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MISSING

The Canadian Engineer

ESTABLISHED 1893.

WITH WHICH IS INCORPORATED

THE CANADIAN MACHINE SHOP.

VOL. XIII.—No. 6. TORONTO, JUNE, 1906. PRICE 15 CENTS $1.00 PER YEAR.

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

Longfellow.

J. W. Tyrrell, C.E.

President, Association of Ontario Land Surveyors.

Roads have in all times been among the most influential agencies of Society; and the makers of them, by enabling men readily to communicate with each other, have probably been regarded as among the most effective pioneers of civilization. —(Smiles: "Lives of the Engineers.")

At the present time, the eyes of Canadian engineers are being directed towards Hudson Bay—the "Mediterranean of of America." Reports are coming down from the North, of recently discovered coal beds and extensive ore deposits near the shores of the great inland sea. From the lips of Captain George Comer—the famous whaler who knows more about the northern waters of Hudson Bay than any other man living—we have heard the story of the wonderful resources of fish, porpoise hide, walrus ivory, and even whales abounding in this long neglected region. All that it requires, is a statesmanlike policy on the part of the Ontario Government of encouraging enterprize; then the best engineering skill will soon be at work, navigating the Albany River—in accordance with the unique project of Col. Harvey, laying down railway lines from thence to Lake Superior on the one hand, and Toronto on the other; opening out to the teeming millions in the Northern States and the rising populations of Ontario, an abundant food supply; and developing lines of business which will give employment to multitudes; cause thriving towns to arise in the wilderness, and thus contribute to the progress and wealth of the Dominion. The time is ripe, and thanks to the geologist and surveyors, excellent maps of the lands near the western shores of the great sea are available. To no man is the country more indebted for this than to the distinguished civil engineer and explorer, whose portrait appears above.

J. W. Tyrrell, was born at Weston, Ontario, May 10th, 1863. Educated academically, at Weston High School, and technically, at School of Practical Science, Toronto; graduating in civil engineering, May, 1883. His first two years of business life were spent on topographical and geological work in the Lake of the Woods district, under Dr. R. Bell, late chief of the Canadian Geological Survey. In April, 1885, was appointed Provincial Land Surveyor for Ontario; immediately followed by selection as Dominion Hydrographer and Meteorological Observer, in the Government expedition to Hudson Straits and Bay—under command of late Lieut. A. R. Gordon: and spent two eventful years in these far northern latitudes. In 1887, he was commissioned as Dominion Land Surveyor; but shortly afterwards accepted position as assistant engineer on the International Railway of Maine (Eastern extension of C. P. R.). Upon completion of this line in autumn of 1887, he retired into private practice, as engineer and surveyor, in the city of Hamilton. The degree of "C.E." was conferred upon him by Toronto University, June, 1889. Upon receiving in 1893 an irresistible call, he left his flourishing private practice, and started out with his brother, J. B. Tyrrell, upon one of the most notable modern exploratory journeys; 3,200 miles through the so-called Barren Lands lying on the northwest of Hudson Bay. The story of this remarkable journey, is told in a book from his pen entitled, "Across the Sub-Arctics of Canada"—now in its third edition. Seven years later, while occupied on professional work in a remote section of Rocky Mountains, he received a telegram from the hand of an Indian courier, requesting him on behalf of the Canadian Government, to take charge of an exploration over the country between Great Slave Lake and Hudson Bay. This 4,600 miles journey in dog sleds, etc., occupied eleven months. An official report was published in 1901 by the Department of the Interior. Following this adventurous journey, we next find Mr. Tyrrell in the Klondike—in conjunction with his brother, "J. B."—surveying, and doing some profitable mining. Since his return from the Klondike he has been actively engaged on private surveys, and the making of reports on mining propositions; as well as surveying settlement lands for the Canadian Government in various parts of the Dominion. His latest expedition was made for a private company to the mouth of the Churchill River, on the western coast of Hudson Bay. Mr. Tyrrell is **the** authority on the western lands which bound the inland sea about to be opened out to civilization.

In physique, Mr. Tyrrell is the personification of perennial youth; in manner unassuming—but his real worth has been recognized by the men who know him best: manifested in his election to the honorable position of president of the Association of Ontario Land Surveyors. His name will live in the scientific records of his country as one of the pioneers who have risked health, life, and limb in the plotting out of roads and lands by forest and flood in the wilderness and solitary places; so that the emigrant and settler may have landmarks to guide them in founding communities and building new cities, which some day will give an additional lustre to the fame of this fair Canadian land.

EUROPEAN HYDRO-ELECTRIC DEVELOPMENT

By Charles H. Mitchell, C. E.

ITALIAN PLANTS AT MILAN.

III.

That Milan is one of the most prosperous and enterprising of European cities is well known. It is the centre of the great plain of Lombardy, which for centuries has been famous for its wealth in agricultural products and dependent industries. The city has always been the commercial metropolis of Northern Italy, and is now the emporium of all Italy, just as Genoa is the national seaport.

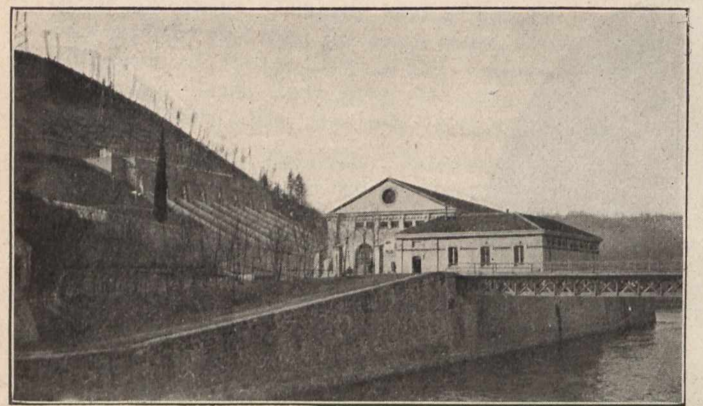


Fig. 1.—Paderno: General View of Station.

To describe the industries of Milan would require a lengthy enumeration of nearly all branches of commerce and manufacture; and the long list would, without a doubt, represent a greater diversity of interests than any American city of like size, and even larger population. The proximity of Milan to the Alps on the north and availability of economical electric power from hydraulic plants situated within transmission distance of the city has had the natural result of stimulating industry and establishing numerous factories.

The first application of electrically transmitted power was, of course, to lighting and traction, and for this purpose the pioneer company, "Societa Generale Italiana Edison di Elettricita," constructed and commenced operating a hydraulic plant at Paderno, on the Adda River, twenty-five miles north-east of the city. This was in 1898, but the same company had already a steam plant in Milan dating from 1883, with railway and lighting franchises. After the installation of the hydraulic plant, motor power for manufacturing purposes came gradually into great demand, with the result that this company not only extended its original hydraulic and auxiliary steam plants, but, with partially allied companies, has recently installed several other hydro-electric generating stations, with which the Paderno and steam stations run at times in parallel. These new stations are Zogno, 40 miles distant north-east, which commenced operation about January 1, 1905; Vigevano, 20 miles south-west, commenced operation January 15, 1906, and Trezzo, 20 miles east, which will commence in the summer of 1906. The plants of these companies supply not only the city of Milan, but groups of large towns lying to the east and north, such as Monza, Brianza, etc., aggregating some 35,000 h.p. The second group of plants is that owned and operated by the "Societa Lombarda per Distribuzione di Energia Elettrica," which came first into the field with its plant at Vizzola, 30 miles north-west of Milan, in 1901, and later with a smaller one at Turbigo, 25 miles west in 1905, aggregating about 25,000 h.p. The latter, however, is not sent to Milan, but is distributed to numerous small cities to the north and west.

As examples of the hydraulic installations in the vicinity of Milan, the two large plants of the parent groups are chosen in this article as representing the practice in construction. In some respects these two developments are similar, but each has special features of interest. Viewed from the American standpoint, the substantiability and ponderous construction of each is most noteworthy.

The Paderno Station, Adda River.

The Adda River is the outlet from Lake Como, which is supplied by glacier-fed streams from the Alps. At Paderno which is about 15 miles from the lake, the river is in a broad, winding valley, and has such a fall as to produce a head of about 90 feet in a distance of a mile and a half. The flow of the river varies between 2,000 cubic feet per second and a flood discharge of, perhaps, ten times as much.

At the head works, a previous river regulation system, some 200 years old, was partially utilized in securing an adequate supply of water, and, with the reconstruction of earth embankments and the introduction of a needle weir with adjustable crest, a maximum supply of 1,600 cubic feet per second was ensured. Below this is a series of basins and short canals, one of which is navigable for shallow draft, and, after passing a headgate, the water for the station is carried by means of tunnel and cutting about 7,500 feet to the forebay on the hillside, above the station. The forebay or receiving basin, shown on the left of Fig. 1, is a heavy masonry chamber, in which the velocity of water, after 8 feet per second in the tunnels, is reduced to about 3 feet. At one end of the basin is a weir discharging to a waste-way, consisting of a flight of colossal masonry steps, 95 feet high and 90 feet wide, down which surplus water spills to the Adda, alongside the station.

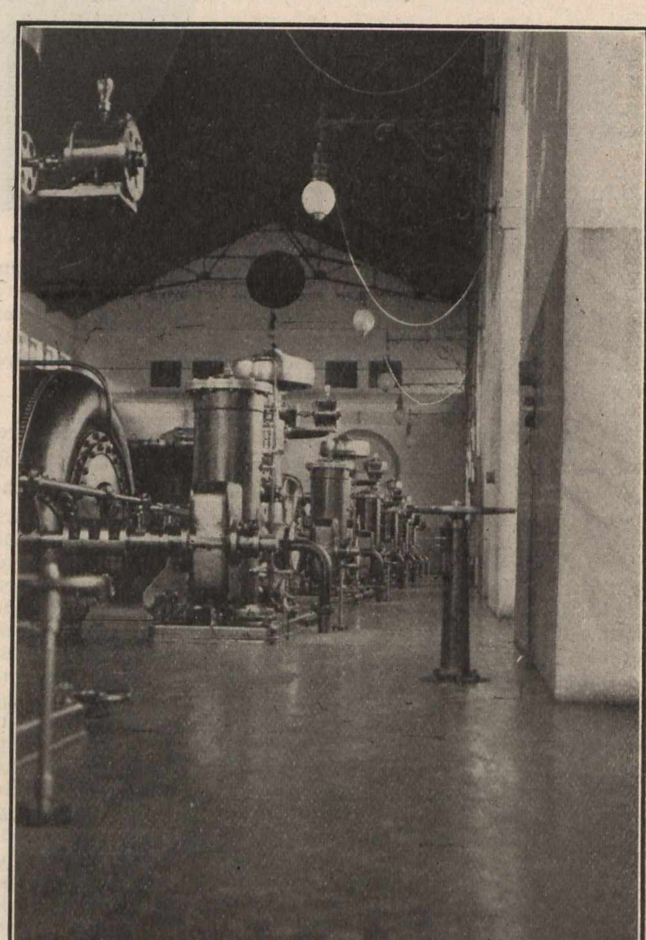


Fig. 2.—Paderno: Turbine Governor.

The seven penstocks, 7 feet in diameter, discharge from the bottom of the forebay, each having a separate bay, closed with a sluice gate and protected by screens; they are carried down at an incline to the station rear wall, a length of 205 feet and, entering under the floor, are fitted with butterfly valves just before connection to the wheel cases.

Seven main units, each of 2,200 h.p., under the normal head of 94 feet, constitute the power installation. Each unit consists of a single reaction turbine, made by Riva, Monneret & Co., of Milan, and a 1,500 kw. three-phase alternator by Brown, Boveri & Co., of Baden, directly connected, on horizontal shaft, at 180 r.p.m. The turbine runners are "American" type, having inward or radial admission, with register gates and axial discharge. The governors, shown in Fig. 2, are operated automatically by water pressure from direct acting pumps, and give close

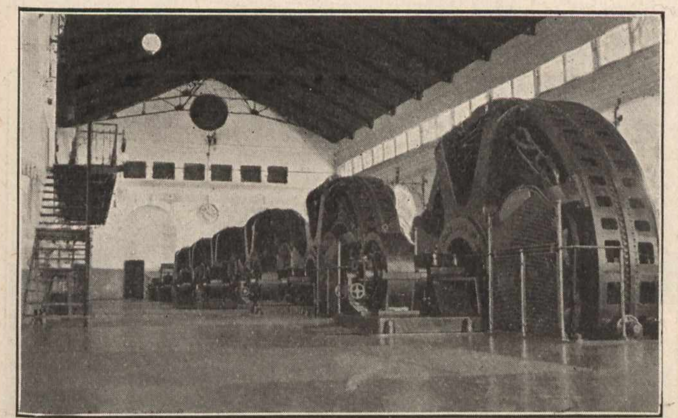


Fig. 3.—Paderno: Interior of Generating Station.

regulation. The generators are wound for 14,000 volts at 42 cycles, and work through the switchboard to the transmission directly, without transformers. In the days when this electrical equipment was installed the high generating tension was a new departure, but there never has been trouble from such cause; and, indeed, the paralleling of this with the steam station at Milan and with other hydraulic plants is frequently accomplished without incident. Fig. 3 is an interior view of the station, showing generators and switchboard gallery.

