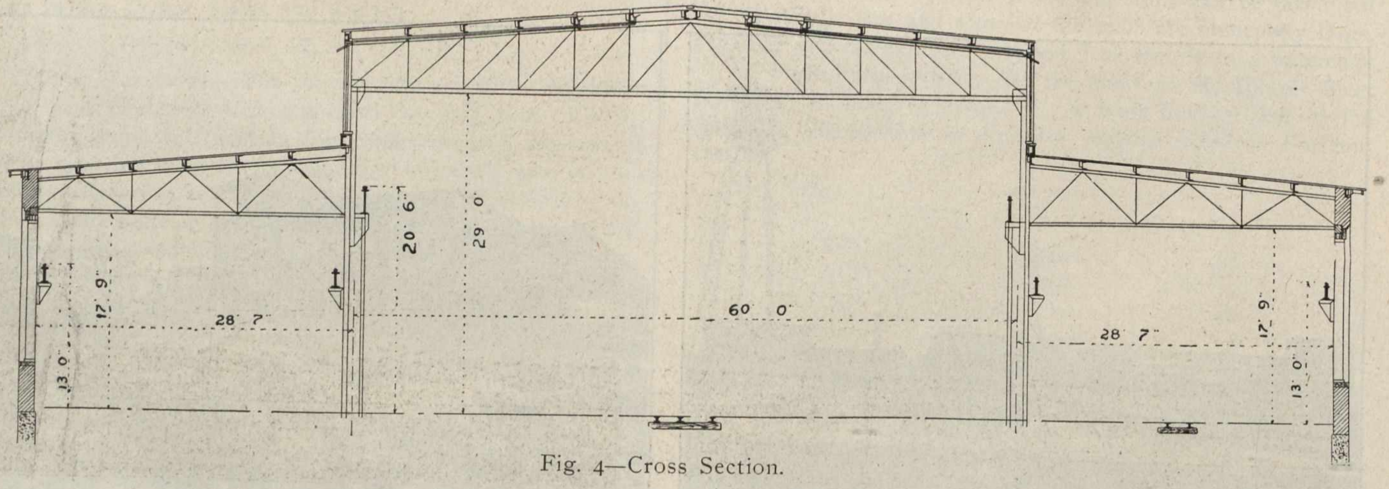


Fig. 4—Cross Section.

means of a narrow gauge track, with turntables and light ball-bearing trucks. In Fig. 2 a yard locomotive is shown hauling a C.P.R. freight truck into the main building. Thus, general transportation is provided for adequately.

About 117 feet of the north-west end is railed off, and reserved as a general store department. Here, in stacks, racks, and bins, are stocked in systematic order plates, sheets, flanged ends, flue tubes, angles, bars, rivets, bolts, etc., all under the middle bay and side wing travelling cranes, or, within easy reach of the narrow gauge floor

city, 1¼-inch plates and 1¼-inch holes. In the southern corner of this wing we found two ingenious machines, made by Goldie & McCulloch Co., i.e., adjustable vertical drills, each spindle having four cutters, for drilling tube holes in flanged end plates for boilers. Nearby, on the first column of middle bay, is a nine-feet triplex, vertical roll, for half-inch plates, also made by themselves. An additional appliance of this type is in course of construction.

Another section of considerable interest is the high rivetting Tower at the eastern corner, which has a floor space of 36 feet by 30 feet. The tower is provided with a 20-ton, overhead travelling crane, for progressive boiler shell hoisting, having a vertical lift of 35 feet, together with a three-ton air hoist at the inner end, used for minor work done on the smaller rivetter. This department is equipped with a powerful vertical hydraulic rivetter, made by the Chambersburg Engineering Co., Pennsylvania; also a smaller one; and a coke-fired Rivet Heater, made by the Kenworthy Engine and Construction Co., of Waterbury, Conn., U.S.A.

Starting from the rivetting Tower along the north-east

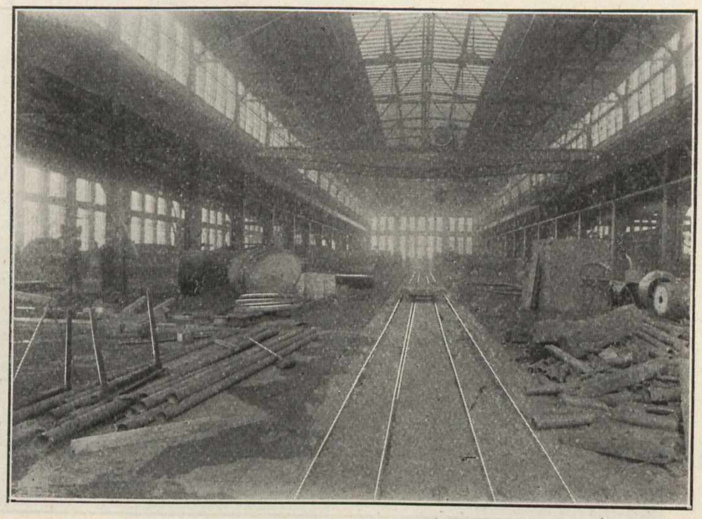


Fig. 5—Interior.

wing, we perceived a pipe-cutting machine—maximum capacity, three inches—made by the Cox & Sons Co., Bridgetown, N.J.; a Swing Grinder, of their own construction; two one-inch drill presses; a light sheet Shear; two smaller Punching Machines, and a set of light Bending Rolls (Fig. 8), the latter manufactured by Bertram & Sons Co. These minor machines are all belt-driven from wall shafting as illustrated in Fig. 8. In an alcove, midway down this wing, are workmen's closets, etc., of modern design, and kept scrupulously clean.

Following the narrow gauge track, we pass into the Forge, or Flanging Room Annex, 80 feet by 30 feet, at western corner of main building. The most prominent appliance is the Hydraulic Flanging Machine, made by R. D. Wood Co., Philadelphia, capable of forming flanged

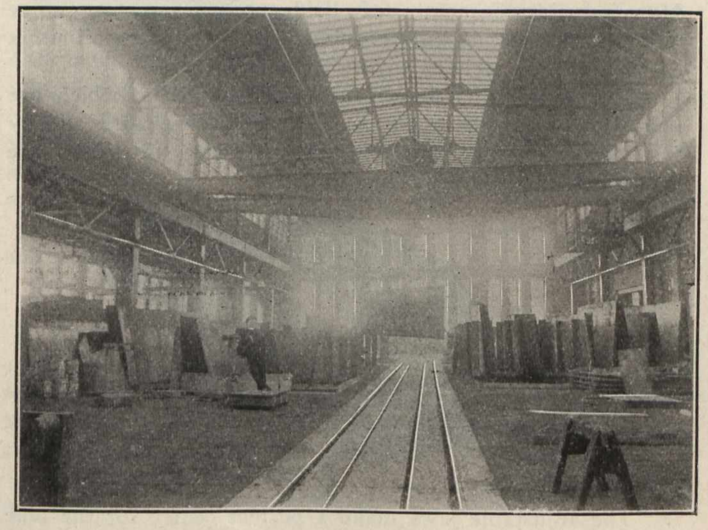


Fig. 6—Stores.

boiler ends 73 in. dia. by 9-16 in. thick at one operation. Scattered here and there along the walls, or conveniently adjoining special tools, are smith's fires and forges of the most approved recent type, all connected to exhaust flues: hence, the place is always free from smoke. A comparatively large Heating Furnace, made by Kenworthy Engineering Co., with down-draft flues, is located near the Flanging Press. On the opposite side of the Annex is a machine for scarfing and welding tubes.

But the appliance which had special attraction for us, was the Tube Rumbling Machine, 40 inches diameter by twenty feet long, for cleaning tubes prior to welding. This machine is manufactured by Goldie & McCulloch, and is manifestly a simple, efficient, labor-saving device. A Tube Annealing Furnace; series of Steam Hammers; Overhead Trolley Track, fitted with "Triplex" Hoisting Blocks; narrow gauge floor track, with ball-bearing trucks, one having revolving top, and portable shear fixed thereon, etc., completes the up-to-date equipment of this important department of the plant.

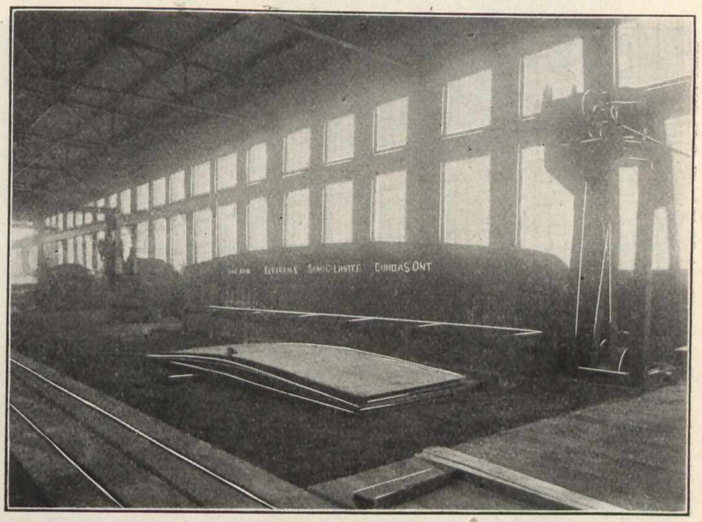


Fig. 7—Large Plate Planing Machine.

Having described the workshops and their equipment, we now come to the Power House, where the Steam, Electric, Hydraulic and Pneumatic energy for driving the various machines and appliances, is generated and developed.

The Power House is situated at the north-west end of the main building, in tandem with the Forge. That the Engines, Compressors, and Pumping Machinery, with their auxiliary parts, have been laid out with economy and skill is quite evident; but they appeared to the writer somewhat crowded.

The main driving of the plant is done by a 9 x 16 x 12 in. Goldie & McCulloch, "Ideal" Tandem, tandem compound, steam engine, working at 125 lbs. steam, 275 revs. per minute, and direct connected to a 75 h.p. Canadian General Electric Generator.

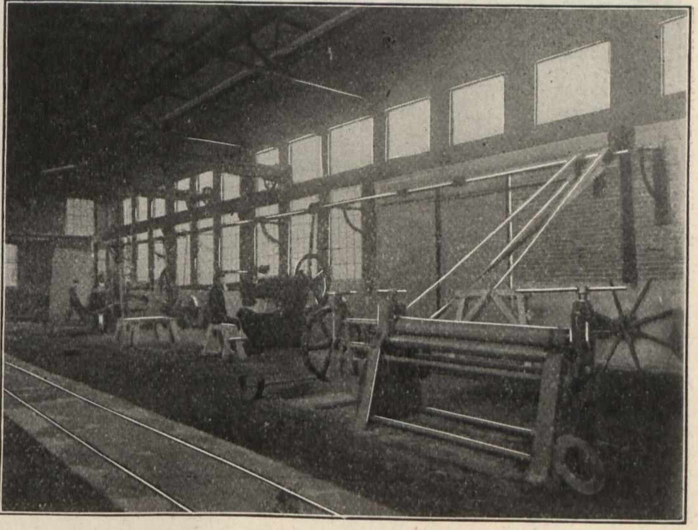


Fig. 8—Small Rolls.

Parallel to the "Ideal" Engine, on the opposite side of the building, is the air compressor, made by the Canadian Rand Drill Co., Sherbrooke, Quebec, with cross compound steam cylinders, 10 x 18 x 16 in. and 10 x 16 in. air cylinders, making 80 revs. per minute, and giving a pressure of 25 lbs. in the intercooler, and 100 lbs. in tank, operating the pneumatic rivetters, caulking machines, etc., in the middle bay. In the corner diagonally to the Compressors, is a 75 ton Hydraulic Accumulator, developing a water pressure of 1,600 lbs. per square inch, for service to the hydraulic machines throughout the shops, etc., while in the corner behind the Steam Engine is located the excellent Hot Water System, invented by Evans-Almirall & Co., of New York, by which a proper temperature in the buildings is maintained by means of exhaust steam, with a vacuum ranging from 25 to 15 ins. From this compact Water Heater starts, in a winter's mornng, hot water at a temperature of 80 degrees or more, which circulates throughout the network of piping which lines the

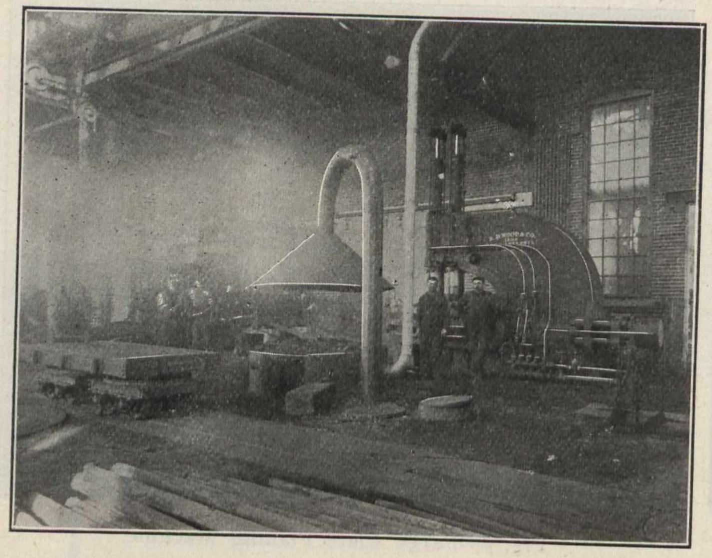


Fig. 9—Forge.

lower part of the walls everywhere, and quickly the general temperature of the shops is 65 degrees. Should the necessary opening of the main doors reduce the general temperature below the normal 65 degrees, the engineer can, by manipulation at the Boiler and Water Heater End, raise the temperature throughout the shops ten degrees in less than twenty minutes! An altogether admirable system of warming factories and workshops! All the Engines and appliances we have been describing are on the ground floor. We next descend to the basement, and first of all, run up against a vertical

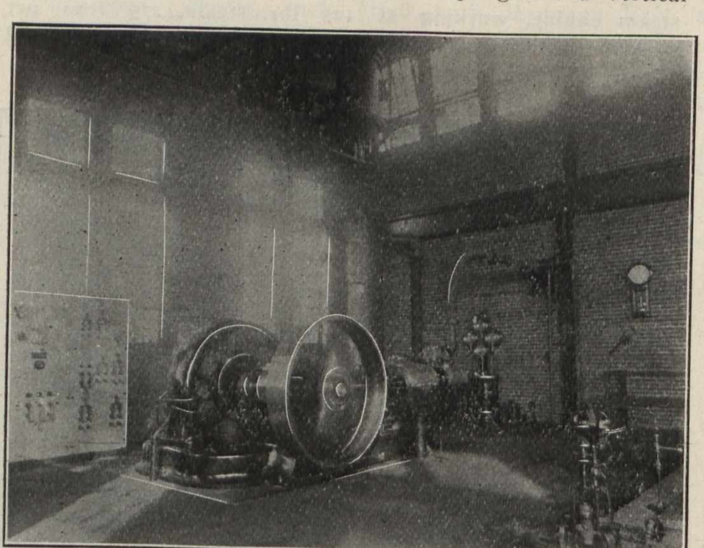


Fig. 10—Engine House.

cold water Reservoir, which receives its supplies from a drinking water well in the corner, 6 in. diameter by 200 feet deep. This water is pumped into the said reservoir (also the large tank outside) by a compressed air pump and to Water Tower (pictured on Fig. 1) by means of an Underwriter Fire Pump, 18 in. by 10 in. by 12 in., with a capacity of 1,000 gallons per minute, at 70 revs., made by the Canada Foundry Co. Next is a Moffat Patent Feed Water Heater and Purifier, manufactured by Goldie & McCulloch, which has only to be used in any steam plant to be appreciated. After examining the 8 in. by 14 in. by 12 in. Air Pump and Jet Condenser, made also by Goldie & McCulloch, our attention was directed to an imposing, and well-finished Hydraulic Pump, 14 in. by 22 in. by 4 in. by 16 in., made at the Snow Steam Pump Works, Buffalo, N.Y. But not the least attractive object lesson in these subterranean vaults was the miniature Water Turbine, 10 h.p., 2,400 revs., made by Greenwood & Batley, Limited, Leeds, England, a cunningly designed, finely and effective piece of mechanism.