The transmission lines of the Paderno plant have become noteworthy in electrical engineering, as they were the first in Europe using metallic poles with high tension. All the fears then expressed have proven groundless, and this line, traversing a region where storms are violent, has been remarkably free from troubles. In the light of transmission practice of the present day, however, with tensions three and four times that of Paderno, much that has been learned from this pioneer European work is now eclipsed by American practice. The line towers, with a roadway crossing "cradle," are shown in Fig. 4. The insulators used, though frequently illustrated, still remain a standard, and may be of added interest herein. (See Fig. 5.) The main line to Milan, 25 miles long, is in duplicate, carrying six circuits on two lines of towers nine feet apart, and spaced about 35 feet high above ground, and are set in concrete. Railroad crossings are elaborate, consisting of veritable structural steel bridges, very substantial, but very unsightly.

As before noted, this company owns and operates the city and suburban electric railways and lighting systems, and a visitor to Milan cannot but be struck by the admirable modern methods everywhere in operation, especially in the street railway. In 1904 the company had some 100 miles of track, with 425 cars; also 2,500 arc and 190,000 incandescent lamps. In motors for general use in and around Milan they sold about 21,000 h.p. to 3,600 motors. The prices obtained are approximately as follows: In Milan, depending on use, amount and distance from a minimum of 2 cents to a maximum of 8 cents per kilowatt hour for the use of 1,000 hours or less per year; for large powers, for, say, 6,000 hours per year, the price is as low as 1 cent per kw. hour. The price of steam coal in Milan is about $7 per ton.

The Vizzola Plant, Ticino River.

In a similar manner to the Adda River, the Ticino drains Lake Maggiore, another of the beautiful Italian lakes, and in its course to the River Po is rich in valuable water-power, which is being gradually developed. The Vizzola plant is only about ten miles from the lake, and is situated on the north side of the valley, in such a manner as to have an intake common with that of a navigation and irrigation canal, on the banks of which the station is situated.

This plant differs from Paderno in that it supplies many independent towns and works widely separated from each other. These works consist mainly of silk, cotton, and fabric mills, which had previously been operated by steam, or low-head direct hydraulic installations. The generating station is situated 30 miles north-west of Milan by railroad and road, but the main transmission lines, which form a network in the surrounding cities, notably Gallarate, Legnano, Busto Arsizio, and Saronno, vary in length from 10 to 30 miles. The total output is about 20,000 h.p.

The common head canal is about 3¾ miles long, winding along the edge of the valley until arriving at a deep cut near the station, where it separates into three outlets, one to the power station, a middle course to a series of three locks down to the Ticino River at tail-race level, and a third following the valley for navigation.

That portion of water required for the power station, amounting to about 2,200 cubic feet per second normal, is conveyed by means of an aqueduct to an elevated forebay above the station, whence by inclined penstocks it is led in the usual manner to the turbines. The elevated concrete aqueduct and forebay, or receiving basin, constitutes the principal feature of this installation. As shown in Fig. 7,

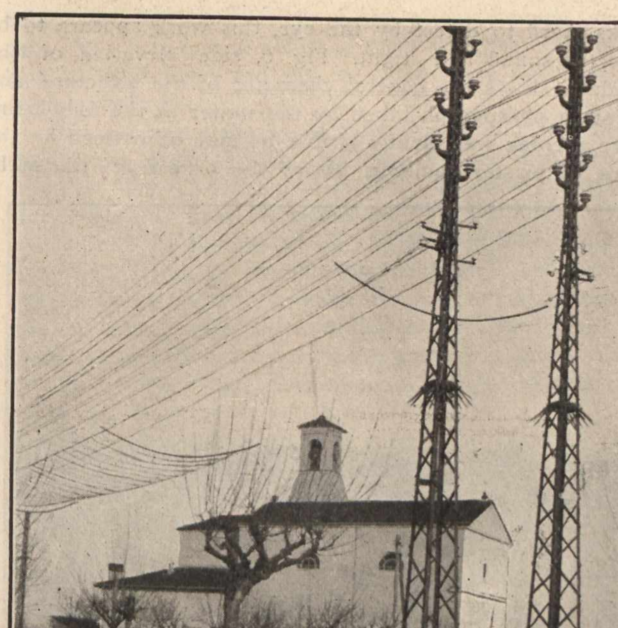


Fig. 4.—Paderno: Transmission Line, showing a Roadway Crossing.

the aqueduct is a massive structure, a monolith of concrete, about 700 feet long, passing over a former depression, and carried on arches of 16 feet span, 36 inches thick at crown. The waterway is 22 feet wide and 12 feet deep, of trapesoidal section, having sides on a batter of 1:4, and the surface of water is about 35 feet above the graded ground level. The whole structure is supported on a pile foundation; this fact, together with the feature of unequal expansion in the aqueduct and adjoining forebay, a total length of 1,000 feet, involved special design to secure tightness and stability, and the subject was consequently most carefully studied. The whole mass, consisting of some 25,000 cubic yards of material, was made of concrete, laid in cement, in order to minimize shrinkage; and the laying of concrete was not unduly hurried. In addition, an envelope of three thicknesses of tarred felt was interposed in the concrete forming the waterway at a distance of 12 inches back from the entire wetted surface. Except a few minor

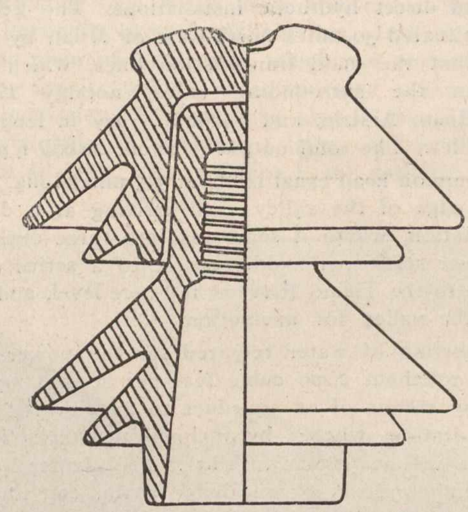


Fig. 5.—Paderno: Standard Line Insulator.

cracks, hard to detect by the eye, this work appears to be perfectly sound and tight. Fig. 6, side elevation of the aqueduct, shows the general character of the structure, and is from a photograph taken by the writer at the only point where a crack was plainly visible, as may be noticed by the traces of plaster caulking above the crown of the arch;

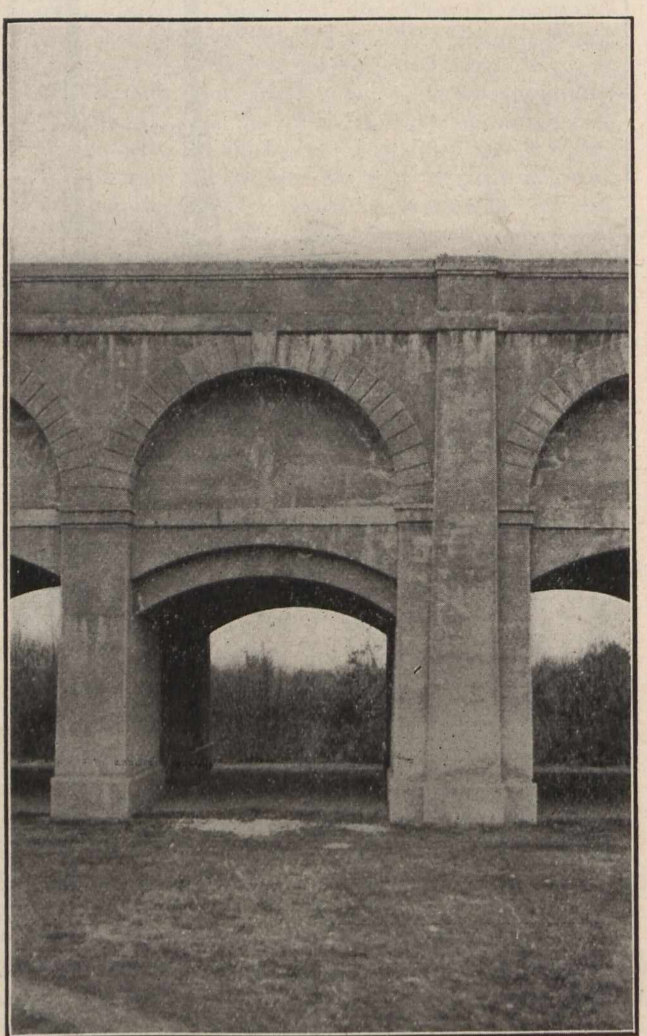


Fig. 6.—Vizzola: Side Elevation of Aqeduct.

this, too, was on a cold February day (1906), with the thermometer at freezing point.

The forebay structure is of the same character and general design as the aqueduct, having on the one side the screen and gate-house, over the entrances to the penstocks, and on the other, an over-flow regulating weir, permitting spill of surplus water into a basin, which in turn discharges into the lower river level alongside the three canal locks above referred to. This is shown in Fig. 7, the generating station being on the opposite side of the gate-house, below the hill. The over-flow weir is 300 feet long, and, at a lower level, are also three sluice-gates for additional discharge. Twelve bays, each with a submerged arch opening, protected by screens, and capable of being closed by vertical sluice-gates, operated by either electrical or hand power, lead to the twelve penstocks. Ten penstocks for power units are 6 feet, 6 inches in diameter; and two for the exciter units are 3 feet; all are 150 feet long to inside of station wall.

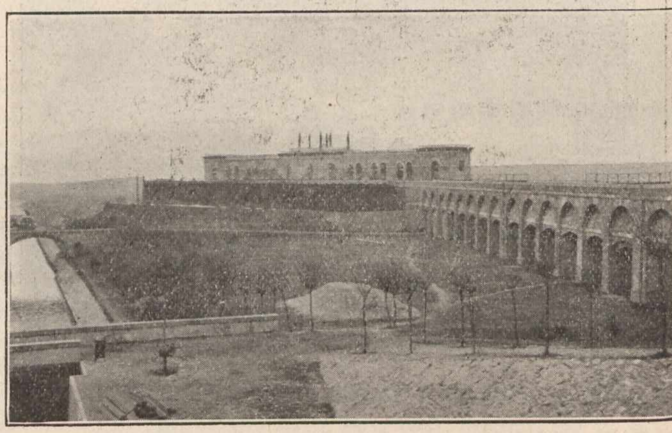


Fig. 7.—Vizzola: Aqueduct, Receiving Basin and Gate-house.

The generating station (see Fig. 8) is a massive but plain building of concrete and stone, and the tail-race (on the right) excavated along its front leads to the low-level navigation canal. The power installation consists of ten 2,100 H.P. turbines, connected directly with horizontal shafts to 1,500 kw. alternators, together with two separately driven exciters. Under high and low conditions of river, the working head varies from 80 to 94 feet, respectively; with the normal at 92 feet. Of the 10 turbines, 8 are built by Riva, Monneret & Co., of Milan, and 2 by Voith, of Heidenheim, Germany. Both types are similar, with double runners and distributors, actuated by balanced gate-rings connected to swivel gates. The governors are water pressure type. The generators are by Schuckert, of Nurem-

Fig. 8.—Vizzola: Generating Station.

burg, revolving field, three-phase, at 187 r.p.m., wound to 11,000 volts at 50 cycles; they work directly on the lines without step-up transformers.

Each large centre of distribution has its own separate transmission line from the generating station, which, while expensive, has proved most satisfactory in convenience of operation, continuity and safety. Lighting current lines are also separate from the power lines. Nearly all the main lines have steel towers, with triple porcelain insulators.

The prices obtained by this company in the widely separated centres of consumption are based on a flat rate, and on a 24-hour day, average about $31 per H.P. year, with a minimum of $23 and a maximum of $44, depending on distance. The price of coal is about the same as in the city of Milan.

A NEW FORM OF FRICTION CLUTCH

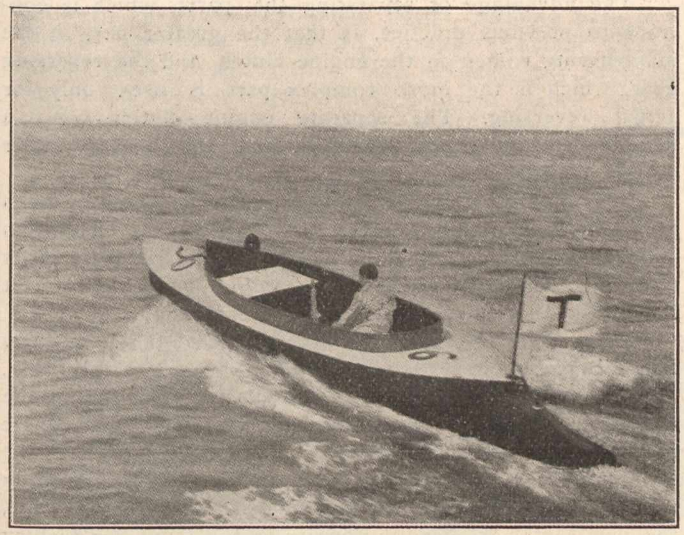


Fig. 1.—A View of the Thornycroft Launch "Scolopendra."

This boat—fitted with Hele-Shaw Clutch Reversing Gear,—won the Yachtsman's Cup at Cork; and the Cowes Cup, Isle of Wight. The following account is taken from "The Engineer," (London):—

"The marine section comprises many interesting features, not the least of which is the 30-ft. racing launch 'Scolopendra,' built by John I. Thornycroft & Co., Limited, Chiswick, which won the 50-guinea Yachtsman's Cup at Cork last summer. The craft has a total tength of 30 feet, with a beam of 5 feet, draught of hull only 8 inches, and extreme draught at the propeller 17 1-2 inches. She is propelled by a 20-brake horse-power petrol motor having four cylinders, and running at a normal speed of 1,000 revolutions per minute. The motor is of this firm's standard pattern, and is fitted with either mechanical or automatic inlet valves. *Reversing and stopping is effected by means of a Hele-Shaw friction clutch, which admits of rapid manoeuvring without shock, while being highly efficient.* The propeller is of bronze, and of the well-known Thornycroft pattern. Six runs over the measured mile, with two persons on board, gave a mean speed of 18.2 miles per hour."

Some years ago Professor Hele-Shaw, LL.D., F.R.S., of Liverpool University, used to drive a Darracq car fitted with a leatherfaced cone clutch of the usual type. Of all the parts of the car the clutch was the most disappointing, and Professor Hele-Shaw determined to find a form of clutch more flexible and less liable to injury than a leather-faced cone.

A series of experiments were conducted; one clutch after another was tried, only to be discarded. Strangely enough, the design that came out of the trials best was the old flat plate clutch, invented by Thomas Weston. The disc principle is a good one in clutch designing, since the torque obtained for a given end pressure is increased proportionately for every additional pair of surfaces. In other words, a clutch can be made more powerful by adding friction plates to the pack without increasing the end pressure.

In the experiments with the Weston clutch it was found difficult to get the plates perfectly flat; a persistent tendency to buckling made the clutches very unreliable. They were, moreover, very sluggish in action and not easily released. All these troubles, however, were overcome by stamping a circular V-shaped groove into the plate. This V groove, or web, was found to give rigidity to the plates in much the same way as a web gives strength to a girder. Thin sheet steel plates, with the V groove stamped into them, showed no tendency to buckling whatever, and developed other qualities of hardly less importance.

The grooves in the plates enter each other at an angle, and consequently the end pressure required for a given torque is diminished by an amount varying with the co-secant of the angle of the V. In other words, the Hele-Shaw clutch will transmit great power with light end pressure. Further, contact is established between the faces of the grooves only. The flat portions of the plates do not make contact with one another, consequently there is a tendency to part rapidly with heat.

Very complete lubrication and, if necessary, cooling of the pack is possible for the same reason. These advantages, following the adoption of the V-shaped groove give rise to one or two properties in a Hele-Shaw clutch which are entirely new and exceedingly useful. For instance, a clutch on Hele-Shaw principles can be applied for slipping indefinitely without injury to the plates, the heat produced being dissipated at once into the lubricant. It is largely to this feature that the Hele-Shaw clutch owes its present position among the automobilists.

Fitted with a Hele-Shaw clutch, a car can be driven through traffic on the top gear with the clutch slipping and the car gliding in and out of the vehicles under perfect control.

It is especially valuable for motor 'buses and heavy vehicles, which are constantly at work in busy streets. In England, it is rapidly becoming universally adopted on all forms of motor vehicles.

It may be readily imagined that a clutch which can make a name for itself in automobile work has had no difficulty in securing a place in industrial engineering.

At a large glass works in Lancashire ten of these slipping clutches are at work transmitting 80 h.p. at 60 r.p.m. It is one of the conditions of working of these clutches to slip 50 per cent. for two hours daily; that is to say, the driving part runs at 60 revolutions, while the driven is running at 30 revolutions. In this way nearly 40 h.p. is being absorbed by friction of the plates running in lubricant. The first two or three of these clutches installed have been at work night and day for three years, and have given every satisfaction.

This unique property of "slipping at will" enables the Hele-Shaw plates to be used for brakes, dynamometers, capstans, etc., and has considerably modified engineering practice in all these directions.

One of the designs which the British Hele-Shaw Company are finding in considerable demand is the automatic release clutch. This is particularly useful for heavy work, such as rolling mills, brick works, and coal-handling plants. In this design the pressure on the plates is suddenly relieved as soon as the torque rises above a definite maximum, and the clutch slips under the load.

When the obstruction is removed and the load reaches the normal, the clutch takes up the load again automatically. The automatic release clutch is installed in a number of automatic coaling barges where the coal is handled by bucket elevators. Formerly, it was necessary to have a weak link in the chain, so that when a bucket came up against an obstruction the link would snap and save the bucket from breaking off. This method worked very well, but it was a long job getting another link and putting the chain back.

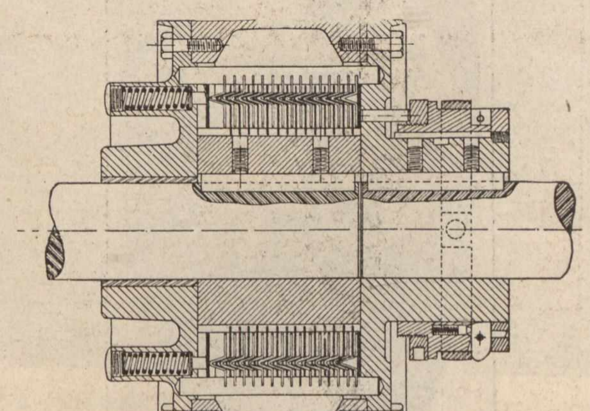


Fig. 2.—Standard Hele-Shaw Clutch Coupling.

With the Hele-Shaw automatic release conveniently placed between the engine and the elevator, a stoppage for obstruction lasts only as long as it takes to clear the obstruction. As soon as the extra stress comes on the chain, the clutch slips and continues slipping until the load falls to the point that the chain will take with safety, when it instantly takes up the drive again automatically.

Another valuable application of the Hele-Shaw clutch is on the armature spindle of electric motors. In this position, the speed being usually very high, the clutch is small and easily contained in the boss of the motor pulley, only the light starting handle at the side of the pulley indicating that a clutch is fitted. The object is to save using the controller continually in driving a heavy machine which has to be stopped and started frequently. Printing machinery, for instance, can be manœuvred entirely on the clutch, the motor running full speed the whole time. It is good practice to put the burden of such trying work as this on a pack of Hele-Shaw friction discs running in oil. They are better fitted to stand wear and tear than electrical controlling

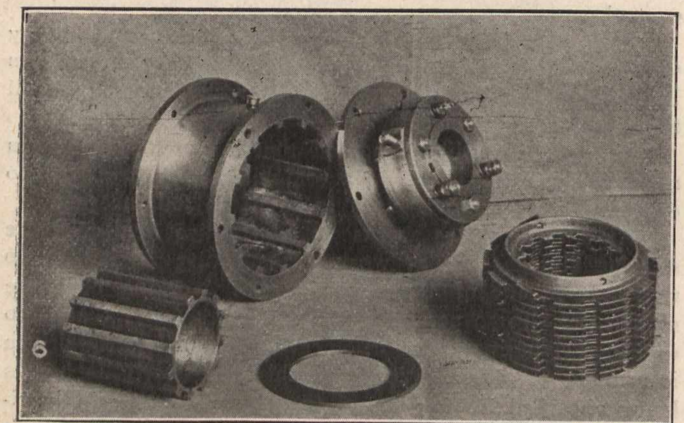


Fig. 3.—Parts of Hele-Shaw Friction Clutch.

gears. In three-phase motors it is almost a necessity to use this clutch.

In all these special applications of the Hele-Shaw clutch it is usual to fit alternate bronze plates, so that the friction is similar to that of a shaft turning in its oiled bearings, and consequently very little wear of the surfaces takes place. It is found with these bronze plates that even constant slipping does little more than cause the faces of the steel plates to be speckled with bronze and the bronze plates to acquire a high polish.

It is manifest that there must be very little wear of the plates when a 150 h.p. Hele-Shaw dynamometer at

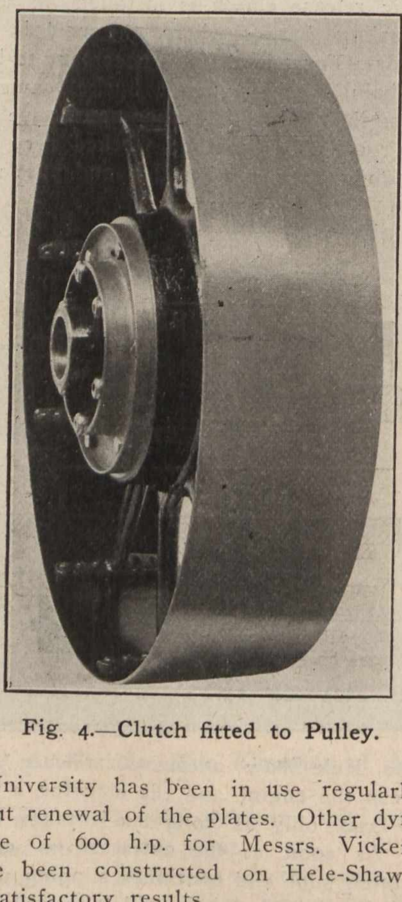


Fig. 4.—Clutch fitted to Pulley.

Liverpool University has been in use regularly for three years without renewal of the plates. Other dynamometers, including one of 600 h.p. for Messrs. Vickers, Sons & Maxim, have been constructed on Hele-Shaw principles, with very satisfactory results.

In marine work the Hele-Shaw reversing gear has secured recognition in the highest quarters as the best design for reversing a petrol launch. The gear consists of a reversing clutch and epicyclic train, with a separate clutch for giving a free engine.

The advantage of separating the parts, which is contrary to previous practice, is that the greater part of the manœuvring comes on the engine clutch, and the reversing gear, which is the more complex part, is used only for actual reversing. The separate engine clutch gives a flexible drive in either direction, and the boat is under perfect control.

This quality of the Hele-Shaw reversing gears is much appreciated in crowded waters, like the upper Thames in summer and Cowes in the yachting season. Motor boats have not the same privileges as sailing boats, and must look after themselves when there are steamers about.

From these instances it will be seen that the Hele-Shaw friction plates have a very wide sphere of usefulness. Hitherto friction clutches have found their field among the factories almost entirely — small clutches for single machines and large clutches for main drives.

The Hele-Shaw has opened up new ground entirely among automobiles and motor launches. At the same time, the new clutch is steadily coming to the front for factory work. The essential simplicity of the designs for pulleys and couplings, the protection of the friction surfaces from dust, and the shielding of projecting parts likely to be a source of accidents, all have their effect in making the clutch popular with mill-owners and mechanics.

In South Africa a Hele-Shaw clutch of the coupling type is transmitting 560 h.p. coupled up to a winding drum

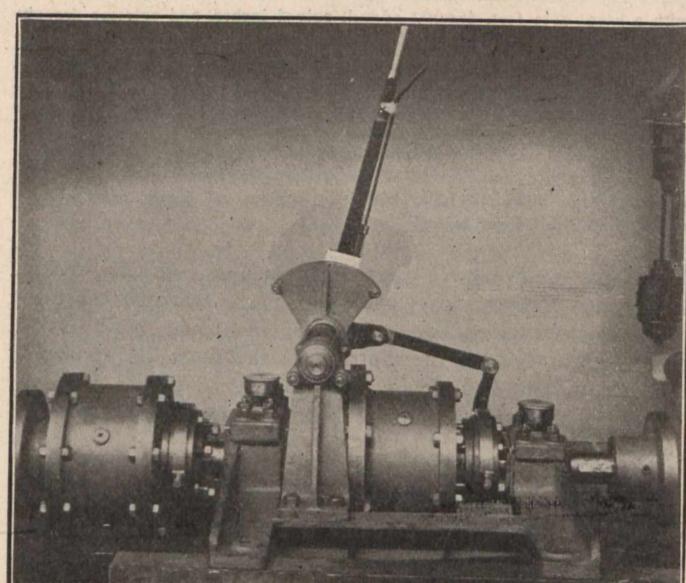


Fig. 5.—Hele-Shaw Reversing Gear.

in the gold fields. In many cases in England the clutch has been applied, transmitting powers over 200 h.p.