The last thing which engaged our attention was the Steam Generating System. This consisted of two 84 in. by 18 feet Return Tubular Boilers, each 200 h.p., hand-fired, and artificial draft, induced by a Sheldon & Sheldon

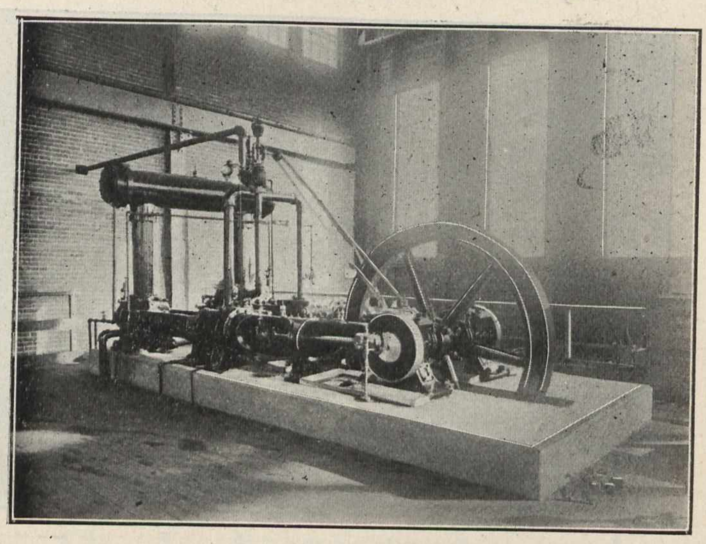


Fig. 11—Compressors.

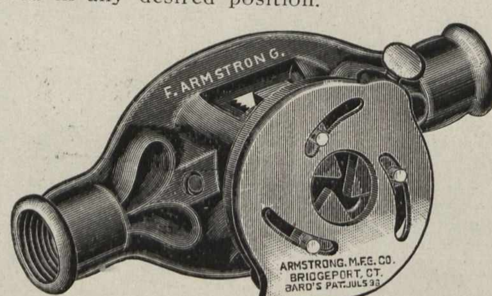
7 ft. Fan, driven by a 6 in. by 6 in. Goldie & McCulloch "Ideal" Steam Engine.

In saying this, we are not unmindful that the Works we have been describing have not reached finality; but even as it stands, is a plant of which any firm can be justly proud. The Goldie & McCulloch Co. are to be congratulated on having set before the engineers of Canada, an object lesson in workshop design, worthy of attention. The startling fact that the tools, machines and appliances installed in this modern plant have been bought wherever the best could be found is a cheering sign of the times.

BARD ADJUSTABLE BUSHING.

The Bard adjustable bushing made by the Armstrong Manufacturing Company, of Bridgeport, Conn., has some new features which will recommend it at once to all users of bushings, as well as to the trade in general.

This bushing is fitted with hardened jaws, which are moved to and from centre by means of a cam plate, and by fastening the plate with the thumb screw the jaws are firmly held in any desired position.



The adjustable jaws make a perfect centre for the pipe or rod, fit closely around the same, and ensure the cutting of a straight thread. When necessary a crooked or drunken thread can be cut with this bushing as easily as with a ring bushing.

When once attached to the die stock it can always remain there. It does away with the necessity of carrying a number of loose ring bushings, and saves the time now lost in hunting for, and changing the bushing for each size of pipe.

No more winding tin or paper around pipe or rod.

This adjustable bushing can be furnished to fit the genuine Armstrong stocks and dies, Nos. 1, 2, 2½ and 3.

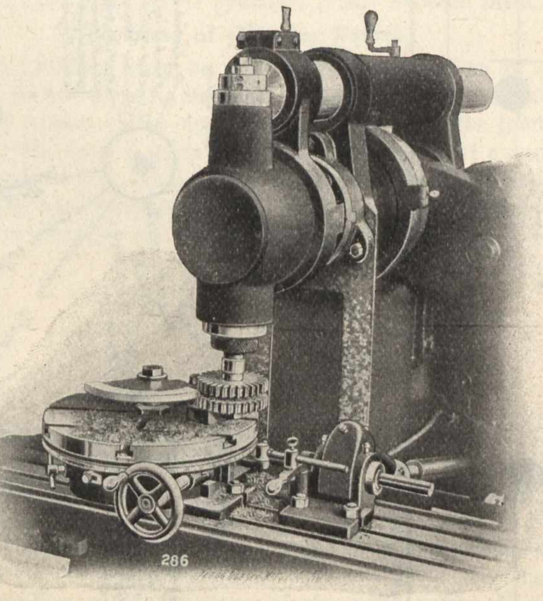
MACHINE SHOP NOTES FROM THE STATES.

By CHARLES S. GINGRICH. M.E.

XVII.

The accompanying illustration shows a job of machining, which is of more than ordinary interest, not only because of the rate at which it is done, but also because of the methods employed.

The work to be finished consists of about one-third of a cast-iron disk 13⅛″ diameter, and 7-16″ thick, and is finished about its periphery, and for a distance of about 1″ on both faces. It is the sort of job that one usually puts on a lathe. The illustration shows how it is done on a "Cincinnati" Miller, fitted with vertical and circular attachments. The cutters are 3″ and 6″ diameter, run about 45 revolutions per minute, removing about 1-16″ metal all around, and the total time for finishing the job takes just about 11½ minutes, including chucking, and the pieces are, of course, accurate as to size and entirely interchangeable. The advantages of this method of doing the work, are at once apparent, and it does not require a special machine, but is done on a standard miller fitted with standard attachments.

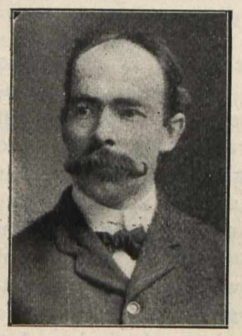


SYSTEM FOR INDUSTRIAL ESTABLISHMENTS.

By A. J. LAVOIE.

(Copyright.)

Science has been defined as "systematized knowledge." I propose, in a series of graphically illustrated articles, to set forth with the exactitude of science, experiences and knowledge gathered at the Accountant's desk, in the Engineer's Office, in the Storeroom, and, above all, by actual work on the pattern shop bench, machine shop tools, foundry floor, blacksmith's forge, etc. In these days of specialization, division of labor, and keen competition, everyone responsible for the good management of factories and workshops, perceives the necessity of system; and this universal want has evoked a number of fancy schemes for organizing factories and cost systems—mostly written by office desk amateurs, and consequently doomed to go into the waste paper basket; since they are altogether too complex, complicated, and provocative of profanity by their impracticability. In Engineering, simplicity is the secret of success. Any tyro can design a complicated machine, but it soon finds its way to the scrap pile.



An efficient system, must be clear, simple, economical, and elastic.

Clear.

A system to be clear, must consist of as few forms as possible; and each form complete in itself. The respective forms must be similar in arrangement, to facilitate quick finding on the one hand, and to avoid unnecessary searching and useless reading on the other.

A factory consists of various shops and office departments. In preparing an industrial system, therefore, it was necessary to collect and organize all the conceivable departments in a modern workshop or factory under one comprehensive plan, as indicated on Chart, Fig. 59.

The respective departments are independent of each other; hence, it is possible to add or cancel any one of them without changing the general system.

An important feature of this system is, that each department is represented by one distinct color and number; i.e., all time cards, cost cards, note pads, etc., relating to a particular department or section thereof, are of the same color, and bear the same departmental number; so that the seeker has three things by which to identify the cards of any particular department, viz., color, name, and number.

After becoming accustomed to the respective colors which differentiate one department from another, the receiver of a time card, cost card, or superintendent's notice, perceives at a glance what department it is from. A like advantage is found when searching for, say, a machine shop cost card, the distinctive color of which is white. You heed not blue, yellow, green, or any other color, but keep your eye on the lookout for white only. To those who have anything to do with the management of a comparatively large manufacturing plant, the advantage of this part of the "Lavoie system" will be manifest; especially in the dividing and assorting of correspondence, or any other data, from the diverse sections of the works. Even supposing you are not familiar with all the colors of the different divisions on the chart, you still have two strings to your bow; for the name of each department and distinctive number of same are legibly stamped on each form issued therefrom. Therefore, it is almost impossible to make mistakes, which is the virtue and reward of a well-carried-out system.

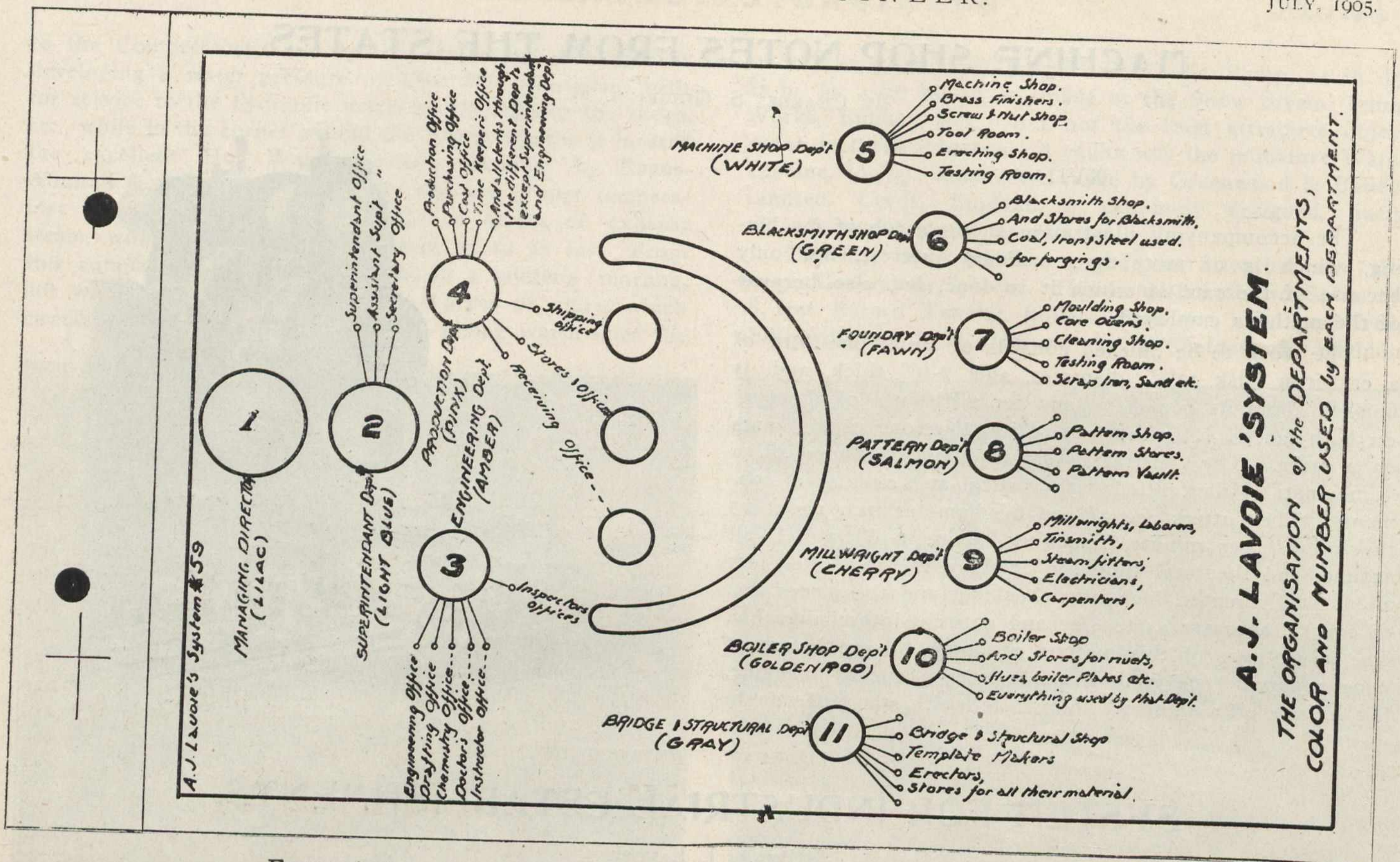
Simple.

All the forms in this system are simple. Everything necessary to aid production of work, and to economize time in the different departments is printed on the form. This printed matter consists mainly of questions, so that the user has only to write answers, which are nearly all figures. And to still further economize time and labor, the forms are printed on both sides, by which there is a considerable saving in the writing of names of articles, weights, time, etc.

Further. All the printing upon these colored cards is done in different colored inks, so that all ink and pencil writing can readily be distinguished from the printing.

All time cards, cost cards, requisitions to stores, etc., are filed together according to Drawing number, under Job number, while the job is in progress of construction.

While a particular job is in progress of construction, it is possible,—if the system has been properly carried out, to give or get, any information desired about drawings, patterns, castings, forgings, finished materials, etc., together with cost of anything made and passed by the inspector. By this practically perfect system of recording, the management is kept in touch with the live work only; all completed jobs being filed away, but always ready for reference.



Economical.

This system is economical, for the cards are in two sizes only.—

(1) Working cards, indexes, and note pads, 3 x 5 in.

(2) Correspondence pads, 6 x 10 in., which, folded, in four, makes 3 x 5 in. also, thus practically reducing the whole filing space to one size, 3 x 5 in.

These forms being so small, each foreman can carry them in his pocket; hence, with his requisition forms on one side and his note pad on the other, he is ever ready to issue requisitions to stores, etc., in any part of the shop he controls. By this plan the foreman has very little writing to do in his office. He is enabled to be more among the benches, the machines, the moulds, or the forges, giving advice, seeing that the work is being properly done, and that the men are adequately provided with drawings, materials, time slips, instruction cards, tools, etc., thus ensuring better work in the shops, and the getting out of work with greater speed and despatch.

Only two sizes of Rodless Cabinets are required, and, as the cards are printed on both sides, the cost of paper is reduced by 50 per cent., and the cabinet space also.

Elastic.

The elasticity of the "Lavoie system" consists in its adaptability to either small or large establishments, and capability of being extended ad infinitum. The general system remains the same, no matter how fast the work comes in or goes out. The filing cabinet will grow as the firm progresses, but the system remains unchanged. In a word, the smooth running of the co-ordinated parts of the system cannot be affected by the addition or subtraction of any part thereof, since every part is complete in itself.

In travelling through a strange country, it is well to have known bounds and landmarks. The foregoing generalized statement of the main features and advantages of the "Lavoie system" will serve, therefore, as a guide to the better understanding of the details and subdivisions which follow. In the endeavor to describe and illustrate the various forms, and methods of handling same, our aim will be to avoid all circumlocution and tedious minutiæ of detail, setting forth only those things which we deem essential to a clear and lucid understanding of the system as a whole. Each form will be explained in logical order, commencing with the Sales Department estimate, and taking in every detail, until the article is manufactured, inspected, shipped, and accepted by the customer.

(To be continued.)

EXTRACTS FROM AN ENGINEER'S NOTE BOOK.

Hints on Design.