The success of the clutch in all these directions is due to the soundness of Hele-Shaw principles, and the thoughtful way in which these principles have been embodied in the designs. It is probably the first time since the days of Thomas Weston that organized methods of research have been brought to bear on the difficult problem of the friction clutch, and it is satisfactory to know that in this case at least the scientific method has been found also the most profitable. The clutches described above are manufactured by the British Hele-Shaw Patent Clutch Co., Limited, Chatham Street, Liverpool.

LONG BRIDGES.

	Length Ft.	Type.
Tay, Scotland	10,779	Girder
Forth, Scotland	8,296	Cantilever
East River, New York	7,200	Suspension
Brooklyn, New York	5,989	Suspension
Clifton	702	Suspension
Quebec, Canada	3,228	Cantilever

WINDMILL AIR COMPRESSION

In our issue of August, 1905, we illustrated an air compressor, operated by **windmill** power, forming part of the special equipment of the SS. "Arctic" (Captain Bernier), about to sail from Halifax, N.S., through the Arctic seas in search of the North Pole! A casual glance over the industrial world shows that windmill power is becoming an important factor in the activities of life. On Nansen's good ship "Fram" there was a windmill electric set installed to give power during her Arctic voyage; and a like set formed part of the equipment of the "Discovery," on her Antarctic exploring expedition, both of which are reported to have worked admirably. "Dr. Charles F. Brush, of arc electric light fame, has on his extensive country residential estate a highly successful windmill electric lighting equipment that furnishes several hundred electric lights, and produces power for pumping water, sawing wood, running electric fans, threshing corn, cutting corn and feed for the farm animals, churning milk, and performing other useful industrial functions." Our esteemed contemporary, the "American Shipbuilder," suggests other applications, one of which is worthy of serious consideration by the Department of Marine and Fisheries at Ottawa:

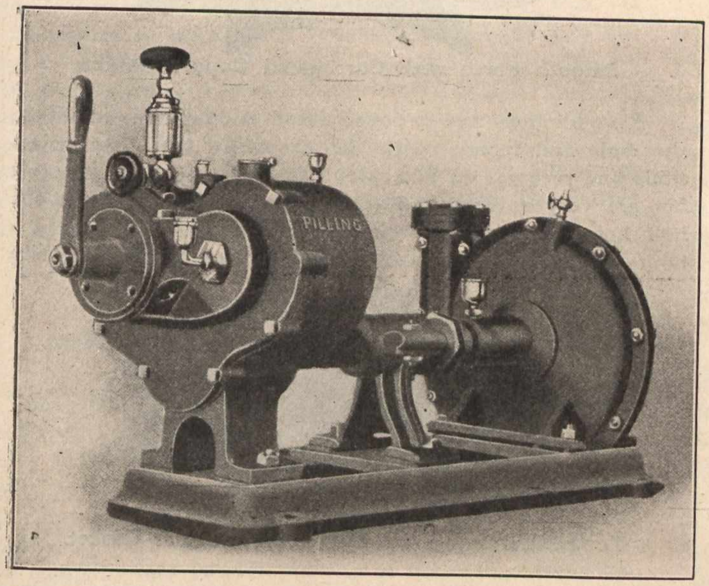


Fig. 1.—Pilling 2½" x 2½" Engine, Direct Connected to 1½" Centrifugal Pump.

"It would seem that windmills might similarly be utilised on board of lightships and alongside of lighthouses, for generating electricity for illuminating purposes and for the signal lights, in connection with electric storage batteries. The subject is certainly worthy of consideration by the lighthouse authorities, and by electrical engineers, as thousands of dollars could be saved to the government annually, if windmill-driven electric lighting plants were installed in all light vessels and lighthouses. "What has been done once can be done again," is an old saying, so why not harness the wind for generating artificial light?"

"Where the lights on lightships and lighthouses are used only on an average of about twelve hours out of the twenty-four, there is no good reason why electric storage batteries of ample capacity could not be fitted in the holds of the lightships to furnish all the power necessary to run the lighting equipment during calm periods, or at times when the breeze was too light to drive the windmill. The electric fluid could also be utilised to charge the storage battery of an electric launch, and to do the cooking and heating on board of a lightship."

An enthusiastic advocate of windmill power is James L. Pilling, master mariner, of 50 Brainard Street, Detroit, who has invented an air compressor (windmill driven) which he applies to refrigeration as well as light, power and heat.

In a communication to the "American Shipbuilder" he says:—

"There is no limit to the amount of air that can be compressed and stored to any given pressure, either in connection with lightships, lighthouses, or, in fact, anywhere —afloat or ashore, using windmills for the purpose.

"The air compressor can be connected direct to the windmill, or through pulley on windmill below deck to a belted compressor in the hold of the ship.

"Ample room is available for receivers in which to store the compressed air, and enough to last several days could easily be accumulated.

"Thus far the compressed air has cost nothing, only for the installation of the plant and normal wear and tear.

"I would compress the air to 125 lb. pressure per square inch at least—for reducing from a high pressure to a low, and then reheating the compressed air thus reduced to pressure required, 40 per cent. is gained thereby over and above the normal cost of the original air compression, which is nothing more than cost of installation of plant, and wear and tear on same,—and connect an engine I have in mind direct to dynamo. Close to the engine I would have an upright boiler 36" by 72", reducing the air from 125 lbs. to 45 lbs., and reheating the same in the upright boiler mentioned, using crude oil or wood alcohol for the reheating. By so doing the 45 lbs. could be raised to 90 lbs. or more, turned into the engine, and electricity generated thereby. So far, again, the cost has been nominal.

"The two prints (Figs. 1 and 2) represent a 2½" by 2½" double-acting, reciprocating, duplex engine running in oil, connected direct to a 1½" centrifugal pump of the Gould-Austin make. The pump is built for 60 gallons per minute. As shown (Fig. 2) it is throwing 69 gallons in 30 seconds. The engine is run with reheated compressed air in the manner described above, was designed for, and is now in use by the Baltimore and Ohio Railroad Co.

Fig. 2.—Centrifugal Pump and Double-acting, Reciprocating, Duplex Engine in Operation.

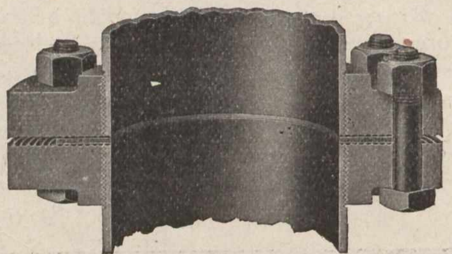
"The time is fast approaching when a compressed air explosive engine will be in successful operation. A very small amount of liquid explosive will be mixed with the air. Aldehyde, hydrogen, peroxide, and oxygen in due proportions will be used, the idea being to use as much air as is practical, taking the removal of the products of combustion into consideration."

In a letter to us dated March 5, 1906, Mr. Pilling says: "I shall build all my goods in Canada, as I have a large demand for them there."

[In view of the increasing importance of this aerial system of motive power it is our purpose to deal with the subject somewhat elaborately in an early issue.—Editor.]

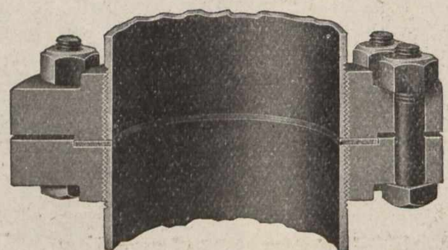
METHODS OF FACING AND OPERATIONS ON EXTRA HEAVY COMPANION FLANGES.

The smooth-faced flange is made by giving the entire surface of the flange an ordinary smooth finish with a broad tool. Flanges faced in this manner will hold metallic, thin rubber, fibrous, or other gaskets. Crane flanged valves, fittings and flanges will always be furnished with this style of facing, unless otherwise ordered.



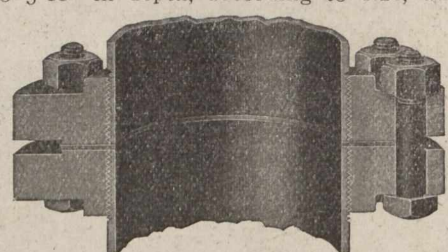
Corrugated Faces with Rubber Gasket.

The corrugated faced flange is made by scoring the face of flange with a series of concentric rings about 1-64" deep. This method is not well adapted to thin copper gaskets nor thin rubber gaskets less than 1-16" thick. If rubber gaskets are used, it is better to make them 3-32 or ⅛" thick, and if the gaskets are asbestos wire insertion, they should not be less than ⅛" thick.



Male and Female Faces with Rubber Gasket.

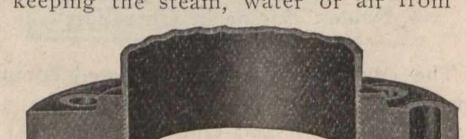
The male and female faced flanges are made with recessed and projecting faces, which fit into each other. The male face projects from 3-16 to ¼", according to size of pipe, and extends out from the inner circle of pipe about half way to the bolt holes. The female face is recessed from ⅛ to 3-16" in depth, according to size, and is made



Raised Faces with Rubber Gasket.

sufficiently large in diameter to receive the male projection without binding or throwing bolt holes out of true.

This method of facing forms a very reliable joint, as the ends of pipe bear on the gasket, thus forming a perfect joint, and keeping the steam, water or air from reaching

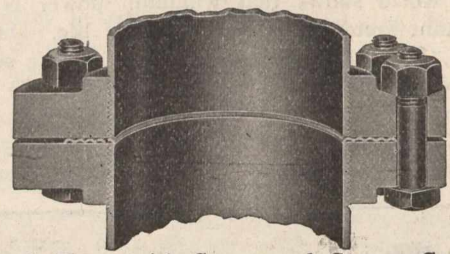


Spot Faced Bolt Holes.

the joints where the flanges are made on pipe. It is also impossible to blow out the gasket, as it is held firmly in the recess, and the contact is so liberal that there is no danger of gasket crushing or squeezing out when subjected to extreme heat or pressure.

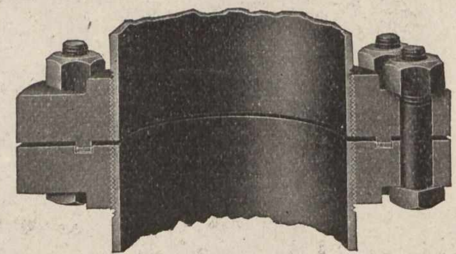
This style of facing is usually specified for pump columns in large mines, and is also popular with a number of leading engineers.

The only serious objection to this style of facing is the difficulty of opening the line in case it is necessary to renew a gasket or replace a fitting, valve or section of pipe.



Smooth Faces with Corrugated Copper Gasket.

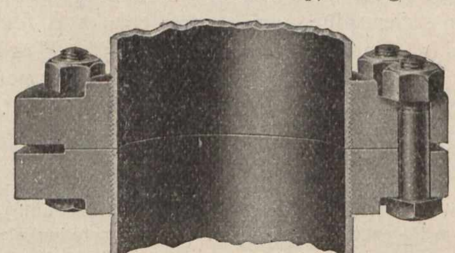
The tongued and grooved faced flanges are similar to the male and female, with the exception that the projections and recesses do not extend to the inner circle of pipe, but are very narrow, and are situated midway between the bolt holes and inner circle of pipe, thus forming only a limited space for the gasket, which, in consequence, is easily



Tongued and Grooved Faces with Rubber Gasket.

crushed or squeezed out of the recess when placed under severe working conditions. Neither does the gasket cover the ends of pipe, this omission, of course, allowing the steam, water or air to come in constant contact with the joints where flanges are made on pipe.

Flanges faced in this manner are subjected to severe strains when the bolts are drawn up, owing to the narrow



Polished Raised Faces for Ground Joint.

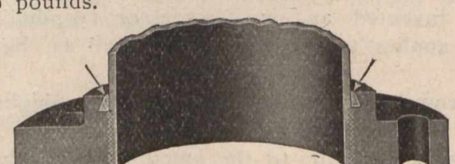
contact between the faces, and, as the method has no advantages not possessed by the male and female joint, and many disadvantages, we do not recommend it.

When tongued and grooved facing is used on pipe flanges, it can be applied only to screwed or welded joints.

The same objection applies to this style of facing as to the male and female, when it comes to repairs.

These flanges with smooth, raised faces are made with 1-32 or 1-16" raised faces inside the bolt holes, and the projecting faces are turned off smooth.

This is a popular method in some sections of the country, and is frequently specified for working pressures up to 250 pounds.



Caulking Recess in Hub.

It is especially suitable where corrugated copper or thin rubber gaskets are used.

The raised faced flanges for grinding are made with 1-32 or 1-16" raised faces inside of the bolt holes. These faces are finished very smooth in the shops, ready for grinding. When the pipe with flanges arrives at its destination these flanges are ground in place by the use of a special grinding or face plate, using emery and oil as a grinding mixture.

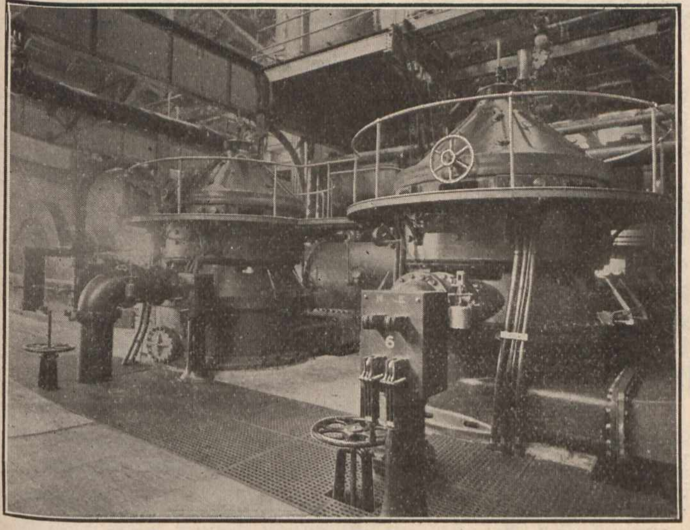
Flanges with spot faced bolt holes are made by facing off around the bolt holes on the back side of flange, where the nut or head of bolt bears. This is done to give the nuts or heads of bolts a more true, firm bearing than could be obtained on the rough casting. It is useless expense, however, to spot face the bolt holes on flanged valves, fittings and flanges, unless the bearing faces of both the heads and nuts are also faced true.

Flanges with calking recesses are made by cutting a recess in hubs on backs of flanges. This recess is ½" in depth, ¼" wide at top and 5-16" wide at the bottom. It can be applied to extra heavy flanges in sizes from 2 to 24". Flanges so fitted are ½" higher than the regular flanges. When the flanges are used on cold water, the recesses are filled with lead, which is caulked in firmly to prevent the flanges from leaking where they are made on pipe. When these flanges are used on steam, the recesses are filled with soft copper, which is caulked in firmly to keep the flanges from leaking where they are made on pipe.

LOW PRESSURE STEAM TURBINES.

The Philadelphia Rapid Transit Company has recently added to its power station at Thirteenth & Mount Vernon Streets an 800 kw. low pressure Curtis steam turbine, direct coupled to a D. C. railway generator. This installation has been manufactured and supplied by the General Electric Co., and is a duplicate of a turbine-generator set finished by the same company and put into service at the end of last year. The installation of the additional unit has been nearly completed and the turbine will be in operation very shortly.

The turbine now in operation is supplied from a steam stack which is connected with the exhausts of five Corliss engines—four of 1,500 nominal h.p each, and one of 2,200 nominal h.p.—which have been operated hitherto without condensers. Each of the 1,500 h.p. engines is direct connected to a 1,500 kw. generator, and it has been conclusively proved, from experience with the first turbine set installed, that the exhaust steam from any one of these engines under full load is more than sufficient to operate the turbine at its rated capacity, without causing any increase of back pressure on the engine.



Type C—5 Pole 800 K.W.—1,200 R.P.M. 575 Volt Curtis Steam Turbines (Low Pressure).
Installed for the Philadelphia Rapid Transit Company.

These results prove that the amount of water used per kilowatt-hour at all loads is greatly improved by the introduction of the turbine, the improvement being greatest at light loads and overloads. This increased economy is due to the fact that the steam engine does not work efficiently at such loads, whereas the turbine has practically the same efficiency at light load as at full load.

The turbine, which is supplied with steam at about one pound above atmosphere, and is of the four-stage type running at 1,200 revolutions per minute, with a condenser vacuum of between 28 and 29 in., easily fulfills the steam consumption guarantees, which state that the steam consumption with dry steam at 15 pounds pressure absolute shall not exceed 36 pounds per kw. hour at full load, and 40 pounds at half load, with 28 in of vacuum. The steam pressure on the turbine has been found quite uniform and constant with three engines operating, though there was just a noticeable pressure pulsation with only one engine running. This pressure variation, however, in no way interfered with the satisfactory operation of the turbine.

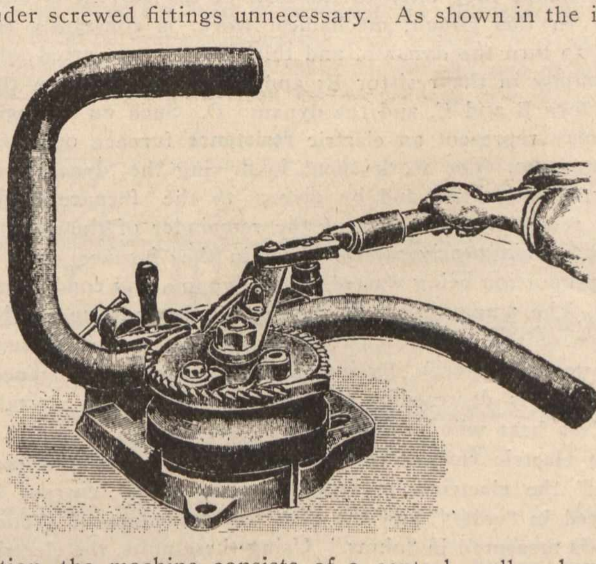
The generator of this turbine set has six poles and is compound wound, but is at present run as a shunt machine. The design is new, and the difficulties of designing so large a direct current railway generator running at such a high speed as 1,200 revolutions per minute have been successfully overcome. The generator has a rather high voltage between adjacent commutator segments, but commutation troubles have been avoided by the proper design of the other commutation constants of the machine. The fact that the machine has given 2,200 amp. at 570 volts, or about a 65 per cent. overload, without serious sparking, demonstrates that no trouble will be experienced in this direction.

When the new turbine set is put into operation, it will effect further economies by increasing the output from the power station without increasing the consumption of coal and water. At present, in fact, there is absolutely no difference to be noticed in firing the boilers, whether the low pressure turbine is running at full-load or shut down.

It is obvious, from these actual results as well as from theoretical considerations, that several of these turbine-units can be installed advantageously in connection with Corliss engines, and that a new field has been opened up in central station practice by the introduction of the low pressure turbine.

AN INGENIOUS PIPE-BENDER.

A new pipe-bender which has been placed on the market by an English firm, should, in our opinion, appeal strongly to heating plant engineers, gas and electrical fitters, plumbers, etc. It is operated by hand, and bends without filling or heating, all sizes of pipe up to one inch diameter; and by heating, but without filling, sizes up to 3 in. The bends made by the machine are absolutely free from pucker; of perfect radius, and may be made at such angles as to render screwed fittings unnecessary. As shown in the illustration, the machine consists of a central pulley, bending and clamping blocks, with groove suited to the outside diameters of various sizes of pipes, a base plate, and lever mechanism. Even old and rusty tubes may be bent with accuracy and safety by this bender, and since it is portable, easily attached to any bench, or even nipped in an ordinary vise, it can be used quickly, with manifest saving of labor.



THE ELECTRIC FURNACE: ITS EVOLUTION, THEORY AND PRACTICE

By Alfred Stansfield, D. Sc., A.R.S.M., Professor of Metallurgy in McGill University, Montreal.

Article II.

General Description and Classification of Electric Furnaces.

The Electric Furnace is an appliance in which materials can be submitted to a high temperature by the dissipation of electrical energy. This definition does not include all cases of electrical heating; and might be limited to the production of temperatures above red heat. In a number of instances —as in the production of sodium, and aluminium—the electric current is required primarily for isolating the metal by electrolysis, and only secondarily for heat. These are usually considered to be furnace operations, because a high temperature is produced; indeed, it has been suggested by Mr. J. Wright,* that electrolysis should only be classed as a furnace process, when fused anhydrous salts are employed; excluding the more ordinary electrolytic processes in which aqueous electrolytes are used.

Heat is produced whenever an electric current encounters any resistance to its flow; the energy, producing the current, being transformed into heat. Even the best electrical conductors oppose some resistance to the flow of an electric current, and work must consequently be spent in maintaining the current. If an electric circuit is made in part, of a good conductor (such as a short, stout copper cable) and in part of a poor conductor (such as a thin rod of carbon) the greater part of the heat will be produced in the poor conductor, which may even become red hot, while the remainder of the circuit remains cool.

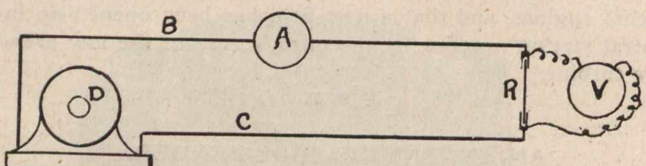


Fig. 9.—Electric Circuit.

Fig. 9 represents such a circuit: D is a dynamo; B and C are stout copper wires or cables, and R is a carbon "Resistance" or "Resistor;" that is to say, an electrical conductor made of carbon that offers a considerable resistance to the flow of the current. The windings in the dynamo D are of copper, and these and the cables B and C are so stout, that the resistance they offer to the flow of the current is only small. In this circuit, mechanical work is constantly required to turn the dynamo, and this work is converted into heat mainly in the resistor R; and to a less extent in the conductors B and C, and the dynamo D. Such an arrangement may represent an electric **resistance** furnace operated by a dynamo. The work spent in driving the dynamo, is converted into heat, and by giving to the furnace a far higher resistance than that of the remainder of the circuit, we can obtain nearly all the heat in the furnace; only a small proportion being wasted in the dynamo and conducting cables. The amount of heat developed depends upon the strength of the electric current, as well as on the amount of resistance it meets. By increasing the furnace resistance, the current is decreased; consequently, beyond a certain point less heat will be developed in the furnace.

An electric current is measured in "amperes;" "volts;" "ohms;" the electrical pressure producing the current is measured in "volts;" and the electrical resistance of a conductor is measured in "ohms." Using these units, the electric current flowing around a circut is equal to the electrical pressure or E.M.F. (electro-motive-force) driving it, divided by the electrical resistance of the circuit.

When an electric current flows through a resistor, as in Fig. 9, the amount of heat produced is proportional to the resistance, and to the square of the current; or, to the E.M.F. and the current. Taking as a unit the heat that would raise the temperature of one gram of water from O°C, to I°C, we find that—where

$$H = 0.24C^2 R t = 0.24 E C t,$$

H = heat produced in gram centigrade units,
C = current in amperes,
R = resistance in ohms
E = electro-motive-force in volts,
t = time in seconds.

In the circuit shown in Fig. 9 the current C would be measured in amperes by means of an ammeter, A, placed in one of the cables; the E.M.F., E., in volts by means of a voltmeter, V, connected to the terminals of the resistor, R, in ohms, would be deduced from the relation—$C R = E$. The above considerations are only exact in the case of an electric current flowing steadily in one direction; in the case of alternating currents a sort of electrical inertia is observed which modifies these results.

In the **arc** furnace, the electric current encounters not only an inert resistance, but also, an opposing electrical force. Both the resistance and the opposing electrical force cause the energy of the current to be turned into heat, and to contribute to the heating of the furnace. A similar opposing electrical force is present in an electrolytic furnace, such as the Hall furnace for the production of aluminium. In this case, however, the work done in overcoming this force, is turned into chemical energy (the isolating of aluminium from alumina) instead of into heat. In most furnace operations, chemical and physical changes are produced, and these increase or diminish the amount of heat liberated in the furnace.

An electric furnace consists of the following essential parts and accessories:—

(1) **Some conducting material heated by the passage of the current.** This may be a vapour, as in the electric arc; or, a solid, such as coke; or, a liquid, such as molten slag, or molten steel.

(2) **A lining of refractory material;** intended to conserve the heat, to retain the charge in the furnace; to exclude the air and to support the electrodes and the charging and the discharging apparatus.

(3) **Electrodes, or conductors for bringing the current into the furnace.** These are subjected to the heat of the furnace at one end, and at the other end must be sufficiently cool to permit of making electrical contact by means of special holders with the cables bringing the current to the furnace. Carbon rods are usually employed, but sometimes electrodes are omitted, the current being generated by induction in the furnace itself.

(4) **Electrode holders.**—These are usually metal clamps for holding and making electric contact with the carbon electrodes; provision being made for preventing the excessive heating of the holder.

(5) **Charging and discharging facilities.**—Some furnaces are intermittent in action—the charge being added, heated in the furnace and then removed before the fresh charge can be added. Other furnaces are continuous in action, involving the periodic, or continuous additions of the raw material, and removal of the products.