A few days ago I listened to a venerable speaker at the Institution of Mechanical Engineers, who was discussing the report of the Steam Engine Research Committee. "How will this complicated mass of, perhaps, interesting information about valve-leakage help any one of the many eager students I see here to-night?" were the pith of the words which he uttered. Not long afterwards I heard Sir Guilford Molesworth make some facetious remarks about the pocket-book which is inseparably associated with his name, at a more festive occasion. He said, at the dinner of the students of the Institution of Civil Engineers, that he would warn them against "that mischievous book." Really, one scarcely knows how to coach students without a Molesworth! "They ought to master the principles underlying formulæ, instead of using them indiscriminately," was one of his expressions, and it is a text which was drilled into me by one of our most famous scientists, from whom I was privileged to get some hints. In design work, however, we have a great deal of empirical formulæ, founded mostly on the experience of others.

The Diameter of a Cylinder.

If we have to design a steam engine, we usually have given us the steam pressure of the boiler, or preferably at the engine stop-valve (the mean-pressure can then be easily calculated when the point of cut-off is decided upon, and for the point of cut-off usual for certain types of engines and steam pressures I must, I fear, again refer you to your pocket-book), and we know also the indicated horse-power that the cylinder is to develop. It is then only a matter of substitution to find the diameter of the cylinder, for we know that

$$I.H.P. = \frac{\pi D^2 p S}{4 \times 33{,}000},$$

where p is mean-effective pressure per square inch of steam on piston, and D the diameter of the cylinder in inches, and S the speed of the piston in feet per minute. From this it is quite clear that

$$D = \sqrt{\frac{33,000 \times I.H.P. \times 4.}{\pi \times p \times S}}$$

The speed of the piston is the distance in feet which the piston goes per minute. The speed, of course, varies from nothing at the beginning and end of each stroke to a maximum near the middle, and the speed reckoned in the mean speed. This is obtained by multiplying the number of strokes per minute by the length of the stroke in feet. It is usual for long-stroke engines to have a greater piston speed than short-stroke engines.

Some Piston Speeds.

From some notes given to me by a designer of marine engines, I find that the piston speeds used in that type of engine vary from 600 ft. per minute up to 1,200 ft. per minute. The former is the speed used for ordinary marine engines of a fair size; the latter for engines of torpedo-boat destroyers. Large mill engines run at from 400 ft. to 800 ft. per minute piston speed; locomotive engines from 800 ft. to 1,000 ft. per minute. Obviously, the first thing that the designer of a special type of engine has to find out is the piston-speed usual to that type.

Concerning the length of the stroke, no definite rule can be given. It is usually a definite proportion of the diameter of the cylinder, and varies from about 1.5 to 3.5 times the diameter. It depends, in vertical engines, how much head-room can be spared for this purpose, and in horizontal engines it is the floor-space which must be considered.

Ratios of Cylinder Volumes.

In designing compound or triple-expansion engines, we have to determine the relative volumes of the cylinders. We must decide upon the distribution of the power between the cylinders, the range of temperature in the cylinder, and the distribution of the initial loads on the piston. In all engines in which the cylinders are not arranged to run tandem, the total power should be equally divided between the cylinders. It is also advisable that the maximum loads on the pistons should be equal. It is difficult to find any empirical rules for the relative volumes of the cylinders of compound and triple-expansion engines. One of the rules which may be followed is that if P be the gauge pressure in pounds per square inch, then we have:

$$\frac{\text{volume of L.P. cylinder}}{\text{volume of H.P. cylinder}} = \frac{4P + 40}{100}$$

This holds only for compound engines. For triple-expansion engines we get a ratio of about the following:

With steam of 120 lbs. gauge pressure the ratios of volume of H.L. to I.P. to L.P. is as 1 : 2.5 : 5; with steam pressure of 180 lbs., the ratios become 1 : 3 : 8. It must be remembered, however, that the great idea of the engine designer is to expand the steam to the lowest pressure possible, and to distribute the work done by the cylinders evenly between them.

Thickness of Cylinder Barrel.

Steam cylinders must be made of either cast iron or cast steel; the former metal is the most usual; It is now quite common to fit a liner to the cylinder. In such cases the joint at the top of the liner is made steam-tight by means of a copper ring dovetailed in a recess. The space between the liner and the cylinder barrel is often used as a steam-jacket. For the thickness of the liner we use the empirical formula:

$$t = \frac{pD}{3,500} + \tfrac{1}{2} \text{ for cast iron.}$$

$$\text{or } t = \frac{pD}{3,000} \text{ for steel.}$$

p is the steam pressure in pounds per square inch, and D is the diameter of the cylinder in inches. If no liner is used, the thickness of the barrel of the engine cylinder is found from the first of the above formulæ.

The thickness of the cylinder flange is usually about 1.25 times that of the cylinder barrel. The width of the flange varies according to the diameter of the bolts used. Enough space should be left for screwing up the nuts and to allow for the bolt heads. Studs are usually employed for cylinder covers.

Diameter of Piston Rod.

The breaking load of a column fixed at one end and guided at the other is given by the following formula:

$$w = \frac{fS}{1 + \frac{16}{9} a \frac{l^2}{d^2}}$$

Where w = crushing load in lbs.

" S = area of rod ($.785d^2$).

" $a = \frac{1}{2,250}$

" l = length of rod in inches.

" d = diameter of rod in inches.

" f = crushing stress.

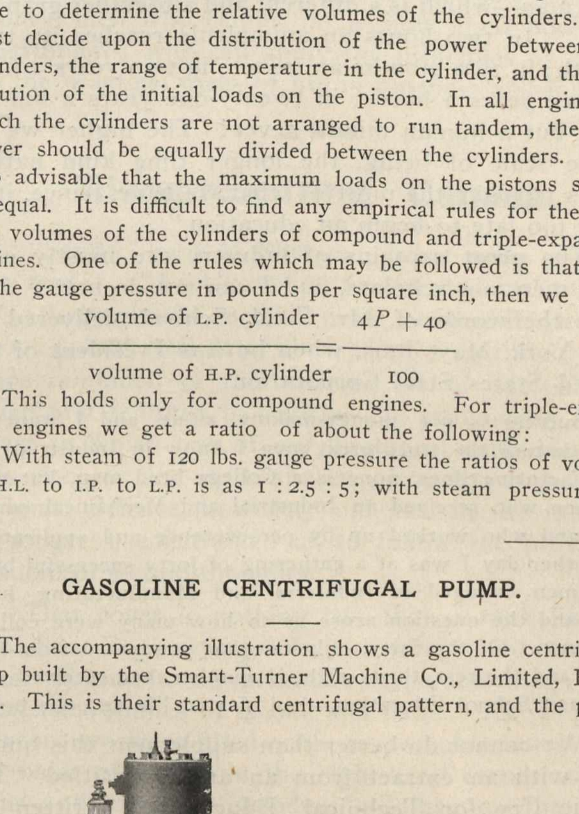
For the material of which piston rods are usually made f = 36,000 lbs. per square inch, but we allow a large factor of safety, and the value most usual is 4,000.

It is obvious that w is the maximum load on the piston.

It should be remembered that the screwed part of the rod is designed only for tension.—Engineering Times.

GASOLINE CENTRIFUGAL PUMP.

The accompanying illustration shows a gasoline centrifugal pump built by the Smart-Turner Machine Co., Limited, Hamilton. This is their standard centrifugal pattern, and the pump



shell is bolted to the hood of the base in such a manner that by simply loosening four nuts the pump may be swivelled upon its axis without detaching it from the base or without disturbing any of its rotating parts, thus allowing the discharge to be taken off at any angle, or in any direction. The gasoline engine is of the 2-cycle marine pattern, equipped with either make-and-break or jump spark ignition. It is very readily started, and as it is made up without any valves, there is practically nothing to get out of order. The speed is adjusted either by the throttle or by advancing the spark. It is so arranged that there is only one lubricator and two grease cups on the engine. The whole equipment is built in a strong and substantial manner, designed for service in exposed places. Further particulars will be cheerfully furnished by the makers.

CANADIAN GOVERNMENT OFFICES IN ENGLAND.

The Canadian Government have secured premises at 73 Basinghall St., London, E.C., where an office has been opened under the designation of "Canadian Government Trade Enquiry Branch," for the convenience of the commercial community.

In due course it is intended to equip and maintain a display room illustrating the products, resources and manufactures of the Dominion. In the meantime, a Canadian representative attends daily to deal with enquiries and applications in connection with Canadian import and export trade, and to supply information about Canadian matters generally. Personal appointments can be arranged when desired.

The Canadian Engineer.

ISSUED MONTHLY IN THE INTERESTS OF THE
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, LOCOMOTIVE, STATIONARY, MARINE, MINING, METALLURGICAL, AND SANITARY ENGINEER, THE SURVEYOR, THE MANUFACTURER, THE CONTRACTOR AND THE MERCHANT IN THE METAL TRADES.

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Editorial matter, cuts, electros, and drawings should be sent whenever possible, by mail, not by express. The publishers do not undertake to pay duty on cuts from abroad. Changes of advertisements should be in our hands not later than the 10th of the preceding month.

TORONTO, CANADA, JULY, 1905.

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TO OUR SUBSCRIBERS AND PATRONS.

Special notice is hereby given that from and after this date all subscriptions for this journal must be paid in advance. The subscription price is $1.00 per year, and no reduction off this rate will be made to any parties or persons whatever. **Present subscribers whose subscriptions are in arrears are notified that unless same are paid up within the next thirty days, the subscriber's name will be removed from our list.**

Until further notice in these columns all subscriptions must be paid to the Head Office, 62 Church Street, Toronto. Subscriptions will be acknowledged by change of date on address slip of each subscriber's paper.

On Technical Education.

In these days, when the struggle for existence is keen, and the Colleges and great Institutions of learning are annually turning into the ranks of industry thousands of young men equipped with their mathematics, physics, chemistry, mechanical philosophy, etc., and willing to work in the shops at low wages in order to get practical experience, it behoves every intelligent mechanic who started work early, with only the rudiments of a common school education, to take time to think, and to think deeply, what this new form of competition means. The old copy-book heading "Knowledge is Power" is as true as ever, and if the knowledge gathered by the college student has been along the lines of true scientific method, then the outlook for an ambitious mechanic with shop training only, is dark; and he must not be surprised if the best positions in the work-shop are grasped by the college man, because of his sound knowledge of basic principles, and of his power to adapt means to ends. Fortunately for the old time shop trained mechanic, the kind of education given in most of the colleges hitherto, has been altogether wrong; for the course of study and methods adopted by these Institutions are mainly adapted to teach young men how to teach others, not to fit them for the practical duties of the business affairs of life. Those who have had exceptional opportunities for observing the actual work of young men fresh from College, especially in the domain of Engineering, perceive the fatal defect of furnishing the memory with unimportant data, and cramming the recesses of the mind with indigestible facts, instead of training the intellect to a firm grasp of fundamental truths and first principles, and by scientific method cultivating accuracy and rapidity in the application and adaptation of these truths of nature and the operation of her laws to the emergencies and critical opportunities of life. The College, or Academic system, is calculated to make *scholars*; but there is a wide difference between a scholar and an educated man. As Henry Drummond has shown, scholars are often the least educated of men, and most educated men have never been, and never will be, scholars. The average mechanic, who left school early, has now very little chance of becoming a scholar, but he has still a chance of becoming an educated man—which is a different and altogether grander thing. "In two hours an animalcule reaches its true growth; in two months an insect; in two years a fish; in three years a horse; in twenty-one years a human body, but a human mind—never! The higher we go in the scale of being, the longer time kind nature allows to make the most of what we have, hence, it is never too late to begin an education."

The great captains of industry are mostly educated men, not scholars, and I can not do better than quote the words of Mr. C. M. Schwab delivered in New York, May, 1903, when he was President of the United States Steel Corporation:

> Success is not money-making, alone, and I want to state that of the truly great men I know in Industrial and Manufacturing lines, none is a College bred man, but they are men who received an Industrial and Mechanical education, and who worked up by perseverance and application. The other day I was at a gathering of forty successful business men engaged in Industrial and Manufacturing business, and the question arose as to how many were college bred men. Of the forty, only two had graduated from Colleges, and the rest, thirty-eight in number, had received only Common School Education,—had started life as poor boys.

We cannot do better than supplement this quotation, with an extract from an article entitled, "The Vague Cry for Technical Education," written by Lord Armstrong, a famous lawyer, Engineer, and founder of the greatest industrial combination in Great Britain, the celebrated Elswick Works, at Newcastle:

> A man's success in life depends incomparably more upon his capacities for useful action than upon his acquirements in knowledge, and the education of the young should therefore be directed to the development of faculties and valuable qualities rather than to the acquisition of knowledge. . . . Men of capacity and possessing qualities for useful action, are at a premium all over the world, while men of mere education are at a deplorable discount. It is melancholy to know, as I do, from experience, how eagerly educational attainments are put forward by applicants for employment, and how little weight such claims carry in the selection. I can affirm with confidence, that had I acted

on the principle of choosing men for their knowledge, rather than their ability, I should have been surrounded by an incomparably less efficient staff than that which now governs the Elswick Works.

Any man who has had experience in any of the great industrial workshops of the world knows well, that these statements made by past Presidents of the two greatest Engineering organizations on two continents is true. It is the old story of the difference between knowledge and wisdom. Let me cite a practical illustration from Joseph Cook:

Napoleon one day riding in advance of his army, came to a bridgeless river, over which it was necessary that his army should cross on a forced march, "Tell me—said the great Emperor to his Engineer, "the breadth of this stream." —"Sire, I cannot"—was the reply, "My scientific instruments are with the army in the rear, and we are ten miles ahead of it." "Measure the breadth of this stream instantly." "Sire, be reasonable." "Ascertain at once the width of this stream or you shall be deposed from office." The Engineer drew down the cap piece on his helmet until the edge touched the opposite bank, then holding himself erect, turned on his heel and noticed where the edge piece touched—in imagination—the land on which he stood, then paced the distance. "Sire, so many yards, approximately." He was promoted, not degraded.

This story typifies exactly the kind of mental training which should be aimed at in Technical education. It should be calculated not to make mere machines, men who cannot do without their books and instruments, who can apply the principles of Science to the practical cases of life in business and industry.

Misrepresenting Canada.

"Sandy," said McPherson, "what maks yer nose sae reed?" "Weel," replied Sandy, "Al jus' tell yer, It's allwus glowin' reed wi' pride, because it doesna go aboot pokin' itsel inta ither peoples' buzness." We were reminded of this antique bit of Scottish wit, when first tempted to criticize the astonishing March cover in which one of our Technical contemporaries was clothed; and we hesitated. Loyalty to the cause of exact Science, however, and zeal in the interests of progress, constrained us to follow the proverbial wisdom of second thoughts.

That cover is nothing less than a rank libel on Canadian Engineering. In the foreground are two Blast Furnaces of primitive type, belching forth immense volumes of smoke and flame. As we gazed thereon, we were filled with unspeakable horror, lest the bales of cotton in the right-hand corner, sailing ships and extensive wooden buildings on the other side of the narrow river should catch fire, and spread devastation all around. The reflection of the flames on the wooden elevator poles is a very pretty sight. One cruel critic even suggested that the molten metal is shown running into the river for rapid cooling, and hence quick delivery to the waiting ships.