Apart from the furnace itself, the following operating factors have to be considered:—

(6) **Source of electric current.**—The electric current is produced by means of a dynamo, and as it is usually supplied at a higher voltage than is suitable for the furnace, transformer may be required to reduce the voltage; the amount of current being simultaneously increased almost proportionately to the reduction in the voltage. The current may be alternating, or direct, but an alternating current is usually preferred, since it can be transformed more readily from one voltage to another. In cases where electrolysis is required,

*Author of "Electric Furnaces and Their Industrial Application."

as in the production of aluminium or sodium, the direct current can alone be used.

(7) **Cables, measuring instruments, and regulating devices:** the latter being required for advancing the electrodes as they are consumed in the furnace, and for regulating by this means—or in some other way—the amount of current flowing through the furnace.

Classification.

The usual classification of electric furnaces depends primarily upon the nature of the resistor used to develop the heat. Thus there are arc furnaces, in which the heat is developed in the electric arc; and resistance furnaces, in which the heat is developed by the passage of the current through a solid or liquid resistor. The classification may depend, also upon the manner in which the heat is transmitted to the charge; thus in arc furnaces the heating may be **direct,** as in Siemens' vertical arc furnace, in which the metal to be melted forms one pole of the arc; or **indirect,** as in his horizontal arc furnace, where independent electrodes are employed, and in which the heat is transmitted from the arc to the charge by radiation and conduction.

In resistance furnaces the charge to be heated may itself constitute the resistor, or else an independent resistor may be employed. The latter nearly always consists of a solid core, usually of carbon, and it may be surrounded by the charge that is to be heated, or imbedded in the walls of the furnace. A charge that is to be heated directly by the passage of the current, may be either liquid, or solid, and in the case of a liquid charge, the electric current may produce heat merely, or may also exert electrolytic action.

The following classification is based on these considerations, and includes examples of each class.

Arc Furnaces.

The heat is produced by one or more electric arcs.

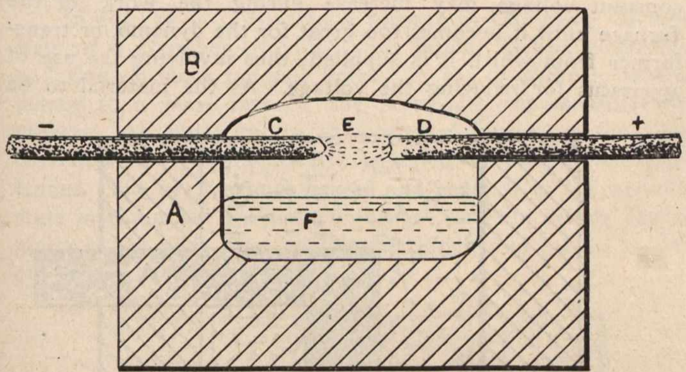


Fig. 10.—Independent Arc Furnace.

(1) **Independent arc furnaces.**—The arc is independent of the charge to be heated; being formed between two or more movable electrodes. The charge is heated by radiation from the arc, which is usually horizontal.

Fig. 10 shows such a furnace, consisting of a refractory chamber, A.B., in which an arc, E, is formed between the movable carbon electrodes C and D; the material to be heated being shown melted at F.

Examples:—**Moissan furnace,** Fig. 6 (p. 172)
Siemens' horizontal arc furnaces, Fig. 3 (p. 171).

The Stassano steel-making furnace.—The last named consists of a chamber lined with magnesia bricks, and provided with three carbon electrodes, between which a three phase arc plays. The ore or other material is placed in the chamber below the level of the arc, and is heated by radiation.

(2) **Direct heating arc furnaces.**—The charge in the furnace forms one pole of the arc and is thus heated directly as well as by radiation. The arc is usually vertical.

Fig. 11 represents an arc furnace in which the material D to be heated, forms one pole of the arc. A is a chamber lined with refractory material, and B and C are the two electrodes: the upper one, B, is movable; the lower, C, is fixed —forming part of the bottom of the furnace, and making electrical contact with the charge D.

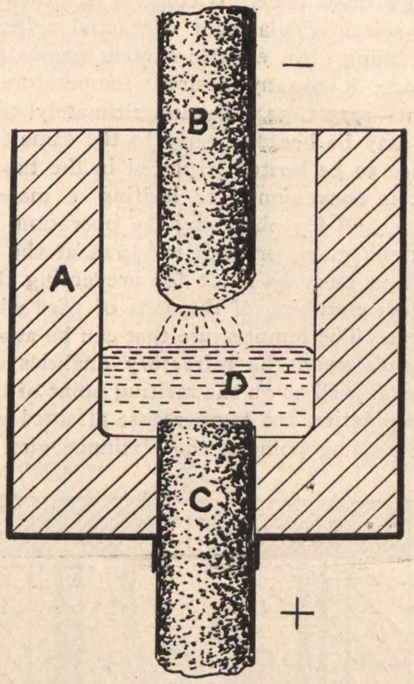


Fig. 11.—Direct Heating Arc Furnace.

Examples:—**Siemens' vertical arc furnace,** Fig. 2 (p. 170).
Willson's carbide fornace, Fig. 7 (p. 172).

Heroult steel furnace.—The latter consists of a chamber for containing the molten steel, and of two vertical carbon rods dipping through holes in the roof. An arc is formed between each carbon rod and the fused charge; the current entering through one rod, passing through the melted steel and slag, and returning through the other rod. Furnaces of this class are rather less convenient for scientific investigations than the independent arc furnace; because it is less easy to regulate the temperature of the furnace; the arc is more difficult to control when the charge consists of cold metal, and the carbon of the electrodes is apt to affect the chemical composition of the charge. On the other hand, the heat is transmitted more directly, thus obtaining a greater economy and only one movable carbon electrode is needed for each arc.

Resistance Furnaces.

In these, the heat is produced by the passage of the electrical current through some solid or liquid resistor. They may be divided into two main classes, in one of which a special resistor is provided, and in the other the charge itself constitutes the resistor. The second class may be subdivided into two classes, conditional upon whether the current is used merely to heat the charge, or in addition, to produce electrolysis of the fused contents of the furnace.

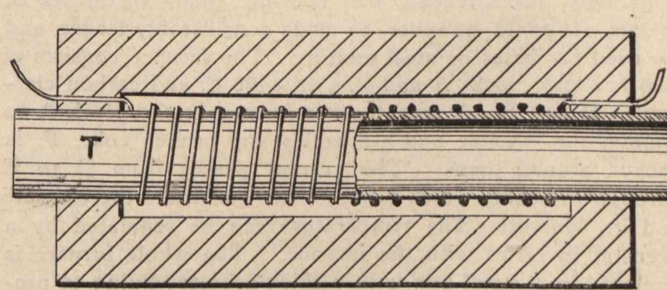


Fig. 12.—Electrical Tube Furnace.

Resistance Furnaces With Special Resistor.

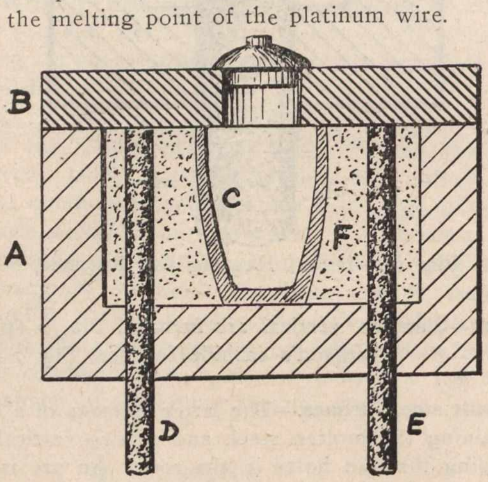
The resistor is a solid, and is imbedded in the walls of the furnace, or in the charge itself.

(1) With the resistor in furnace walls.

Examples:—

The furnace heated by spiral or platinum wire.

This furnace, Fig. 12, is very useful for laboratory experiments on a small scale. It consists of a tube T, often of porcelain, a spiral of platinum wire, and a heat retaining envelope or lining. An electric current passes through the wire and heats it to any desired temperature below its melting point—1775°C 3227°F—and ultimately the tube and its contents may be heated nearly to the same temperature. The substance to be heated is placed in the tube T. This arrangement is convenient for heating a material in any particular gas, and for observing the operation; as this can be done through glass, or mica windows at the ends of the tube. Provision must be made for preventing the displacement and short circuiting of the coils of wire when expanded by the heat. The temperature that can be attained in this furnace depends upon the refractory qualities of the tube, and envelope, as well as on the melting point of the platinum itself, and in practice, the temperature attained would be far short of the melting point of the platinum wire.



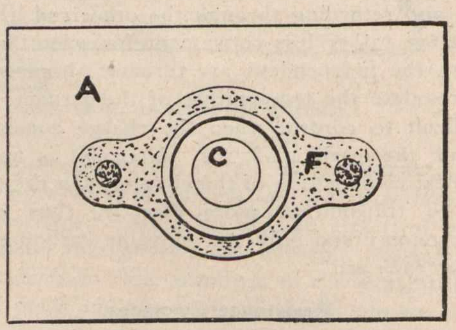


Fig. 13.—Electric Crucible Furnace.

Crucible furnace with carbon resistor.—This represents, in sectional elevation—and in plan with the cover, B, removed—a small electrical crucible furnace, constructed at McGill University, and intended for melting small quantities of metals. It could, however, be made considerably larger, and be used for brass or steel melting. The furnace consists of two fire clay blocks A and B, a crucible C, and carbon electrodes D and E. A receptacle is formed in the block A to contain the crucible and electrodes and broken coke, F, is packed around them. The current passes from D to E through the coke, which becomes hot and heats the crucible and its contents. The temperature can be regulated by a rheostat in series with the furnace. The whole furnace is enclosed in a metal box with a thick asbestos lining to prevent loss of heat.

Conley ore smelting furnace.—One form of the Conley furnace consists of a shaft down which the ore passes and of carbon resistors imbedded in the walls of the furnace. The resistors are heated by the passage of a current, and communicate their heat to the ore passing over them.

Small tube furnaces heated by spirals of platinum wire, are very useful for experimental purposes, but commercial furnaces on these lines have been less successful: mainly on account of the difficulty of maintaining resistors and adjacent parts of the furnace; because, of the slow conduction of heat to the charge, and the large loss of heat through the furnace walls.

(2) **Furnace with the resistors imbedded in the charge.** —The resistor is usually of carbon and horizontal.

Example:—

Borcher's experimental resistance furnace.

In this a thin pencil of carbon C is supported between stout carbon rods A and B, and the charge to be heated

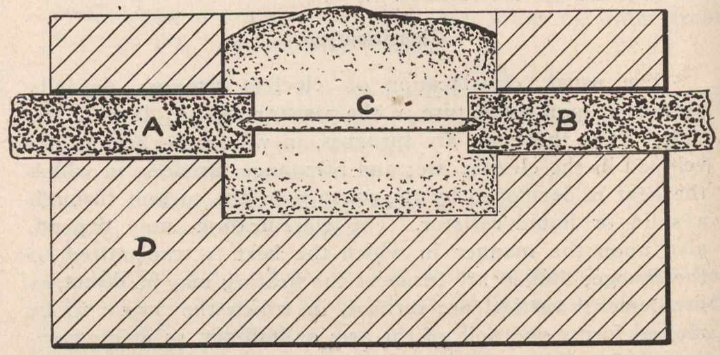


Fig. 14.—Borcher's Resistance Furnace.

surrounds C. The current flows between A and B through C, and may raise the latter to a white heat. The charge serves in part as an envelope to retain the heat.

See Acheson's Furnace for Carborundum, Graphite, Etc. (p. 173.)

In this furnace the conducting core is composed of granular carbon, and is supported and surrounded by the material to be heated. The furnace is efficient, because the heat is developed in the midst of the charge, which serves to retain it. The temperature can also be exactly regulated by varying the current, while by using a number of cores it is possible to obtain a fairly uniform temperature throughout a large portion of the charge. On the other hand, when the furnace has been charged, it is impossible to regulate the resistance of the core, and since this decreases considerably as the furnace becomes hotter, the current, if supplied at constant voltage, may increase during the work of the furnace until it becomes too great for the dynamo, or transformer from which it is supplied; thus involving the use of apparatus for reducing the voltage. As the material to be

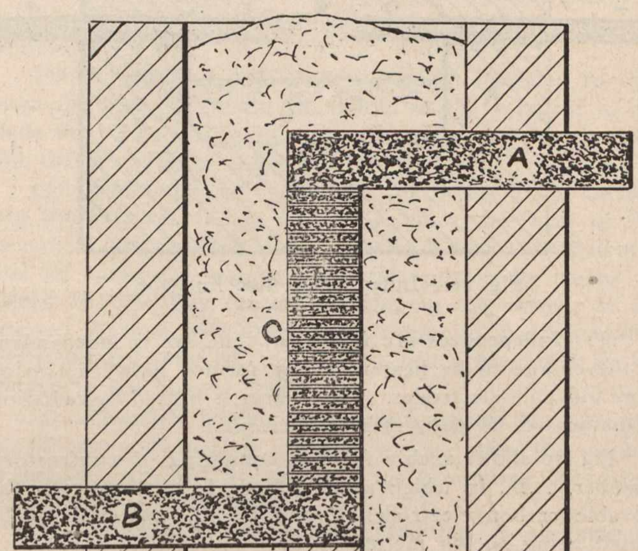


Fig. 15.—Tone's Resistance Furnace.

heated acts as an envelope to retain the heat, and as the charge does not become fused, the outer walls can be of the simplest description; merely serving to retain the charge in position. This furnace would not be directly applicable in case the charge were to fuse, since the core would become broken. The furnace is also essentially intermittent in action, as the charge cannot pass continuously through it;

and on that account it is less efficient, since it must be allowed to cool between successive operations. Although a core is provided in this furnace to carry the current, a portion of the latter is undoubtedly carried by the charge itself.