Now all this may be art, but it certainly does not indicate modern metallurgical practice in the Dominion. Wasteful, open-topped furnaces, like those pictured, existed in Staffordshire, England, and Pennsylvania, United States, eighty years ago; but any firm using them to-day, would be bankrupt in six months! The Blast Furnace should be as cool as possible at the top, as hot as possible at the bottom. In 1860 Cowper invented his famous regenerative stoves for utilizing the waste gases. From that time until now, furnaces have been provided with bell, hopper, closed top, and downcomer; so that the unconsumed gases—rich in carbons—issuing at 350 deg. F. are conveyed down to the stoves, regenerated, and returned to the furnace hearth again, at a temperature of 1,200 deg. to 1,500 deg. F., thus effecting not only a great saving in fuel, but preserving the verdure of the fields, the foliage on the trees, and the health of neighboring villages and towns. The Engineers of Canada have the inestimable advantage of beginning where the European and American leave off. To give an impression, therefore, to the outside world, that they are so far behind the times, as to use an antiquated and criminally wasteful appliance like that pictured on the cover before us, is, to say the least of it, a gross misrepresentation.

Editorial Notes.

American Enterprise in Canada. The London "Times" and other English papers, are giving prominence to the report that the United States Steel Corporation are about to erect a $10,000,000 plant at Sarnia. History showeth that every time there is any talk of the Canadian Government proposing to increase the tariff on steel, etc., the United States Steel Corporation send over Caleb and Joshua, and their special advertising agent, to spy out the land. The bluff has worked before. Statesmen are scared and rivals hesitate.

System. We have pleasure in directing the attention of our readers, to the series of copyright articles commencing in this number, entitled, "System for Industrial Establishments," by A. J. Lavoie. After careful analysis, and *observation of its use in the shops*, we hesitate not to say that this system is the most comprehensive, and at the same time the most *practical* scheme for saving time and accelerating production in Engineering workshops, that we have seen. By the "Lavoie system," the cost of everything—no matter how small and insignificant, is shown; and this is achieved with a minimum amount of clerical work. Works-Managers, heads of departments, and Engineers generally cannot afford to miss the series.

Trade with the Orient. The cordial relations existing between Great Britain and Japan, are already bearing fruit.

Glasgow is securing a very considerable share of the orders for railway running stock, which the Japanese Government has issued. Early in the spring a large contract for locomotives was secured by the North British Locomotive "combine," and now a second order for 100 additional engines has been placed with the same company.

Canada has at least three large plants specially designed for locomotive building, and possesses unique transportation advantages. The question naturally arises, therefore, how is it the Dominion is not getting some of this business? When Japan gets that inevitable war indemnity, there will be stirring times in the industrial world. In view of these trade possibilities, it was very gratifying to notice in the daily Press, that the Government is taking vigorous action towards removing all treaty barriers:—

> Ottawa, June 22nd.—An assurance was given by Hon. Mr. Fisher in the House to-day, that the policy of the Government was to recognize Japan as a nation with which Canada might profitably enter into trade relations, and that the Government had taken steps through the Colonial Office, to get the benefit of the special treaty made in 1894.

In the meantime, it behoves concerns making goods which Japan buys, to see to it that our Imperial ally is thoroughly advised as to Canadian manufacturing resources.

Coming Renaissance in Metallurgy.

In view of the coming revival in iron and steel industry, it is of vital importance that Canadian Engineers be kept fully informed of the latest Electro-chemical and metallurgical processes; so that the resources of the country—especially our *refractory* ores—may be utilized to the greatest advantage. Hence, while design and achievement in Civil, Mechanical, and Electrical Engineering generally, will be fully set forth in our columns by well-known specialists and experts, the revelations of the chemical laboratory, microscope, and testing machine—as to the properties and commercial values of ores, minerals, and metals, will not be neglected. In carrying out this enterprize, "The Canadian Engineer" is opening out new soil, which it is believed will be as profitable to the alert Engineer, as the prairie lands of Manitoba are to the patient, intelligent, industrious immigrant of to-day.

Prof. J. W. Richards' Notable Work.

Upon special request, we have been favored by the Editors of "Electro-chemical and Metallurgical Industry," with the last four issues of that excellent journal, containing the unusually interesting series of papers entitled: "Metallurgical Calculations," by Dr. J. W. Richards, Professor of Metallurgy in Lehigh University. We are unknown to the Treatisor, and have no personal interest in booming his work; but of such intrinsic worth have we found the Thermochemical data contained therein; and of such superlative value to the progressive practical metallurgist, that we deem it a privilege to advise everyone engaged in Laboratory practice, and indeed all interested in the Art of Metallurgy, to secure copies straightway.

Correspondence Section.

Editor Canadian Engineer:—

Sir,—I have been interested and to some extent amused at the manner in which the opposition to the Metric System has developed. Oliver Wendell Holmes described what he called the "hydrostatic paradox of controversy," an analogy drawn from hydrostatics where a small column of water will keep to its own level a much larger column connected with it. So the pros and cons drag on as long as there are debaters who take pleasure in splitting hairs. The whole tone of the opposition has been that of a debating society rather than of sound scientific discussion.

Every report on the Metric System presented to Congress by the Committee on Coinage, Weights and Measures has emphatically recommended its adoption as the sole legal standard in the United States. While we have delayed official action, the system has surely made its way into extensive use for many purposes. It is decidedly wrong to say that the matter has been "happily ended in this country by the defeat of the proposed compulsory legislation." First, the proposed legislation is not compulsory upon manufacturers, who may use any units they choose, although many prefer the meter even now; it has not been defeated because it has not been voted upon, and the matter is not ended, either happily or otherwise, nor will it be until it is settled right. The "American Pharmacopœia" has all of its standard prescriptions stated in the Metric System. This means that the physicians everywhere are familiar with these units and are to an increasing extent using it. This is especially true of the more intelligent. The entire subsidiary silver coinage of the United States is based on the Metric System. The nickel five-cent piece weighs exactly 5 grams, and the weights of the assay commission are each year standardized by reference to metric standards. In the customs service, the law requires invoices of goods from metric countries to be made out in metric units. This covers more than half of our import trade. As far as known, technical laboratories connected with the customs service use the metric units. In the analysis room for classifying textiles in the New York Custom House the Metric System is used almost entirely, although the final reports are translated into customary units. It is used throughout the entire work of testing imported sugars. It is the official system used in all triangulation and topography (except heights), transcontinental levelling, base-bar work, computations, and in a large portion of the instrument construction. In the Navy Department it has been for twenty-five years the official system in all medical and surgical work in the hospitals and dispensaries. Likewise in the army. The Library of Congress uses the system in giving the dimensions of books, prints, manuscripts and broadsides and the standard library cards, millions of which are printed annually, are all in metric sizes. In the Post Office Department foreign postage rates are based on metric units, metric scales being provided for the purpose. Finally, throughout the entire scientific laboratories of the Government the Metric System is widely used.

In manufacturing, the large firms of tool builders are making full lines of metric dimension tools. They are doing this now for profit even before the Metric System is adopted as the only legal standard. "Nothing succeeds like success," is an old motto, and the wonderful advance of science in the past fifty years is partly to be traced to the fact that scientists have a single universal system in the Metric System. It is true that some old units persist in metric countries, although nothing like a chaotic condition prevails, as Mr. Halsey would have us believe. On this point the opposition has greatly exaggerated the facts. I still hold to my former statement that there is little active opposition to the Metric System in this country. Messrs. Halsey and Dale, two editors, are doing all the talking. Resolutions and votes of organizations are a rather poor test unless the entire discussion is published, as was done by the American Society of Mechanical Engineers and the Franklin Institute. Those who read these documents would be convinced that the metric presentation in the case is convincing. There is no organized movement in the United States in favor of the Metric System. It has made its way by force of its intrinsic merits and will continue to do so even if official action is not taken. The fact that so many associations have favored the Metric System is very encouraging as showing the movement is making considerable headway. In a list of those favoring the adoption of the Metric System should, however, be added the National Board of Trade and the Society of German-American Technologists. The whole theme is far above the claims of those who live only for the present, or for their own community, or for their particular self-interest. The attitude of any man on this subject will depend largely on the breadth of his sympathies, and the great men like Edison, Carnegie, Westinghouse, Lord Kelvin, Elihu Thompson, etc., etc., will be found ranged upon the metric side. I am glad that Mr. Halsey is stirring up the question. I believe that it will help the adoption of the Metric System because some opposition is needed to stir up the deep-seated but unexpressed feeling that exists in its favor. Respectfully yours,

ALBERT S. MERRILL,
Junior Member, Am. Soc. Mech. Eng.

Washington, D.C., May 27th, 1905.

Books Received.

Concrete-Steel: A Treatise on the Theory and Practice of Reinforced Concrete Construction: By W. Noble Twelvetrees. New York: Whittaker & Company. (Price, 6s., net.)

How to Become a Good Mechanic. By John Phinn. Second Edition. New York: Industrial Publishing Company, 1901. (Price, 25 cents.)

Machine Design: The Elementary Principles of. By J. G. A. Meyer, New York: The Industrial Publication Company, 1897. (Price, 50 cents.)

The Fan; Including the Theory and Practice of Centrifugal and Axial Fans; By Charles H. Innes, M.A. (Cantab.), Lecturer on Engineering at Rutherford College, Newcastle-on-Tyne. Manchester: The Technical Publishing Company, Limited. (Price, 4s., net.)

Special Design of Dams. By John S. Fielding, C.E., Toronto: The Canadian Engineer Office, 62 Church St., 1905. (Pamphlet). Postage only, 2 cents. This is a valuable reprint of special articles from the series now appearing in our columns. Civil Engineers interested will want the others after reading this.

The Electric Railway. By Frank J. Sprague, Past President American Institute of Electrical Engineers. The Century Magazine, July. This paper contains a resumé of the early experiments in electric traction in America. It is to be followed with a second paper by the same author, describing later developments and forecasting the future.

Modern Engines and Power Generators; A Practical Work on Prime Movers and the Transmission of Power—Steam, Electric, Water, and Hot Air. By Rankin Kennedy, C.E., Vols. I. II. III. IV. V. (1904). Toronto: The George N. Morang Co., Limited, Publishers. (Price, $15 per set.) We purpose noticing this comprehensive, modern work in a subsequent number.

CANADIAN ELECTRICAL ASSOCIATION.

Fifteenth Annual Convention, Montreal, June 21st to 23rd.

"Down to Business" was the note struck at the Montreal Convention of the Canadian Electrical Association. Heretofore it has been felt that the convention was made too much an excuse for a holiday by many of the members, and the influence of the meetings has been dissipated by a preponderance of entertainment. This idea was emphasized in President Thornton's opening address, and was echoed at various times throughout the convention, and to a large extent it was put into practice. The regular banquet was a feature which was conspicuous by its absence.

The attendance was very large, the largest on record, the total registration of delegates and visitors reaching 346. Following are the names of the delegates registered:—

From Montreal.—H. Laporte, Mayor; K. B. Thornton, Pres. C.E.A., Montreal Light, Heat & Power Co.; H. D. Bayne, Canadian Westinghouse Co.; R. S. Kelsch, Consulting Engineer; F. W. Fairman, Dominion Wire Co.; R. E. T. Pringle, R. E. T. Pringle Co.; C. F. Sise, Jr., Bell Telephone Co.; E. F. Sise, Wire & Cable Co.; Dr. R. B. Owens, Prof. Electrical Engineering, McGill University; H. J. Fuller, Canadian Fairbanks Co.; W. C. Johnson, Consulting Engineer, Shawinigan Water & Power Co.; W. F. Dean, Canadian General Electric Co.; A. Collyer, Allis-Chalmers-Bullock, Ltd.; W. A. Duff, Canadian Westinghouse Co.; J. S. McLean, Allis-Chalmers-Bullock Co.; H. A. Burson, Allis-Chalmers-Bullock Co.; D. Sleeth, H. A. Moore, Allis-Chalmers-Bullock Co.; G. A. Stanley, Canadian Westinghouse Co.; H. Woodcock, Montreal Street Railway; C. W. Henderson, Canadian Westinghouse Co.; C. W. Johnson, Allis-Chalmers-Bullock Co.; R. M. Wilson, Montreal Light, Heat & Power Co.; S. W. Smith, Canadian Westinghouse Co.; T. F. Kenny, Allis-Chalmers-Bullock Co.; H. H. Henshaw, Allis-Chalmers-Bullock Co.; J. J. Campbell, Jr., Canadian Westinghouse Co.; W. V. Warren, Allis-Chalmers-Bullock Co.; J. Cahill, Montreal Herald; E. M. Breed, Canadian Westinghouse Co.; R. E. Brandeis; G. M. Gest, Contractor, New York; Alex. Barrie, Wire & Cable Co.; George Bullock, Allis-Chalmers-Bullock Co.; W. P. Roper, Canadian General Electric Co.; G. H. Weaver, Dominion Foundry Supply Co.; P. Johnson, Dominion Bridge Co.; W. H. Reynolds, Canadian General Electric Co.; H. B. Douglas, Canadian White Co.; H. C. Hitch, Canadian White Co.; P. D. Rutty, Canadian White Co.; C. S. Stokes, Canadian Westinghouse Co.; N. Grayburn, Montreal Street Railway; P. S. Sise, Northern Electric Co.; D. C. Meloon, John Forman Co.; J. D. Lachapelle, Richelieu & Ontario Navigation Co.; J. C. Hyde; D. E. Blair, Montreal Street Railway; G. R. Dunkin, Montreal Pipe Foundry Co.; A. E. Wilson, John Forman Co.; E. H. Leonard, Electric Engineering Co.; D. McInade, Electric Engineering Co.; H. G. Taylor, W. G. Ross, D. MacDonald, L. Trudeau, A. F. Byrd, R. H. Lockhart, R. M. Hannaford, H. J. Chapman, G. Boyer, P. Dubec, D. Robertson, H. E. Smith, T. W. Casey, M. Neilson, A. Gaboury, W. M. Reid, Montreal Street Railway; B. Fogarty, Fogarty Bros.; S. Humphries, Electric Repair Co.; C. Thomson, Fred Thomson & Co.; W. D. Bird, Montreal Light, Heat and Power Co.; L. Rousseau, Canada Electric Co.; J. Dick, Montreal Street Railway; P. M. Walder, R. E. T. Pringle Co.; J. A. Fletcher, R. E. T. Pringle Co.; W. P. Kearney, Packard Electric Co.; L. A. Herdt, McGill University; B. Robinson, Montreal Star; R. J. Mercur, Canadian Iron and Foundry Co.; J. J. Yorke, St. Lawrence Sugar Refining Co.; F. J. Bell, Canadian General Electric Co.; J. M. Robertson, Montreal Light, Heat and Power Co.; G. M. Wight, R. E. T. Pringle Co.; R. H. Balfour, Montreal Light, Heat and Power Co.; G. Porteous, Canadian White Co.; H. E. Blatch, Canadian Westinghouse Co.; I. Smith; M. A. Sammett, Montreal Light, Heat and Power Co.; J. M. R. Fairburn, C.P.R.; W. B. Shaw, Montreal Electric Co.; G. H. Muir, Electrical News; C. F. R. Jones, Wire and Cable Co.; D. McEvoy, Canadian Rubber Co.; T. Rogers, Great North-West Telegraph Co.; H. W. Weller, Babcock & Wilcox; E. H. Hughes, H. W. Johns-Manville Co.; W. J. O'Leary, W. J. O'Leary & Co.; G. H. Olney, E. F. Phillips Electrical Works; J. A. Mann; W. S. Gardner; J. Westgate; G. Teroux; A. Pringle; R. F. Jones; Bell Telephone Co.; R. W. Hogg, Canadian General Electric Co.; W. J. Plews; J. A. Dawson; C. G. Buck, J. A. Dawson & Co.; S. A. Stephens, J. A. Dawson & Co.; F. J. Parsons, McDonald & Wilson; T. R. Fulton, E. Phillips Electric Co.; L. Rubenstein, Montreal Light, Heat and Power Co.; T. J. Mullen, Allis-Chalmers-Bullock; J. S. Hartman, Canada Car Co.; E. Craig; J. A. Burnett, Montreal Light, Heat and Power Co.; J. Warren, Packard Electric Co.; J. A. Burns, Munderloh & Co.; F. G. O'Grady, Canadian Iron and Foundry Co.; H. K. Deutcher, Allis-Chalmers-Bullock; F. A. McKay, T. Pringle & Sons; N. M. Campbell, Canadian Rand Drill Co.; A. Maclean, Robb Engineering Co.; T. F. Nivin, Otis Elevator Co.; A. R. Hanry, Ross & Holgate; W. McLea Walbank, Montreal Light, Heat and Power Co.; D. H. Wilson, American Locomotive and Machine Co.; E. A. Rhys-Roberts, Dominion Bridge Co.; A. E. Smaill; J. N. Smith, Ross & Holgate; D. Logan, John Forman Co.; P. R. Diamond, Canadian Bronze Co.; A. J. Gorrie, Great Northern Railway; S. T. Callaway, Locomotive and Machine Co.; F. H. Pitcher, Montreal Water and Power Co.; E. R. Carrington, Thiel Detective Co.; V. Falconer, F. B. Brown, C. Martin, J. J. York, T. Bastien, L. A. Lapointe, M. K. Adams; A S. Forman, with John Forman; W. D. Hall, G.T.R.; G. W. Sadler, Sadler & Haworth; J. C. O'Brien; A. J. Carrol, Phillips Electrical Works; W. A. Walker, Phillips Electrical Works; C. D. Cliffe, McLean Pub. Co.; R. A. Ross, J. M. McKee; J. W. McKee, J. W. Gilmore, A. Musher, J. Elson; E. A. Seath, with John Forman; G. C. Burnham, Allis-Chalmers-Bullock; E. Camp, with W. J. O'Leary; E. F. Waterhouse; L. Yorston; J. M. Cox; H. B. Pope; H. McPhee; Fred Thomson & Co.; A. P. Horner, Canadian General Electric; F. D. Gillies, Montreal Light, Heat and Power Co.; A. Freudberg; Wm. Andrews, Canadian General Electric Co.; B. G. McBurney, Canadian General Electric Co.; V. Boyd, Canadian General Electric; J. D. Hathaway, Wire and Cable Co.; F. E. Barbour, New York Central Railway; F. Thompson, F. Thompson & Co.

From Toronto.—H. S. Dodd; R. H. Zavitz; Wm. McCaffrey; E. J. Jenkins, Canadian General Electric; N. G. MacLeod, Beardmore Belting Co.; J. P. Thompson, Phillips Electric Co.; R. M. Saxby; W. A. Paterson; C. H. Martin; R. G. Black, Toronto Electric Light Co.; C. H. Mortimer, "Electrical News"; A. B. Smith, G.N.W. Telegraph Co.; J. J. Wright, Toronto Electric Light Co.; C. W. Bongard, Wire and Cable Co.; R. T. McKeen, Canadian General Electric Co.; A. Esling, R.E.T. Pringle Co.; H. C. Philpott, Canada Foundry Co.; E. P. Hannam, Canada Foundry Co.; H. B. Hall, Conduits Co.; F. Rose, Canadian General Electric Co.; E. I. Jenking, Canadian General Electric Co.; B. F. Selby, Canadian General Electric Co.; A. M. Wickens, Canadian Casualty and Boiler Insurance Co.; J. H. Webber, Montreal Rolling Mills; J. W. Campbell, Canadian General Electric Co.; Wm. Buckle, Canadian General Electric Co.; A. B. Lambe, Canadian General Electric Co.; R. B. Reid, Beardmore Leather Co.; E. J. Bengough, "Canadian Engineer"; E. S. Keith, "Canadian Machinery"; A. Burrows, "Railway and Shipping World"; W. G. Irwin, "Canadian Manufacturer"; J. P. Thomson, E. P. Phillips Electrical Works; A. W. Smith, "Canadian Engineer"; T. R. Price, Sunbeam Incandescent Light Co.; N. Mactavish.

From Ottawa.—J. Murphy, Ottawa Electric Co.; A. A. Dion, Ottawa Electric Co.; T. Hilliard, Canadian General Electric Co.; O. Higman, Chief Electrical Engineer Inland Revenue Department; D. P. Burke, Ottawa and Hull Power Mfg. Co.; C. G. Keyes, Ottawa Electric Co.; J. Johnson, Public Works Department; J. A. Maclaren; J. E. Hutchison, Ottawa Electric Railway Co.

From Hamilton.—G. Henderson, Superintendent Cataract Power Co.; N. S. Braden, Canadian Westinghouse Co.; P. J. Myler, Canadian Westinghouse Co.; H. O. Hart, Canadian Westinghouse Co.; J. A. Kammerer, Cataract Power Co. J. Sangster, Hamilton Cataract Power, Light and Traction Co.

From New York.—T. A. Aiton, Aiton Machine Co.; M. L. Gordon, H. G. Brown, E. Steinler, C. W. Price; F. Beck, Westinghouse Co.; F. C. Ransom; H. C. Kelley, New York Turbine Engineering Co.; P. H. Hover, New York Insulated Wire Co.; T. H. Bibber, American Circular Loom Co.; P. G. Gossler, J. G. White Co.; W. P. Ambos, Osborne Flexible Conduit Co.; E. Waugh, General Chemical Co.; D. Trainor, Canadian Copper Co. **From Quebec.**—E. A. Evans, Quebec Railway Light and Power Co.; E. R. Frost, Jacques Electric Co.; L. Burran, Quebec Railway Light and Power Co.; T. D. Lonergan, Chateau Frontenac; L. Denis, Quebec-Jacques Cartier Electric Co.; A. P. Doddridge, Quebec Railway Light and Power Co. **From Renfrew.**—A. A. Wright, M.P., President Electric Light and Power Co. **From Shawinigan.**—W. C. Johnson; Shawinigan Water and Power Co. **From Owen Sound.**—B. E. Reesor, Manager Georgian Bay Power Co. **From Pittsburg.**—W. Bradshaw, Westinghouse Electric and Manufacturing Co.; H. G. Steele, Pittsburg Transformer Co.; H. A. Hamilton, Westinghouse Electric and Manufacturing Co.; G. S. Chester, Westinghouse Electric and Manufacturing Co. **From Walkerville.**—J. W. Purcell, Hiram Walker & Sons. **From Perth.**—R. J. Smith, H. H. Scott, Canadian Electric and Water Power Co. **From St. Catharines.**—G. C. Rough, Packard Electric Co.; E. Irving, Manager Sunbeam Incandescent Lamp Co.; R. B. Hamilton, Packard Electric Light Co. **From Halifax.**—J. W. Pilcher, Canadian General Electric; C. C. Starr, Canadian Westinghouse Co. **From Stratford.**—F. Chowen, Stratford Gas and Electric Co. **From Cleveland.**—S. Carey, Jandus Electric Co. **From Pembroke.**—J. A. Thibodeau, Pembroke Electric Light Co. **From Brantford.**—L. W. Pratt, Brantford Electric and Operating Co.; C. A. Waterous, Waterous Engine Works. **From Peterboro'.**—H. O. Fisk, Peterboro' Light and Power Co. **From Sudbury.**—R. H. Martindale. **From Sarnia.**—W. Williams, Manager Sarnia Gas and Electric Co. **From Waterloo.**—C. W. Schiedel, Manager Waterloo Electric Light Co. **From Berlin.**—E. D. Brand, M. C. Hall, J. Cochrane, Berlin Electric Co. **From Cataract.**—J. M. Deagle, L. M. Deagle, Cataract Electric Co. **From Cornwall.**—W. L. Macfarlane, St. Lawrence Power Co. **From St. John, N.B.**—C. H. Abbott, R. E. T. Pringle Co; F. P. Vaughan. **From Farnham.**—W. C. Girard, Farnham Electric Co.; C. Lesperance, Farnham Electric Light Co. **From Port Arthur.**—T. H. McCauley, General Superintendent Municipal Plant. **From Fort William.**—F. S. Jones, Superintendent Electric Light and Telephone Co. **From Lakefield.**—C. L. Farrar, Lakefield Light and Power Co. **From Barrie.**—T. Beecroft, Barrie Electric Light Co. **From St. Johns, Que.**—T. Chand; F. A. Chisholm, St. Johns Electric Light Co. **From St. Casimir, Que.**—H. Grandbois. **From Winnipeg, Man.**—D. H. Hudson, Hudson Electric Supply Co. **From Bracebridge.** W. E. Simmons, M. Ney, Bracebridge Light and Power Co. **From St. Francis.**—A. E. Sangster, St. Francis Hydraulic Co. **From Sherbrooke.**—A Sangster, Sherbrooke Power, Light and Heat Co.; R. A. Robins, Sherbrooke Power, Light and Heat Co. **From Buckingham.**—A. MacLaren, James MacLaren Co.; E. S. Leetham, Lievre Valley Power, Traction and Manufacturing Co. **From Whitby.**—F. Hatch; R. W. Saxby.

A. H. C. Dalley, Chicago; A. L. Doremus, Crocker Wheeler Co., Ampere, N.J.; R. N. Robins, Sherbrooke; J. Wood, Jr., Nova Scotia Steel and Coal Co., New Glasgow; L. A. Howland, St. Johns, Nfld.; N. Curry, Amherst, N.S.; A. N. Dufresne, J. N. Blanchet, and J. A. Picard, St. Cesaire, Que.; T. T. Renton, Campbell & Renton, Kingston; S. B. Condit, Jr., Conduits Co., Boston, Mass.; G. R. Joghins, I.C.R., Moncton, N.B.; C. A. King, Royal Pulp and Paper Mills, East Angus, Que.; L. A. Casgrain, Manager Chicoutimi Electric Co.; G. A. Brebner, Schenectady, N.Y.; L. B. Hastings, Stanley Electric Manufacturing Co., Pittsfield, Mass.; E. S. Edmundson, Oshawa; T. Sadler, Lindsay Light and Power Co., Fenelon Falls; E. I. Sifton, Electric Construction Co., London.

Headquarters for the convention were at the Windsor Hotel, where the delegates registered and received their identification buttons; also books of complimentary tickets courteously supplied by the Montreal Street Railway Co. The various supply companies occupied rooms in the hotel, and these formed convenient rendezvous for the delegates between sessions. The meetings were held in the rooms of the Canadian Society of Civil Engineers, at 877 Dorchester Street, just across the square from the hotel. These rooms, which are occupied also by the Canadian Mining Institute, are excellently arranged and tastefully decorated. The assembly room, located on the ground floor, is conveniently equipped with lantern and other appurtenances, while in the front part of the building there are the library, reading-room, committee room and office. Of the whole premises the Canadian Electrical Association were practically proprietors during their stay.

The secretary-treasurer's report, which was presented at the opening session, showed the Association to be progressing. The membership is now 411, there having been a gain of thirty-six during the past year. It was suggested that, if possible, branches should be formed in Winnipeg, Vancouver and St. John, which would enable those not able to attend the convention to meet together, while at the same time widening the influence of the Association. Finances were shown to be in a satisfactory state. The apathetic interest taken in the meetings and welfare of the Association by a large number of the members called for comment by the president, K. B. Thornton, and it was decided to appoint a special committee to take whatever steps may be necessary to increase the membership and induce more to take part in the papers and discussions. The Association will have to keep a close watch on legislation in the future; so reported the Legislative Committee. The Provincial Secretary has announced that the Ontario Government intend bringing down a bill next session which will make certain changes in the Conmee Act, and in this connection vigilance is called for on the part of the Electrical Association.

The papers provided were selected with a view to furnishing information of service to the average central station man. They were all very much appreciated, and the discussions were at times quite animated.

The first paper of the convention was read by M. A. Sammett, of the Montreal Light, Heat and Power Co., and dealt with the Operation of Transformers at Varying Frequencies and Voltages. Mr. Sammett's paper dealt with the iron losses in reducing frequency, those losses being hysteresis and eddy currents. Formulas were given for finding each of these, and comparisons were made between these two losses. It was shown that while eddy current loss remains the same for all frequencies, a decrease in frequency will result in an increase in hysteresis, and consequently a higher temperature of the transformer iron. This temperature rise will cut down the current-carrying capacity of the transformer, and what would under normal conditions be called a normal load would with a lower frequency be an overload, and may cause the burning out of the transformer. The author showed that with an increase of 20 per cent. above normal voltage, hysteresis will increase 34 per cent., eddy current will increase 44 per cent., and the combined loss will increase 37.8 per cent. A change of 10 per cent. above the voltage for which the transformers are designed will allow satisfactory operation and increase the total loss by 0.8 per cent., affecting the result as to the efficiency of either the transformers or the plant but very slightly, while a higher change in voltage will affect the efficiency of the apparatus as well as its rating to a considerable degree. A lowering of 10 per cent. will result in an increased all-day efficiency, as well as cause the transformer to run hotter.

Prof. Herdt, of McGill University, in discussing the paper, stated that some recent experiments show that the eddy current does not vary just as the square of the thickness of the lamination. In very thin laminations it does so, but with thicker laminations it is not as the square, this being probably due to induction in the plates themselves. Tests have also shown that at a temperature of 50 deg. Cent. the eddy current loss would be diminished by half. The pressure on the laminations also affects the eddy current; if the pressure is raised, the eddy current loss is increased.

R. T. McKeen, of the Canadian General Electric Co., read a paper on "Transformers," in which he sketched the history of the transformer and the evolution of the standard types. The paper was freely illustrated by means of the lantern. The early transformers were all of the shell type, and this type held the field until 1896. In that year the core type was developed, and now both types are before the public. About 1896 transformers were developed for use with oil as an insulating and cooling agent. The oil preserves insulating fabrics by keeping them soft and by excluding air and moisture. It also assists in preventing breakdown of insulation, due to minute puncturing by momentary excessive potentials. The magnetic characteristics of iron have been investigated with the result that core losses in transformers have been reduced very greatly, the average core loss per kilowatt in sizes up to 2,500 watts being reduced from 163 in 1889 to 28 in 1905. Several slides were shown illustrating the study of microscopic metallography, by which it has been found that the proportion and distribution of the various components in iron or steel bear a definite relation to its physical and magnetic properties. The characteristics of insulating materials is a subject which has been less studied than any other field connected with transformers. Moisture is the bugbear of the transformer designer, and to prevent the entrance of moisture to the windings, and to remove what may have got in during manufacture several methods have been devised. Mr. McKeen combatted the idea that low core loss is the chief consideration in choosing a transformer, as all types are now very similar in that regard, while possessing wide differences in other respects. The ageing of iron does not, in Mr. McKeen's opinion, receive the attention it deserves, when it is considered that in inferior types of transformers the core loss may increase 10, 20, 30, or in some cases even 100 per cent. from this cause. The question of ageing has been investigated, and, though the cause of it has not yet been determined, it has been found that this increase of loss is dependent upon the temperature at which the iron is maintained. There is a great difference in the ageing of different qualities of iron and steel; soft sheet steel being much less subject to ageing than soft sheet iron. The tendency to age is greater the greater the temperature, but a sheet steel can be obtained which does not age materially at moderate temperatures (below 75 deg. Cent.). This is now used by the large manufacturers, and the transformers so designed as to take the best advantage of its non-ageing qualities.