Cowles' Furnace for Aluminium Alloys. (See Fig. 4.)

In this furnace, the charge becomes partly fused, and no doubt serves to carry the current, but during the heating of the furnace the current is carried by a carbon core and so the furnace may be included in this class.

Tone's resistance furnace for the reduction of metals is shown in Fig. 15. The central resisting core C is placed vertically in order to permit of continuous charging, which would break down a horizontal core. It is constructed of carbon blocks separated from each other so as to increase the resistance of the core. A and B are carbon electrodes for making electrical connection with the core. The charge is fed in around C, and the reduced and melted metal flows through small holes at the base of the furnace into the receptacles, D and E.

Resistance Furnaces without Special Resistor and without Electrolytic Action.

In these furnaces the material to be heated forms the resistor; it is usually solid, but may become molten during the operation. These furnaces may be divided into four classes:

(1) **Furnaces of the Acheson Type.**—The Acheson furnace can be run without a special resistor if the charge itself is a sufficiently good conductor of electricity; the charge remaining solid and being removed from the furnace at the end of the operation.

(2) **Shaft Furnaces with Lateral Electrodes.**—In these furnaces provision is made for the continuous or intermittent removal of the solid or liquid products, and for the introduction of fresh material while the furnace remains in continuous operation. They resemble the Acheson furnaces in having lateral electrodes and a horizontal flow of current.

In Fig. 16 is illustrated a furnace of this type. It consists of a chamber provided with lateral carbon electrodes and one or more tapping holes. It has a striking resemblance to a blast furnace, the electrodes representing the tuyeres. An objection to this type of furnace is that the current cannot be effectively regulated by moving the electrodes. The ore becomes heated and reduced to the metallic state in the upper part of the furnace, and the whole charge melts in the zone between the electrodes, and can be tapped out at the bottom.

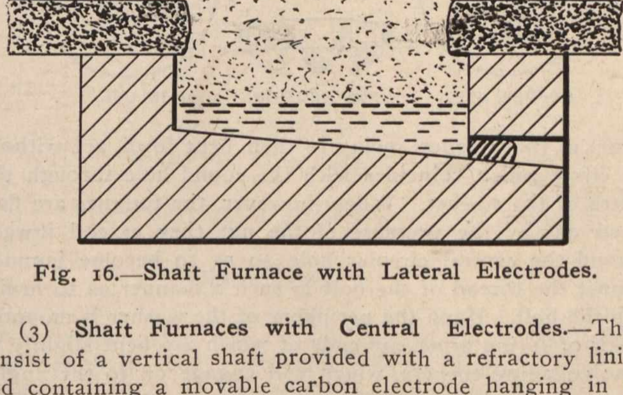


Fig. 16.—Shaft Furnace with Lateral Electrodes.

(3) **Shaft Furnaces with Central Electrodes.**—These consist of a vertical shaft provided with a refractory lining, and containing a movable carbon electrode hanging in the shaft and a fixed carbon electrode in the bottom of the furnace. The ore is fed around the upper electrode, and the current passes through the heated ore mixture between the electrodes.

Fig. 17 represents a shaft furnace with one large electrode hung in the middle, surrounded by the material to be heated. The other electrode, B, is fixed, forming part of the bottom of the furnace; and merely serves to make electrical contact with the fused material in the furnace. An advantage in this furnace is that the current can be easily regulated by raising or lowering the upper electrode. Moreover, the hottest part of the charge is in the middle

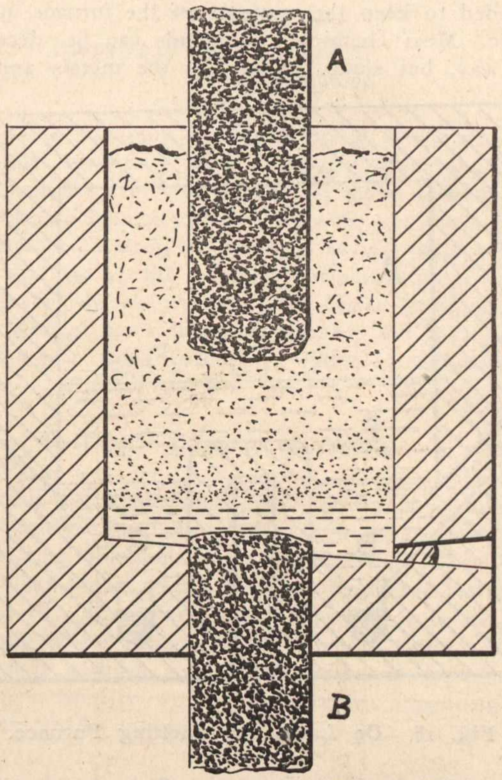


Fig. 17.—Shaft Furnace with Central Electrode.

of the furnace, thus leading to a greater economy of heat and to a longer life of the furnace walls.

Examples:—

Heroult Furnace for smelting Iron Ores.—This furnace, as used recently at Sault Ste. Marie for the electrical smelting of Canadian ores, is essentially of this type.

The Keller Furnace for Smelting Iron Ores.—This consists of two or more shaft furnaces, communicating below to a common receptacle for the fused iron and slag.*

(4) **Furnaces having a Liquid Resistor.**—These consist of a refractory reservoir, containing fused slag, or metal, through which the electric current passes. The liquid becomes superheated by the passage of the current, and is able to melt the fresh material, which can be added at intervals or continuously. The current is introduced by carbon electrodes, by water-cooled metal electrodes, or by induction.

Examples:—The De Laval furnace consists of a chamber, A, the lower part of which is divided into two troughs, B and C, containing molten metal, and electrical contact is made with these by metal terminals. A molten slag, E, fills the furnace above the dividing wall, and the electric current flows between B and C through the molten slag. The slag becomes superheated and dissolves the ore, F, which is added through a hole, K, in the top of the furnace. Alternating current should be employed to avoid electrolysis. The slag fills the furnace up to the hole, F, at which it overflows. The metal in the troughs overflows at the spouts, G and H, as fast as it is formed. In order to prevent the current melting away the wall between the troughs a water-cooled metal block, J, is inserted.

The Gin Steel Furnace.—This consists of a long, rectangular tank, folded with a zigzag form for compactness, containing molten steel. The current is introduced by water-cooled metal terminals, and fresh metal can be added to the molten steel superheated by the passage of the current.

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* This, and the Heroult furnace, will be described in detail in a later article.

Kjellin Steel Furnace.—In this the canal containing the molten steel forms a closed ring, and an electric current is induced in this ring without the use of any terminals, the ring forming the secondary of a transformer.

Electrolytic Furnaces.

In these furnaces the power of a continuous current to divide a fused chemical compound into two component parts is utilized, while the heating effect of the current is also needed to keep the contents of the furnace in a state of fusion. Most chemical compounds can be decomposed in this way, but some behave like the metals and alloys,

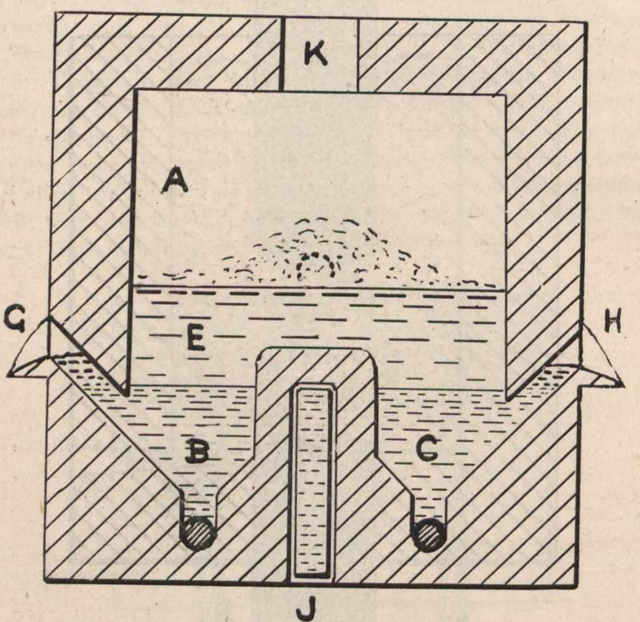


Fig. 18.—De Laval Ore-smelting Furnace.

and carry the current without suffering decomposition. Mixtures of two or more compounds are often employed, as this facilitates the passage of the current and renders the charge more fusible.

Example:—Furnace for Electrolysis of Fused Zinc Chloride (Fig. 19).

This consists of a chamber, A, containing the fused chloride, B. The positive electrode, C, is made of carbon, and dips into the electrolyte, while the fused zinc, D, resulting from the operation, forms the negative electrode, electrical connection being made with it at E. The passage of the current splits the zinc chloride into zinc, which collects at D, and chlorine, which is liberated at the electrode,

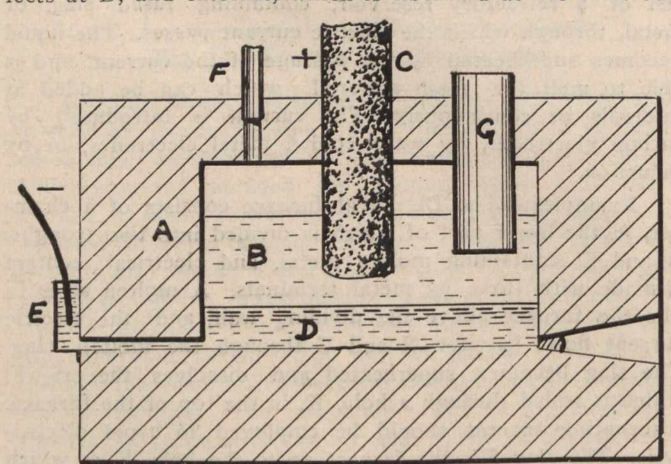


Fig. 19.—Electrolytic Furnace.

B, and is withdrawn from the furnace by the pipe, F. A cylinder, G, passes through the roof of the furnace and dips into the fused electrolyte, to enable fresh chlorine to be added without allowing the chlorine to escape.

Furnaces for the production of aluminium (Figs. 4 and 5) are also examples of electrolytic furnaces.

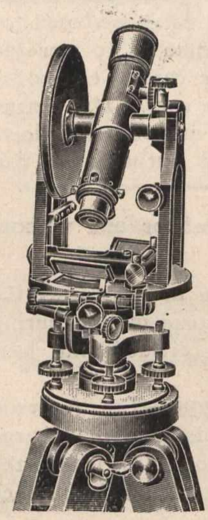
Recapitulation.

In this article only the main principles of the electric furnace have been set forth, leaving the discussion of theory and details of construction for subsequent consideration. The respective types of electric furnaces have, as far as possible, been systematically classified; for many furnaces cannot be placed in any one class, since they combine the features of two or more.

(*Continued.*)

A PROTECTED TRANSIT INSTRUMENT.

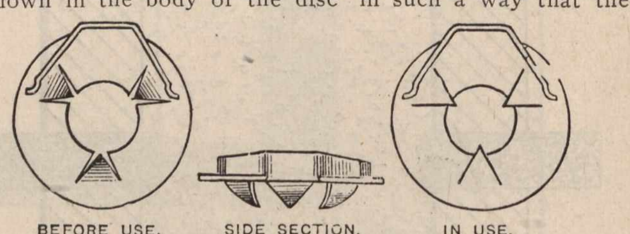
Every engineer who has had to use surveying instruments in mines or in difficult country knows how much trouble, dirt, and dust, and wet can cause. Messrs. J. Davis and Co., Limited, of Derby (represented in Canada by Messrs. Peacock Brothers, Montreal), have brought out a transit instrument specially designed for surveying in gold mines. The principal feature in this is that all the circles, verniers, draw tubes, and screws are protected by metal covers, the verniers being read under glass. The telescope is 7½ in. long, and has a 1 in. aperture, the eye-piece being "18 diameters and inverting." Both the object glass and eye-piece are protected with mud, rain, and dust guards. There is a 4 in. graduated level under the telescope. The horizontal circle is 4 in. in diameter, and is provided with a double row of figures from 0 deg. to 360 deg. The vertical circle is also 4 in. in diameter. The instrument is made either in gun-metal or aluminium, weighing in the former metal 18 lb. 7 oz., and in the latter 15 lbs. 4 oz., the weight of the legs in each case being included. The instrument is wonderfully compact, the intention is excellent, and the reputation of the makers is sufficient guarante that it has been successfully put into practice. The accompanying engraving gives a good idea of what the instrument is like.