After this paper, A. A. Wright opened a discussion on the use of oil in transformers, and the following points were brought out: When oil becomes carbonized and thickened it loses its cooling properties, owing to the absence of flow. Whether it loses or increases its dielectric property when carbonized was a point on which there was a difference of opinion. Unless it becomes quite thick there is no great objection to its use. Oil for use in transformers should possess certain characteristics: it should have a low flashing point; it should be absolutely neutral as to acidity and alkalinity; it should be neither too thin nor too thick; it should be capable of withstanding very low temperatures without becoming thick; all moisture should be absolutely excluded—1-10 per cent. moisture in oil reduces its dielectric strength nearly 50 per cent.

William Bradshaw, of the Westinghouse Electric and Manufacturing Co., Pittsburg, read a paper on the "Selection and Maintenance of Service Meters," in which he dealt with the mechanical and electrical characteristics of meters, and their testing. The bearing of a meter, which is the strategic point, can best be constructed by the use of a steel ball between the jewelled surfaces. The torque, or driving force of the meter should be as large as it is possible to obtain with a minimum weight of moving element. To make the effect of friction as slight as possible, the ratio of the torque necessary to overcome friction and the driving torque should be a maximum. Service meters have an inherent tendency to run slow after considerable use, and consequently should have periodic inspection and test. The most accurate method of test is by the use of a special standard integrating watt meter, this being the secondary standard, while the primary standard is kept at the central station. An operating company equipped with a good, reliable and accurate standard and several of the integrating test meters can maintain cheaply and accurately a large number of service meters, and increase its revenue by a considerable percentage. Mr. Bradshaw closed his paper with an outline of a convenient system of recording both line and laboratory tests of service meters.

In the discussion which followed the reading of this paper, Ormond Higman, Chief Electrical Engineer of the Inland Revenue Department, told how the Department tests meters. The meter is tested for starting current at 2 per cent. of its full load capacity. For accuracy they start at quarter load and go up through half and three-quarter to full load and down again. There is also a test for external magnetism. Tests are also made for frequency, variation in wave form, friction, resistance, drop of series coil, consumption of energy, and a temperature test. Mr. Higman would like to see a durability test but in the majority of cases this is impracticable.

A. B. Lambe, of the Canadian General Electric Co., held the attention of his audience thoroughly while he gave an enthusiastic and highly interesting talk on incandescent lamps. With charts of illumination and specimens of lamps, good, bad, and indifferent, as well as specimens to show the process of manufacture of a lamp, he illustrated his talk in a most practical way. Mr. Lambe explained the units used in measurement of light, the unit of light, or candle power, the unit of illumination, or candle foot, and the unit of intrinsic brightness. He then explained the methods of testing lamps for these qualities. By charts of light distribution he showed the differences between various forms of filament. Efficiencies in lamps are of three standards, 3.1, 3.5, and 4 w.p.c. Where power is cheap, a low efficiency lamp will bring the light cost to a minimum, but where dear, the high efficiency lamp is the cheapest in the end. There comes a time in the life of a lamp when it should be "Oslerized," for, though it may go on giving light, its useful days are ended. The efficiency goes down with age, and the time comes when a 16 c.p. lamp consumes 6 watts and gives only 8 candle power. According to the best usage at present, a lamp should be retired when its candle power becomes 80 per cent. of its original power; that is, 12.8 c.p. for a 16 c.p. lamp. The life of a lamp is not affected by the number of times it is turned on or off, or by alternating current as opposed to direct current, or by the number of frequencies in the former; it is affected by the candle power of the lamp, by the efficiency, and by the voltage, because these are the factors which, if changed one way or the other, alter the diameter of the filament. Troubles are usually in the form of burn-outs. From an inspection of the lamp you can usually locate the trouble. Examine the ends of the broken filament; if they are pointed and a dull black in color the lamp did burn out; if not, it was broken. The two common causes of a burn-out are poor vacuum and high voltage. The vacuum may be roughly tested by observing the vibration of the filament in the bulb. If it vibrates freely, the vacuum is good; if it comes quickly to rest, the vacuum is faulty. High voltage is the most prolific source of trouble, and to locate this the lines must be gone over with a meter at all times of load. Mr. Lambe strongly advised the free renewal system for light companies, as this keeps the service good, and the customers contented, and accounts are cheerfully paid. At the close of his paper, Mr. Lambe exhibited a tantalum lamp, the new type which is just now arousing a great deal of interest in Germany. The filament is composed of tantalum, and the particular point about the lamp is its high efficiency, about two watts per candle. Tantalum increases in resistance with heat, and this should make the lamp less susceptible to high voltage than the carbon lamp.

The question of the change of lamp bases to Edison type called out some questions and remarks. It was generally conceded that this was a matter of great convenience to the manufacturer, and the consumer should fall into line, especially as the introduction of the adapter made the course comparatively easy. Said Vice-President Wright on this point: "I always thought one type was as good as the other, and better; and I would just as soon have one as the other, and rather."

When the convention assembled the second morning, A. L. Mudge read a paper on the "Operation of Alternators in Parallel." The problem of parallel operation is largely one of the regulation of the prime movers—a mechanical, not an electrical problem. At the same time there are certain electrical requirements in the generators. They must have practically the same wave form, they must have the same frequency, the same terminal voltage, and they must be in synchronism. With prime movers of uniform torque, such as water wheels, steam turbines, etc., the question of parallel operation is a very simple one as regards uniform angular velocity. Division of load between alternators depends entirely upon the prime movers; two alternators belted to the same shaft will run satisfactorily in parallel if pulley dimensions are such as to make the frequencies exactly the same, and the tensions on the belts are the same. An inequality of belt tension, however, will divide the load unevenly. Synchronizing connections were treated of by Mr. Mudge, and methods of testing described Several miscellaneous points connected with the subject brought this instructive paper to a close.

Some discussion followed, which brought out the point that the difficulties of parallelism are exaggerated, and that the question largely depends on whether the machine is direct connected or belt driven, whether it is driven from an engine with a single crank or two cranks, and on the nature of the governor.

H. A. Burson, of Allis-Chalmers-Bullock, Limited, discussed the Polyphase Induction Motor. Stepping to the blackboard, Mr. Burson quickly sketched the Behrend circle diagram of the induction motor, and using this as a starting point he opened a discussion. He was bombarded with questions from all sides, but proved himself equal to attack, and he gave satisfactory answers to all questions as to the nature and operation of the induction motor.

For the past three years McGill University has been the scene of some research work which is of great importance and interest to the electrical world, and which is revolutionary in its character. This is an investigation into the Heating of Enclosed Conductors, and in the conclusions which are being reached it is being shown that the present information on the subject is far from complete, and existing tables are consequently quite incorrect. This work was to have been described to the convention by Prof. R. B. Owens, but in his absence Prof. L. A. Herdt discussed the subject. The paradox has been established that the thicker the insulation on a conductor, the more current is required to cause a given rise in temperature. Though this seems absurd at first, it is explained by the fact that the thicker insulation has a greater radiating surface. If two small wires are placed in a small duct they can carry 30 per cent. more current than if they are in a large duct, for in the large duct there is no chance of radiation except where the wires touch the duct, and still air is one of the worst conductors of heat. Consequently, when laying out a system for ten degrees rise, it is necessary to place the wire with as thick insulation as possible, and in as small a conduit as possible. In experiments with bare wire in still air the results tally very well with the tables given in the standard textbooks, but as soon as wires are placed in conduits, the old formulas do not apply at all. So far, these experiments have been conducted for rubber insulation only. Several members of the Association expressed the hope that the work might be carried on to include concentric paper cables and lead-covered wire.

The second afternoon of the convention was spent in sight-seeing. Special cars were in waiting at noon, and carried the party out to Rockfield, where they were received by the Allis-Chalmers-Bullock Co. A splendid luncheon was served in a large tent pitched on the company's grounds, and over two hundred sat down at the tastefully arranged tables. The gratitude of the Association for the hospitality shown was expressed by President Thornton, and replies were made by George Bullock, president of the company, and H. H. Henshaw, the general manager. After the luncheon the party visited the shops, where several large pieces of electrical machinery are now under construction. Demonstrations were made of the operation of coal-cutters, air-compressors, etc.

Time was too short to examine all the interesting things to be seen in and about the shops, for about three o'clock the call, "All aboard!" was heard around the establishment, and the party had to return to the cars. The Association was carried back to the city, to the Maisonneuve sub-station of the Shawinigan Water and Power Co., where there is installed the largest frequency changer ever built. A description of this equipment was given in a recent issue of "The Canadian Engineer."

In the evening special illuminated cars conveyed the delegates to Electric Park, where a smoking concert was held, about fifteen artists having been brought from New York for the occasion. The entertainment went merrily on till the "wee sma' hours," and it may be remarked in passing that the ten o'clock session of next morning did not assemble till about eleven.

Friday morning was devoted to two papers on "Isolated Plants" and "Steam Economy," respectively. The former, "The Economy of Isolated Plants," was prepared by K. L. Aitken, consulting engineer, of Toronto, and read in the author's absence by J. W. Campbell, of the Canadian General Electric Co. The author assumed the position of the purchaser of light and power who wishes to ascertain whether or not it would be a paying investment to instal a plant of his own. "People have often come to me and asked in a very indignant tone why they have to pay more per kilowatt hour for their light than for their motors, having been informed upon good authority that there is little or no difference between the kinds of electricity supplied for the two purposes." Taking this as a text, the author showed that the load factor is the determining consideration in fixing power and light rates in a proportion of something like three to ten, and the same factor is the important one in the isolated plant question. Mr. Aitken has found few plants which he considers economical. Under the ideal conditions the load would be steady all day, with no lighting, but where the energy required for lights is large compared to that taken by motors, the plant must have a capacity sufficient to handle the combination of the two, and consequently the load factor of the system will be low. Wherever the load factor is in any way favorable, the installation of a private plant will effect a material saving over the cost of purchasing energy from a steam-driven central station.

The discussion which followed was entered quite generally, R. G. Black, R. S. Kelsch, J. J. Wright, and Lewis Burran bringing out points for the central station, and A. M. Wickens and J. J. Yorke contesting for the isolated plant. Strangely enough, no mention was made of the storage battery as a means of circumventing the load factor problem, while in a recent address before the Institution of Civil Engineers, Col. R. E. B. Crompton strongly advised the accumulator, even in its present state, as the best solution of this problem in the isolated plant.

The last paper of the convention consisted of "Suggestions for Steam Economy," by Wm. McKay, of the Robb Engineering Co. Questions of grate surface and fuel feeding were dealt with, as was that of types of boilers. Heating of feed water was treated at some length, and then the writer passed on to the consideration of type of engine. Some of the principal causes of loss in steam plants were also spoken of. A discussion followed, which turned largely on questions of grate surface, oil in the boiler, and the brick furnace.

The final session of the convention was purely a business session. A notice of motion was given by B. E. Reesor for an amendment to the constitution to form an Electric Light and Power Section.

A. A. Wright, M.P.

An invitation for the next convention was received from the Halifax Board of Trade, and was seriously considered, but it was finally decided that the meeting should be held in Niagara Falls.

The election of officers was carried out with great unanimity. The new office-holders are as follows: President, A. A. Wright, M.P., Renfrew; first vice-president, R. G. Black, Toronto; second vice-president, John Murphy, Ottawa; secretary-treasurer, C. H. Mortimer, Toronto. Executive Committee—A. A. Dion, Ottawa; B. E. Reesor, Owen Sound; J. J. Wright, Toronto; J. A. Kammerer, Hamilton; C. B. Hunt, London; K. B. Thornton, Montreal; J. W. Purcell, Walkerville; H. O. Fisk, Peterboro'; L. Burran, Quebec; Wm. Williams, Sarnia.

The Question Box, which was, as last year, edited by Mr. Dion, was unfortunately crowded out of the programme, so that there could be no discussion on the questions and answers it contains. It forms quite a large pamphlet, and contains a great deal of information. Over eighty questions are asked, these touching Management, Rates, Water Wheels, Boilers, Engines, Steam Turbines, Generators, Motors, Station Operation, Lines, Wires, Cables, Wiring and Testing, Transformers and Grounding, Meters, Lamps, and a number of miscellaneous subjects. Mr. Dion received the hearty thanks of the Association for his work in this matter, and he will be asked to continue this work next year.

A. A. Wright, M.P., President of the Canadian Electrical Association, was born at Farmersville (now Athens), Ont., June 16th, 1840. He received his education at Athens Public and High Schools, and Toronto Normal School, after which he became head master of the Gananoque Public School. In 1865 he entered the Military School at Montreal, obtaining a first-class military certificate. In 1870 he went into mercantile life at Renfrew, Ont., and in 1886 entered the electrical field by installing an arc plant in that town. This was later supplemented by an incandescent plant, and the business is now carried on by the Renfrew Electric Co., Limited, of which Mr. Wright is president.

Mr. Wright was a charter member of the Canadian Electrical Association, and has been an active member since its organization. In 1899 he was elected member of the House of Commons, which position he still holds.

RAILWAY NOTES.

The Canadian Pacific Railway Station, at Cranbrook, B.C., collapsed while undergoing repairs, and eleven men were severely injured.

The Canadian Pacific Railway is preparing to extend its Calgary and Edmonton branch across the river from Strathcona into Edmonton.

The Dominion Government has given permission to the Windsor, Essex and Lake Shore Rapid Transit Company to extend its line from Essex to Tilbury, Ont.

The Niagara, Dunnville and Erie Electric Railway Company has been authorized to build a line from St. Catharines to Dunnville and Port Dover, and to establish a rural telephone service.

Foley Bros., railway contractors of St. Paul, have been awarded a $3,000,000 contract to make extensions on the Canadian Pacific. This firm recently secured a $7,000,000 contract for constructing on the Grand Trunk Pacific.

Lakes Beautiful and Coquitlam, British Columbia, are now connected by a tunnel and the British Columbia Electric Railway Company have the power generated by the united water of both lakes.

The city council of Brantford has granted the Brantford & Erie Electric Railway, which is to be built this summer as part of the radial system of railways, a western entrance into the city. It will run between Brantford and Port Dover.

Negotiations between the Canadian Northern Railway and the Grand Trunk Pacific for the erection of a Union Depot, at Winnipeg, are still progressing, and the announcement is expected shortly. It is understood that the Northern Pacific are also interested in the project.

The Temiskaming Railway Commissioners have received reports from electrical engineers as to the electrification of the Temiskaming and Northern Ontario Railway, and have decided in favor of the change. Their recommendation is now being considered by the Ontario Cabinet.

An agreement has been reached between the municipal councils of the townships of Pickering and West Whitby and the village of Pickering on the one side and the Toronto and York Radial Railway Company on the other, by which the early extension to Whitby of the Scarboro line of the Toronto radial system is assured.

The London, Chatham and Western Electric Railway Company has been incorporated, with a capital of $2,000,000, to build 113 miles of track from London to Windsor. The company has also been granted permission to sell power with the consent of the municipal councils interested, and to sell light and heat with the consent by by-law of the people. The road must be operated in four years.

The Canadian Street Railway Association recently held their annual convention in Toronto. One of the most important subjects discussed was the efficiency of various fenders, trolley and wheel guards and other contrivances to save life and reduce the number and severity of injuries. A model in wood of a fender resembling the cowcatcher of a locomotive, was shown. It is said to be the most practicable fender for radial lines, throwing whatever may be encountered to one side. The board of officers for the ensuing year were elected as follows: W. G. Ross, Montreal, president; W. H. Moore, Toronto, vice-president; A. H. Royce, Toronto Junction, secretary-treasurer.

INDUSTRIAL NOTES.

The Public Works Department, at Ottawa, has adopted a policy of specifying Canadian cement for use in public works.

The big cement works of the Rathbun Company, one of the first to be established in Canada, at Strathcona, on the line of the Bay of Quinte Railway, are to be closed down at an early date.

A disastrous fire occurred in the business part of Fort Frances, Ont., causing damage estimated at $200,000, with insurance of about half that amount. Incendiarism is suspected.

Dean & Main, of Boston, have placed an order with the Robb Engineering Company for two large boilers for the new factory of the Walter M. Lowney Company at Montreal.

McLaughlin & Ellis, Winnipeg, have purchased about twenty elevators from the McHugh Christensen Co. They are situated at C.P.R. points and range in capacity from 25,000 to 260,000 bushels.

The contract for the Traders Bank skyscraper, Toronto, has been let to V. J. Head, Sons & Co., 1 Madison Square, New York. The architects of the new building are Carner & Hastings, of New York, represented in Toronto by F. S. Baker.

Engineers W. O. and O. C. Hammant have purchased land in Barton township, Ont., for the purpose of erecting a factory for the manufacture of steel dump cars and cars for mining purposes.

The wood-working factory of Chapell Bros. & Co., Limited, Sydney, was completely destroyed by fire; cause unknown The factory was probably the best equipped in Nova Scotia. The loss is estimated at $30,000, on which the insurance is $7,500.

E. R. Baconbridge, Chicago and Midland, has received the contract to build the Grand Trunk's elevator near Midland. The contract calls for an elevator of a million bushels' capacity to be completed next fall. It is to cost $500,000.

The Toronto Board of Control has let the contract for the new tunnel for the waterworks extension to M. J. Haney, of Toronto, at $269,000. The tunnel is part of the million dollar improvement scheme, and is to be used to convey water from the lake under the harbor to the pumping station.

The Grand River Metal Works, Limited, are shortly to leave Galt. This industry has been amalgamated with the Canada Steel Goods Company, of Leamington, and the new company have bought land in Hamilton. A modern factory will be built at once, and the machinery of both companies will be installed.

The Alberta Railway and Irrigation Company, of Lethbridge, has ordered a 175-h.p. Robb-Mumford boiler from the Robb Engineering Company, Amherst, N.S. This makes eight boilers of this type that the company has purchased during the past few years.

A company has recently been formed at Vancouver, B.C., to manufacture a teredo-proof pile covering, an invention of a resident of British Columbia. A pile covered with this material was placed in a very exposed position on the water front three years ago and remains as perfect as when it was first driven.

Final tests of the Canadian Pacific's new grain elevator plant at Fort William, Ont., have been finished, and it is now ready for the reception of wheat. It will be able to unload and store 38,000 bushels per hour and to load into ships at the same time at the continuous rate of 100,000 bushels per hour. Its storage capacity is 6,000,000 bushels.

The application of the Toronto Furnace and Crematory Co., Limited, for permission to locate a foundry and machine shop at the corner of Golden and Silver Avenues has been granted, as was that of the Street Railway to erect a machine and blacksmith shop on the corner of Sherbourne and Esplanade streets.

The Imperial Steel and Wire Co., Limited, will double the capacity of their works at Collingwood at once, making the output fifty gross tons of wire per day. The plant has been running steadily night and day since February last, when it was first put into commission. Additional boilers, engines and machinery will be ordered immediately.

W. R. Townsend, of New York, who some time ago obtained from the New Brunswick Oil Company the right to operate in an area adjacent to Moncton, has begun boring operations. A strong syndicate of New York capitalists are said to be behind him, and if oil is secured, there is expectation that the work will be vigorously pushed.

The Canadian Rubber Company, of Montreal, Limited, has purchased exclusive rights for the manufacture and sale of the "Republic" side wire tires for Canada, and will commence work immediately. This side wire tire is manufactured in the United States by the Republic Rubber Company, of Youngstown, Ohio, and is the latest, and the manufacturers claim, the most scientifically constructed carriage tire on the market. In the United States, the sales of "Republic" carriage tires have reached enormous figures.

Another epoch in the steel industry in Cape Breton was marked on June 14th, when the first rail passed through the rail mill of the Dominion Iron and Steel Company, at Sydney. The machinery worked to the satisfaction of the experts and other officials present. The turning out of the first rail was watched by J. P. Sandberg, an English rail expert, in the interests of the Grand Trunk Pacific, for whom the first order of rails of 25,000 tons will be filled.

Percy Pitman, Ledbury, England, has booked orders for the following Pelton water wheels: 150-B.H.P. for the British Mining and Metal Co., London, for their Devonshire mines; large Pelton wheel for the Glyn Slate Co., for North Wales; high pressure wheel for the Cyanide Plant Supply Co., London, for South Africa; multiple nozzle wheels for A. & Z. Daw, London, for Rio, Mexico, and N. Andrew, Wanganni, New Zealand.

Two hundred practical plate and sheet iron workers are to be brought to Canada from South Wales to be engaged at Morrisburg in the plant which is being established there by the Canadian Tin Plate and Sheet Steel Company. The intention is that these men shall teach the other hands employed there. Among the directors or those financially interested are: N. Lewis, of Cardiff, Wales; Messrs. A. C. Pratt, M.P.P.; G. P. Bull, E. P. Pearson, J. J. Main, and others of Toronto; C. H. Meldrum and J. W. Allison, New York.

The Northern Aluminum Company, Shawinigan Falls, Que., is doubling the capacity of its works, in order to make provision for the manufacture of finished materials, such as aluminum plates, rod and wire. The new buildings required will cost between $200,000 and $300,000. These include an additional furnace room measuring 200 by 100 feet, a building to be used for wire mill, measuring 250 by 150, and an office building.

A meeting of the shareholders and creditors of the Laurie Engine Co., Montreal, has been called, to appoint a liquidator. The company was incorporated in June, 1894, with an authorized capital of $250,000, to take over the business previously carried on by the firm of Laurie Bros. There was not any great amount of cash capital then contributed, and though the business has been an active one, the earnings have always gone into plant extension, and they have nearly always shown more or less strain in the conduct of their finances. Recently a syndicate of the principal shareholders endeavored to effect a reorganization, offering to buy out the general shareholders at a figure, and put in a certain amount of fresh capital, but this scheme has apparently fallen through, and liquidation will follow.

MINING MATTERS.

Iron ore in abundance has been discovered at Riding Mountain, Man.

The Montreal and Boston Consolidated Company has closed down its mines in the Boundary district, B.C. The exact cause of this action is not known.

A rich deposit of iron ore, according to a report at the Parliament Buildings, has been discovered on the English River, north of Kenora, and near the boundary line between Ontario and Keewatin.

The convention of the American Institute of Mining Engineers is being held in Victoria B.C., on the 3rd, 4th and 5th inst. At the close, the party will leave by steamer for Skagway and about ten days will be spent in Alaska and the Yukon.

The Tip-Top copper mine and machinery, on Round Lake, Ont., has been sold to Colonel Ray for $23,000. There is on the property a complete set of camp buildings, machinery and ore dump, which with ore actually in sight is valued at $400,000.

The Western Fuel Company, of Nanaimo, has closed the principal mine there, No. 1, which has been operating continuously nearly thirty years. One thousand men are out of employment and a town of 5,000 deprived of almost its sole source of income, as the result of the refusal of the men to accept the company's terms.

The Acadia Coal Company has struck coal in their No. 2 Allan shaft, near Stellarton, N.S. From the small portion of the seam uncovered, the coal appears to be even superior in quality to that mined from the same seam in the operations of the Foord pit, which was considered unequalled in Canada. This will enable the Acadia Coal Company to quadruple their present production, since the mine will have a capacity of 240 tons per hour.

PERSONAL.

J. A. Macdonald, Hermanville, P.E.I., and party, are making preparations to start on a surveying trip for the Transcontinental Railway, through the forest north of Lake Nipissing.

George D. Hunt, formerly with the Fensom Elevator Co., has opened an office at 114 Yonge St., Toronto, as Canadian representative for John Bennie, Star Elevator Works, Glasgow.

W. H. Wiggs, proprietor of the Mechanics Supply Co., Quebec, was made the recipient of a handsome presentation from his employees on the eve of his departure for England with the Manufacturers' Association excursion last month.

Charles Chaplin, M.Sc., Demonstrator in Civil Engineering at McGill University, has now assumed the position of Mechanical Engineer of the Dominion Arsenal, at Quebec, to which he was appointed some time ago.

Mr. C. J. Fensom, B.A.Sc., who for some years has been connected with the Fensom Elevator Works, has opened an office, as consulting engineer, in the Aberdeen Chambers, corner of Adelaide and Victoria streets, Toronto.

Capt. C. P. Marshall, of the Canadian Pacific Railway steamer Empress of India, has retired after fourteen years' service. He has been appointed one of the Elder Brethren of Trinity House, the corporation which looks after the lighthouses of the coast of Great Britain.

Clarence Morgan, of Burlington, Vermont, has been appointed professor of the new transportation department in connection with the faculty of applied science at McGill University. Mr. Morgan has been in the service of the New York Central Railway and has been treasurer of the Rutland Railway. He is a graduate of Harvard University. He will take up his duties at McGill in September next.

B. F. Reesor, general manager of the Light, Heat and Power Co., of Lindsay, Ont., has resigned in order to take charge of the Georgian Bay Power Co., recently organized to develop power for transmission to Owen Sound and vicinity. It will take a year or more for the construction of these works, which will yield about 3,000-h.p. Mr. Reesor's son, W. E. Reesor, succeeds to the management of the Lindsay company.

E. C. Reeder mining engineer, who has just been appointed representative of Allis-Chalmers-Bullock, Limited, at Nelson, B.C., is a native of Michigan, and received his education in the Public Schools of that State. He graduated later from Michigan College of Mines as mining engineer, and supplemented his college work with courses at the Massachusetts Institute of Technology. He had several years' practical experience in Montana after graduating, where he worked as a miner and smelter man in the mines and smelters at Butte. Later he went to Utah, where he held responsible positions as foreman and engineer for several of the large mining and smelting companies of that city.

A number of changes of importance are announced in connection with the operation of Mackenzie-Mann interests in Canada and elsewhere. Ewan Mackenzie, superintendent of construction of the Toronto Railway, has resigned to become a railway contractor: His first work of importance will be the construction of the Metropolitan line from Newmarket to Jackson's Point, on Lake Simcoe, north of Toronto. Alex. Smith, brother of J. M. Smith, comptroller, who has been twenty-one years in the street railway service, also has resigned. He was electrical superintendent, and is succeeded by J. Donnelly, of Cincinnati. W. H. Moore, secretary of the Canadian Northern Railway, and manager of the York Radial Railway, has resigned from the latter. James H. Wallace, inspector of the Toronto Railway, has an appointment under E. H. Keating, resident manager in Monterey, Mexico, of Messrs. Mackenzie & Mann.

LIGHT, HEAT, POWER, ETC.

The Southwestern Traction Company, London, has decided to enlarge its power house.

The Selkirk Electric Light and Power Company has been organized and incorporated with a capital stock of $50,000. Winnipeg and Selkirk parties are interested, and the object is to furnish electric light and power to consumers of Selkirk.

The Chatham, Wallaceburg and Lake Erie Railway Company is building a new line of electric railway from Chatham to Wallaceburg, Ont., a distance of about twenty miles, through a rich farming and fruit-raising country. An order for four double equipments and one quadruple equipment of No. 101 railway motors has been placed with the Canadian Westinghouse Company, Limited.

The negotiations which have been pending for some time between the Cornwall Street Railway Co. and the Stormont Electric Light and Gas Co., have been brought to a close by the former taking over the business of the latter. Extensive changes will be made at once under the direction of W. Hodge, superintendent, which will reduce expenses and ensure better service.

The Windsor and Tecumseh Electric Railway is to be equipped with 300-K.W. 3,300 volt Westinghouse single-phase engine type generators, direct coupled to Robb-Armstrong engines, and its car equipments are to consist of two 50-h.p. Westinghouse single-phase motors each. As this is the first single-phase road in Canada, its development will be watched with considerable interest. One of the advantages of this equipment for short interurban roads is the elimination of feeders, sub-stations and raising transformers. The generator voltage is fed directly to the car through the trolley wire, and step-down transformers are carried by each car.

To take care of its rapidly increasing business, the Hamilton Cataract Power, Light and Traction Company is making extensive additions to its power plant at De Cew Falls. Orders specifying prompt delivery have been placed with the Canadian Westinghouse Company, Limited, for the following apparatus: Two 6,400-K.W., three-phase, 2,400 volt, 8,000 alternation, 287-R.P.M.; two bearing generators with motor-driven exciters and switchboard apparatus; four 3,200-K.W. oil insulated water cooled raising transformers.

In the surveys for the improvement of the Tennessee river, the United States Government engineers have shown that a power plant may be erected and the river improved at the same time. A charter is now being granted to a private company, who will develop the water power under the supervision of the Government engineers. It is expected that 36,000-h.p. will be generated, all of which will be delivered in Chattanooga. This is the first power development in which the Government has taken an active part.

MUNICIPAL WORKS, ETC.

Portage la Prairie, Man., will spend $20,000 on improvements and additions to the local gaol.

A by-law to grant $35,000 for an electric light plant will be voted on in Napanee.

At Gananoque, a by-law to grant $35,000 to complete the waterworks and sewerage systems will be voted on by the people.

Southampton, Ont., ratepayers have voted for a by-law to spend $4,000, chiefly for the extension of the waterworks system.

Property owners of Vancouver voted in favor of by-laws to raise $500,000 for the improvement of the city streets and the erection of a new fire station.

At Indian Head, N.W.T., the by-law to borrow $150,000 to secure electric lighting, waterworks and sewerage for the town passed almost unanimously.

$57,000 is to be spent on extending and improving the waterworks system of Sarnia, Ont. A five-million imperial gallon pump will be put in.

The city council of Fredericton has definitely decided in favor of a sewerage system, and it is expected that tenders for the work will soon be called.

The Woodstock water and light commissioners have recommended the expenditure of $50,000 on the city's plant. It is proposed to built a reservoir at a cost of $18,000, and to purchase a new pump for $13,500.

Dalhousie, Ont., has decided to engage an engineer to look into the question of water, sewerage, and electric light, and to furnish estimates on the cost of plants for these necessary works.

TELEGRAPH AND TELEPHONE

It is proposed to form a local company, in Manitou, Man., to install a telephone system.

The Bell Telephone Company announces to its shareholders that they will have an opportunity of subscribing for an additional $1,000,000 of stock at 125. This will bring capitalization up to $8,000,000.

The Cunard steamship Campania, on a recent trip, received messages direct from the Marconi station at Poldhu, Cornwall, at a distance of 2,200 miles, thus establishing a new wireless long-distance record. The previous record was about 2,000 miles.

While visiting in England this summer, Sir William Mulock will visit some of the cities and towns in which municipal telephone systems are established, with a view to reporting thereon to the special telephone committee. He will also consult with the authorities of the British Telegraph Department with a view to ascertaining how the trunk telephone system is being operated.

The Government of Newfoundland has recently introduced in the Legislature a bill imposing an annual tax of $4,000 on every telegraph cable landed on the coast of the island; a tax of 1 per cent. on the traffic receipts of every telegraph company doing business in the colony; a tax of $4 on every telephone operated, and $4,000 on every wireless telegraph company doing commercial business, those which only report ships being exempt. So far, the only company affected by the proposed law is the Anglo-American Telegraph Corporation, which operates cables, land lines and telephones, on which it will have to pay nearly $40,000 annually under this scheme of taxation.

At the annual meeting of the New Brunswick Telephone Co., held in Fredericton, it was decided to erect a number of lines during the present season. They will include a line from Chatham to Dalhousie, connecting with Bathurst, Campbellton, and other places along the North Shore, also a line from Canterbury to McAdam, another from St. Stephen to Moore's Mills and from Lepreau to Musquash. The company also decided to connect with the Kamaraska Telephone Company, by extending the line to Edmundston. A $6,000 brick building will be erected in Fredericton for the use of the company's head offices.

MARINE NEWS.

The city of Toronto has been authorized to expend $45,000 for a freight shed on the city wharf.

The Dominion Parliament has voted $30,000 for the further prosecution of hydrographic surveys in the St. Lawrence and on the Pacific coast.

The Quebec Steam Whaling Co. has purchased the steamer Falke in Norway, for whaling purposes in the Gulf of St. Lawrence. The Falke was expected to reach Quebec June 15th.

Merchants and business men of Quebec have petitioned the Dominion Government to abolish the tax of 5 cents per register ton on shipping at that port.

The Nova Scotia Government will extend the breakwater at Port Morien 260 feet, at a cost of $25,000. The work is to be of a permanent character.

The St. John, N.B., city council has decided not to build the straight wharf for the winter steamboat trade, as was reported recently.

Portage la Prairie, Man., will issue $10,000 worth of debentures to pay for the raising of the Crescent Lake bridge, so as to allow of large launches passing under.

The French steamer Pro Patria, running between St. Pierre, Miquelon, and Nova Scotia ports, which went ashore at Forchee at the end of May, has been abandoned as a total loss, and will be sold by the underwriters.

The old steamer, John Instine, has been rebuilt and renamed the John Randall. She has been fitted with new compound engines, and is intended to run between Rideau Canal points and Oswego, N.Y.

The Reid Wrecking Co., of Sarnia, proposes to build a floating dry-dock at that place. It has already begun the work of constructing a new 380-foot wharf on its property recently acquired there.

The Richelieu & Ontario Navigation Co.'s steamer Canada, which was sunk after collision with the Cape Breton and subsequently raised, has been rebuilt at the Davis shipyards, Quebec. She is now at the company's yards at Sorel, Que., being refitted.

The steamer Pierrepoint has been chartered by the Department of Marine as a lighthouse tender to temporarily replace the burned steamer Scout. The Scout has been raised and will be reconstructed. The cost of this work is at present estimated at $50,000.

The Dominion Government has passed an order in council providing for reciprocity with the United States in regard to steamboat inspection. The Secretary of Commerce and Labor will, in accordance with the powers vested in him, make a similar order in respect of Canadian vessels requiring United States inspection.

The Niagara Navigation Co. has arranged to inaugurate a freight service on its line between Toronto and the Niagara River during the current season of navigation. W. E. Tibbetts, Toronto, has been appointed general freight agent. The steamers of the company will make close connection with the trains on both sides of the Niagara river.

The Great Lakes Steamship Company will put another steamer on the route between Montreal and Lake Superior in the general grain and merchandise traffic. The vessel, which has been named the Royal, is under construction at an English shipyard. She will be 256 feet long, 48 feet beam, and 20 feet deep, and will carry 75,000 bushels of grain through to Montreal.

A test has been made in Hamilton, Ont., Bay, of a vessel propelled by water pumped through a brass tube running along the full length of the hull. On the trial a 45 ft. boat was used and a 37-h.p. gasoline engine was used to pump the water into the tube in which there is a number of valves. It is claimed that the compression of the water in being forced through the tube makes the vessel move. The inventor is J. Dudley. Those interested propose forming the Hydraulic Navigation Co.

A delegation composed of Hon. Richard Turner, Messrs. H. M. Price, J. T. Ross, Thomas Harling, J. G. Scott, and W. A. Kingsland, representing a proposed new steamship company, waited upon the Quebec Harbor Commissioners recently. This company, to be known as the Quebec Transportation Co., hope to establish a line of steamers with Great Britain; Quebec to be its terminal point in Canada. The vessels are to be owned and managed in Quebec, and are to form a fortnightly line from that port. To assist in the establishment of the line, the delegation ask that the company be exempt from all harbor dues, and be given the use of certain berths. The requests of the committee will be considered.

The steamer City of Collingwood was burned to the water's edge on June 19th, at the cost of the lives of four of the crew. Those burned to death were: James Meade, Prescott, fireman; Lyman Peters, Owen Sound, deck hand; A. McLellan, East Tawas, Mich., deck hand, and one deck hand not identified. The City of Collingwood was the flagship of the Georgian Bay division of the Northern Navigation Company, and was valued at $125,000. She was built by John Simpson, in Owen Sound, in 1893. She was a wooden vessel, 213 feet long and 34 feet wide, and was insured for $80,000. The Grand Trunk freight sheds were also destroyed, the loss being estimated at $20,-000.

The International Waterways Commission began its regular sessions in Toronto the second week in June, meeting two or three times in private conference. The Canadian Government has acceded to the United States' claim that the scope of the commission covers only those waterways whose natural outlet is the St. Lawrence, on the understanding that at the next session of Congress there will be special legislation for the purpose of widening the powers of the Commission to inclrde the St. John river, on which there are difficulties requiring settlement. Among the problems that have come up for consideration by the Commissioners is the building of a dam at the outlet of Lake Erie, and the probable effects of such a work on the lower St. Lawrence levels. The Commission is now adjourned, to meet Montreal on July 7th. Sessions will later be held in Buffalo, Toledo, Detroit, Sault Ste. Marie, and other points along the Great Lakes. Public sittings will be held, which will be duly announced, where cases may be laid before the Commissioners by interested parties.

NEW INCORPORATIONS.

Dominion.—The Portland Mica Co., Ottawa, $6,000; F. W. Webster, Boston, Mass.; J. F. Higginson, Buckingham; H. Allen, Ottawa; W. R. Taylor, and T. W. Symmes, Aylmer.

Ajax Metal Co., Montreal, $50,000; G. M. Pyke, J. R. Meadowcroft, W. D. Hutchins, W. J. Henderson, and W. D. Garland, Montreal. To deal in metals and compositions of metals.

The Ottawa Cement Block Co., Ottawa, $10,000; L. S. Macoun, J. D. LeMoine, G. S. May, R. Wright, and C. A. Irvin, Ottawa. To manufacture blocks of cement, concrete, and other material for building purposes, and to carry on the business of contractors for the construction of buildings.

The Model Building Stone Co., Montreal, $20,000; J. Boddy, A. Valine, D. Loynachan, J. E. Wilder, Montreal, and J. M. Reid, Outremont. To deal in building and cement stone, artificial and composite stone, bricks, tiles and sewer pipes.

Laird Paton & Sons, Montreal, $95,000; J. Paton, H. L. S. Paton, W. J. Thompson, J. Sutherland, Montreal, and G. A. Robertson, Westmount, Que. To take over the business carried on by Laird Paton & Sons, Montreal, also to deal in and repair yachts, boats, canoes, etc.

Kakabeka Power Co., Fort William, $100,000; H. S. Holt, C. R. Hosmer, F. W. Thompson, H. W. Norton, Montreal; and F. H. Phippen, Winnipeg. To carry on the business of a power and electric heating and lighting company.

The Barnett-McQueen Co., Winnipeg, $20,000; L. C. Barnett, Superior, Mich.; F. R. McQueen, R. C. Hanna, Minneapolis, Minn.; W. H. McWilliams, H. Sutherland, Winnipeg, Man. To carry on the business of mechanical and electrical engineers and contractors.

Shippers Cartage Co., Montreal, $1,500,000; A. C. Casgrain, C. M. Cotton, S. J. LeHuray, K. J. Beardwood, and L. L. Legault, Montreal. To operate machine shops, blacksmith shops and factories for the manufacture of wagons, drays, automobiles, etc.

Ontario.—Eagle Lake Gold Mining Co., incorporated in Arizona, has been granted a charter to operate in Ontario.

The Chatham Steam Heating Co., Chatham, $40,000; G. W. Kipp, E. Walen, Tonawanda, Pa.; J. T. O'Keefe, W. N. Warburton, and N. H. Stevens, Chatham. To operate works for the production of steam, hot air, or water for the purposes of power and heating, also to distribute electricity or natural gas for similar purposes.

Temagami Navigation Co., Toronto; $50,000; J. E. Russel, S. Hall, J. M. Sinclair, J. J. Main, A. H. Jeffrey, Toronto. To establish lines of steamers and build wharves, piers, docks, etc.

Russel Elevator Co., Toronto, $20,000; J. Russel, A. Russel, E. Marshall, C. Q. Parker, and A. T. Struthers, Toronto. To manufacture elevator and hoisting machinery.

Toronto Construction Co. Toronto, $200,000; G. S. Deeks, A. B. Cook, Toronto; W. Winters, Spokane, Wash.; H. H. Boomer, and T. R. Hinds, Butte, Montana. To carry on business as contractors for railways, canals, bridges, docks, etc.

Doolittle & Wilcox, Hamilton, $100,000; C. M. Doolittle, H. W. Wilcox, W. Doolittle, Hamilton; F. W. Schwendiman, and M. W. Schwendiman, Tp. Barton, Ont. To carry on business as quarrymen, miners, etc., and to enter into contracts for the construction of roads, bridges, etc.

The Port Rowan Natural Gas Co., Port Rowan, $40,000; C. S. Killmaster, J. L. Buck, W. O. Franklin, F. H. Pearsall, J. Hanson, and E. Meek. To drill for and sell natural gas for purposes of heat, light and power.

MacDonald Engineering Co., incorporated in Illinois, to construct elevators, warehouses, power plants, etc., has been incorporated in Ontario, to use not more than $50,000 capital. W. H. Adamson, Toronto, attorney.

New York Oil Co., incorporated in Arizona, U.S., has been granted a charter to operate in Ontario, provided not more than $1,000,000 capital is used.

Crescent Oil and Gas Co., incorporated in Arizona, has been granted power to use $1,000,000 capital for operations in Ontario.

The Welch Manufacturing Co., Toronto, $40,000; A. H. Welch, A. J. Welch, A. Welch, L. M. Welch, and E. G. Welch, Toronto. To deal in gold, silver, and precious stones and metals of all kinds, to operate mines containing metals or precious stones, and maintain establishments for grinding and polishing the same.

Manitoba.—Russel Telephone Co., $5,000; A. G. P. Smellie, W. J. Doig, J. J. Moon, T. A. Wright, and A. Tingley, Russel. Operations to be carried on within the municipalities of Russel, Silver Creek, Boulton and Schell River.

Melita-Arthur Telephone Co., Melita, $10,000; D. Day, F. C. Coulter, J. V. Collard, A. Gould, J. F. Atkinson, M. S. Shantz, Arthur; J. W. Hunt, Lyleton; and W. J. S. Atkinson, Melita. To do business in the village of Melita and municipality of Arthur.

British Columbia.—Salmon River Placer Mining Co., $40,000.

Boundary Iron Works, $25,000; to manufacture machinery, tools, and carry on business as founders.

The William Ralph Co., $50,000; to carry on business as sanitary, lighting, heating, and electrical engineers and contractors.

Laclede Mining Co., $150,000.

The Pollock Mines Co., $1,000,000; to purchase and carry on business in "Maple Leaf," "Pine Knot," "Daisy," "Martin," and "Minnehaha," mineral claims in Yale, B.C.

—The Krupp Company, at Essen, Germany, is turning out field pieces made of paper. They have half the lightness of forged steel, but will endure an equal strain. They are mounted on light carriages to be drawn by infantry.

CATALOGUES RECEIVED.

Cadiz Electric Co., Cadiz, O.—Price list of telephones, tools and appliances.

John Watson Manufacturing Co., Limited, Ayr, Ont.—Forty-page catalogue, of trucks, wheelbarrows, casters, etc.

The following catalogues have been received since last issue, and may be obtained from the respective firms by mentioning "The Canadian Engineer:"

Pratt & Whitney Co., 111 Broadway, New York.—A novel folding postcard, shows photographs of a new 12 by 48 thread rolling machine and several of its products.

The Skinner Chuck Co., New Britain, Conn.—This company announce a new independent lathe chuck, of which they will send a catalogue to any one interested.

The United Electric Co., Limited Toronto, announce that they are now ready to quote on Johnson D. C. multipolar, multispeed motor.

David Williams Co., 232-238 William St., New York.—The Iron Age Directory for 1905 is now issued, and contains a classified list of 1,400 dealers in iron goods of all descriptions.

Stevens Co., of Galt, Limited.—Announcement of vise manufactured by this company for which special features are claimed.

Cameron & Sutherland, Melbourne and Ballarat.—A folder describing the Dodge split pulley, "made in Canada," for which this firm is the agent.

W. H. Blake Steam Pump Co., Hyde Park, Mass.—Catalogue 25, illustrating jet and surface condensers of all sizes. Eight pages, 6 by 9.

Michigan College of Mines, Houghton, Mich.—As a supplement to the regular year book, the college has issued a book of views, giving a couple of dozen photographs taken in and about the college, which shows the scope of the work undertaken.

Canadian Westinghouse Co., Hamilton.—Booklet on Points for Consideration when Purchasing Series A. C. Lamps, being a paper read by G. Brewer Griffin, before the Ohio Electric Light Association. Fully illustrated.

Superior Portland Cement Co., Limited, Orangeville.—Portland Cement; Its History, Manufacture and Possibilities, being a booklet of sixteen pages, describing the present condition of the industry in Canada.

Jeffrey Manufacturing Co., Columbus, O.—Folder illustrating contractors' outfits made by this company, including excavating, screening, elevating, and other apparatus. Also folder illustrating crushers and pulverizers.

Hyatt Roller Bearing Co., Harrison, N.J.—Bulletin 118, containing report of comparative frictional tests of Hyatt Roller Bearings, cast iron, bronze, and babbitt bearings. Also Bulletin 123, containing correspondence compiled from the records of the sales department.

Consolidated Engine-Stop Co., 100 Broadway, New York.—A small booklet, with the appearance of a law book, which contains a judgment given in Rhode Island in which the possession of a Monarch Engine-Stop exonerated the proprietor of responsibility for injuries to a workman.

Westinghouse Electric and Manufacturing Co., Pittsburg.—Two booklets containing papers read before the Ohio Electric Light Association, viz., Notes on Incandescent Street Lighting, by K. C. Randall, and Instrument Equipment of a Testing Department by F. Conrad. Also Bulletin 1,113 on belted type rotating field alternators.

Wellman-Seaver-Morgan Co., Cleveland, O.—Ore and coal handling machinery, a magnificent catalogue of over 100 pages, 9 by 12, printed in two colors on enamelled paper, with lined cover. The contents treat of ore unloaders, bridges, cranes, car-dumping machinery, locomotive cranes and derricks, and excavating buckets.

Canadian General Electric Co., Ltd., Toronto.—Construction Material, being Section 3 of the Supply Catalogue, showing insulators, tapes, brackets, construction tools, etc. 60 pages, 8 by 10. Also Bulletin 836, single phase Thompson type I. induction meter for house service.

Yale & Towne Manufacturing Co., 9-15 Murray Street, New York.—Two small booklets published for the International Railway Convention. One deals with locks, builders' hardware and door checks, and the other with chain blocks and electric hoists.

Niles-Bement-Pond Co., 111 Broadway, New York.—Progress Reporter for May, showing thread milling machine, chucking lathe, multiple drills, bending rolls, and other machines.

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—Fire broke out in the electric light station at Atlin, B.C., which for a time threatened the whole town. The electric light station, the Northern Lumber Co.'s mill, and the steam laundry were totally destroyed. The loss is $60.-000, with no insurance.