The Davis Protected Transit.

THE "FASTNUT" WASHER.

The number of devices that have been designed to lock a nut upon a bolt is legion, and great is the variety in construction of such devices, which have a common object. A device of great simplicity in construction and general applicability as to use has been put on the market by a company trading under the name of Fastnut, Limited, of 60, Aldermanbury, London, E. C. One form of the device is illustrated in the adjoining diagrams, which show the shape of the device before use both in plan and side section and a plan of the device in use. It consists of a circular dics of metal having three inwardly projecting pointed discs punched down in the body of the disc in such a way that the



points of the tongues, owing to their bent form, are without the circle which coincides with the round hole through the centre of the washer. When, however, the tongues are flattened out by the pressure of the nut they extend inward beyond the central circular hole so as to become jammed against the thread of the bolt in such a manner as to firmly grip the bolt. Upon the periphery of the washer is mounted a pair of spring arms, the ends of which are bent slightly to form engaging corners, which will engage on to the angles of the nut and maintain it in position on the bolt. This device has been used for a number of purposes, and judging from the copies of the testimonials we have seen, has been most successful. Amongst the users may be mentioned the Underground Electric Railway of London, where an extended use of the washer has been made, and after practical trial of some time it is stated that it has been found by the engineers to be the best and cheapest washer invented for holding nuts tight that they have had practical experience with. This, we think, speaks very highly for the capacity of the device and consider that the test is a crucial one, and may be taken by intending users as excellent evidence of what may be expected of the device.

ELECTROCHEMICAL CALCULATIONS.

By Joseph W. Richards, A.C., Ph.D.

(*Continued from last month.*)

Professor of Metallurgy in Lehigh University, Past-President of the American Electrochemical Society, Author of "Metallurgical Calculations," etc.

Example: How much oxygen and hydrogen should be produced per day by 300 amperes passing through twenty cells in series?

Solution: The ampere hours performing electrolysis are

$$300 \times 20 \times 24 = 144{,}000$$

The Faradays' passing are

$$144{,}000 \div 26.82 = 5{,}370$$

The volumes of gas produced will, therefore, be:

$5{,}370 \times 11.11 = 59{,}670$ litres of hydrogen.
$5{,}370 \times 5.55 = 29{,}835$ litres of oxygen.

If the gas evolved is a compound gas or acid radical, which is formed at the electrodes, the valence of the acid of basic constituent in a molecule of the gas, is the basis of calculation. For instance, CO, CO^2, CH^4, H^2S all represent molecules of the said gases, of a volume of 22.22 litres, and contain respectively:—

CO	contains	2	gram-equivalents	of	oxygen.
CO^2	"	4	"	"	"
CH^4	"	4	"	"	" hydrogen.
H^2S	"	2	"	"	"

One Faraday (26.82 ampere hours), which would produce one gram-equivalent of oxygen or hydrogen, would, therefore, produce ½ a molecule (11.11 litres) of CO or H^2S or ¼ molecule of CO^2 or CH^4 (5.55 litres).

Another means of calculating the volume of these gases is to note that CO^2 and H^2S are equal in volume to the oxygen or hydrogen contained in them, CO is double the volume of the oxygen contained in it, and CH^4 is double the volume of the hydrogen going into its composition; so that the volumes of the compound gases can be calculated from the volumes of the simple gases going into their formation. The relations alluded to are shown by the Roman numerals indicating molecules or volumes in the following equations:—

$$\overset{\text{I}}{O^2} + 2C = \overset{\text{II}}{2CO}$$

$$\overset{\text{I}}{O^2} + C = \overset{\text{I}}{CO^2}$$

$$\overset{\text{II}}{2H^2} + C = \overset{\text{I}}{CH^4}$$

$$\overset{\text{I}}{H^2} + S = \overset{\text{I}}{H^2S}$$

Ohm's Laws.

The resistance which the electric current encounters to its flow through the body of a substance is determined by the specific resistivity of the body per unit cube of substance, multiplied by its length and divided by its cross-sectional area. The specific resistivity is given in tables per centimeter cubed, in ohms, and the simple arithmetic described gives us the resistance of any bar or wire of said material. The resistance of the body being known, Ohm's laws furnish us with the relation between the applied voltage and current flow through the body, as follows:—

$$\text{Current} = \frac{\text{potential drop}}{\text{resistance}}$$

or,

$$\text{Amperes} = \frac{\text{volts drop}}{\text{ohms resistance}}$$

These relations apply to the current **in the body** of an electrolyte just as strictly as to a metallic wire (and tables of specific resistivity of electrolytes are given in almost all books on electrochemistry),* but they do not apply at all to the resistance or drop of potential at the surface of an electrode; that is, at the contact surface where current enters or leaves an electrolyte. That latter potential drop is due to chemical work being performed, and has no connection whatever with ordinary ohmic resistance and Ohm's laws.

Resistance Capacity of Vessels.

In making electrochemical experiments, as in tubes or in vessels between fixed electrodes, it is often convenient to calculate, as a constant of the apparatus, the "resistance capacity" of the vessel. This is simply its ohmic resistance, between the two fixed electrodes, supposing it to be filled with a liquid whose specific resistance is unity. If the cross section is uniform, and the electrodes of similar area, this resistance capacity would be, in ohms, supposing the measurements made in centimeters:

$$\text{resistance capacity} = \frac{\text{length between electrodes}}{\text{cross sectional area of electrolyte}}$$

Thenceforth, if said vessel is filled between the electrodes with a liquid whose specific resistance is known, the ohmic resistance of the electrolyte will be simply the product of the resistance capacity by the specific resistance of the given liquid used: that is Ohmic resistance of electrolyte = resistance capacity of the vessel × specific resistance of electrolyte.

Determination of Ohmic Resistance.

If the conductor is not electrolyzed by the current, its resistance is measured by sending a known current through it and measuring the drop of potential at its terminals.

$$\text{resistance (in ohms)} = \frac{\text{potential drop (in volts)}}{\text{current flowing (in amperes)}}$$

The current used may be either direct or alternating; the former is preferable because of the more accurate measurements possible. Another method, not so often used, but applicable under many circumstances, is to put a delicate thermometer or thermo-couple in contact with the conductor and measure the rate at which its temperature **begins** to rise. Knowing its specific gravity (weight of one cubic centimeter in grams) and its specific heat (per unit of weight), the heat generated per second in one cubic centimeter is known:

Heat generated (gram calories) = specific gravity × specific heat × rise of temperature per second.

But this quantity is also equal to the heat value of the current used, which is 0.2385 times the watts used, or 0.2385 times the square of the current used into the resistance. We, therefore, have:—

$$\text{resistance (in ohms)} = \frac{\text{heat found calorimetrically}}{0.2385 \times (\text{current used})^2}$$

* Kohlrausch and Holborn's "Leitungsfähigkeit der Elektrolyte" is the most complete collection of such data.

The above method is particularly applicable to electrolytes of any kind if they are placed in a long tube of low heat-conducting material, and the rise of temperature thus measured at a point remote from the electrodes. Then, whatever action, chemical or thermal, occurs at the electrodes, and whatever potential drop may occur, it is only necessary that the amount of current passing be accurately measured, the specific heat and specific gravity of the electrolyte be known, and the rate of rise of temperature be measured at the first few seconds after turning on the current, to be able to calculate the specific resistance.

The use of alternating current for measurements of ohmic resistance using Kohlrausch's method of Wheatstone bridge and a telephone is applicable with accuracy to non-electrolytic conductors, and has generally been assumed to be applicable quite as accurately to electrolytes. Recent work on the possibility of electrolysis occurring when alternating current is passed through an electrolyte has rather cast doubts upon the accuracy of these tests. It is possible that most determinations thus made have been free from error, but we can understand now that tests so made might be erroneous in many instances, if made with certain electrodes and with certain frequency of alternation of the measuring current

For many practical purposes, the ohmic resistance of an electrolytic cell can be determined by the following simple device and calculation: Use electrodes equal to the cross section of the electrolyte, and put in series with a relatively high resistance, so as to keep the strength of current as nearly constant as possible. Measure amperes and voltage drop with the plates as wide apart as possible; draw together till they are exactly half the distance apart, and measure again. If the outside resistance is high enough, the amperes will be constant within the ability of the ammeter to record, while the voltage will decrease. Double the decrease in voltage will be the total voltage drop in overcoming the ohmic resistance of the whole cell. Designating this as the voltage drop due to electrical conductivity of the electrolyte, V^c, we have:—

$$\text{Resistance of cell (in ohms)} = \frac{V^c}{\text{amperes passing}}$$

Voltage Drop at the Electrode Surfaces.

This is the loss of potential across the electrodes corresponding to the work done at the electrodes. It is practically determinable by measuring the total potential drop, and subtracting from it the drop due to overcoming the ohmic resistance of the electrolyte. Calling V the total drop of potential and V^d that part of it absorbed in chemical (or physical) work at the surface of the electrodes, then

$$V^d = V - V^c.$$

If V^c has been determined in the manner described in the last paragraph, or has been calculated from the specific resistance of the electrolyte, properly determined, and the resistance capacity of the electrolytic vessel, then V^d represents accurately the voltage drop due to all phenomena occurring **at the surface** of the electrodes, as distinguished from the mere phenomenon of electric conduction, ruled absolutely by Ohm's law, occurring **in the body** of the electrolyte.

It may not be amiss to remark, **en passant,** that the fact that Ohm's law applies absolutely to the conduction of electricity through the body of an electrolyte, in the same manner as in a metallic conductor, combined with Prof. Hopkins' recent determinations that the conducting of the current is practically instantaneous in electrolytes, as it is in solids, and that the body of an electrolytic conductor acts in all respects magnetically, etc., exactly the same as the body of a metallic conductor—all prove the identity of the mechanism of electric conduction through the substance or body of an electrolytic conductor and through solid metallic conductors. The phenomena at the bounding surfaces, the electrodes, are different in the two cases, but there is no experimental evidence of any dissimilarity in the mechanism of the conduction in the body of the conductors in the two cases.

Transfer Resistance.

This is supposed to represent resistance to the passage of the current from the electrolyte to the electrode, of the nature of the work done when current is passed across a thermo-electric junction; that is, it is a resistance purely physical in its nature, existing simply because the current passes from one conducting substance to another one, and, finally, a resistance which causes the current to either generate heat, by heating this junction, or to absorb heat, by cooling the junction. It is, therefore, a reversible phenomenon, either subtracting potential from the current in such quantity as that the heat thus generated represents the heat equivalent of the watts thus lost, or else contributing potential to the circuit in such quantity that the potential thus furnished represents, when multiplied by the amperes flowing, the watt equivalent of the heat energy absorbed.

In your lecturer's opinion, this transfer resistance must be very small. Since it would be of different signs at the two electrodes, absorbing voltage at one and generating nearly an equal amount at the other, the difference between two quantities in themselves small, must be of a low order of magnitude. Further, no reliable determinations are at hand concerning these + and — thermo-electrical potentials, because of the inevitable complication of the measurements by purely chemical changes. For instance, one investigator kept two zinc electrodes in zinc-chloride solution, but at 20° C. difference of temperature, and measured the difference of voltage, calling it thermo-electric difference of potential; but aside from the fact that this ignores any thermo-electric difference of potential between the hot and cold solutions, or in any part of the external circuit, it is certain that it ignores the difference between the heat of formation of zinc chloride in aqueous solution at two temperatures 20° apart, which might easily be equal to the whole potential difference noted. Until, therefore, physicists have cleared up satisfactorily this whole subject of thermo-electric potential between electrodes and solutions, we are making a less error in leaving out its consideration than in trying to account and allow for it—particularly since we know that some of the so-called allowances are certainly erroneous.

I have left out of the definition of transfer resistance that produced by a change in the electrode whereby a film of insoluble salt or gas is produced, and so chokes off the current. Such action is polarization, and such change in the original conditions, practically introducing modified or even new electrode surfaces, is not transfer resistance, properly speaking.

Voltage Required for Chemical Work.

We arrive here at the kernal of electrolytic calculation, the sole and sufficient basis being that the amount of electrical energy expended in doing chemical work must equal the energy equivalent of the chemical work done. If that position does not hold in this question, then energy could be created or lost, and the principle of the conservation of energy violated. We must admit, however, that if an electrolytic cell cools off while the current is passing, that external heat energy is being supplied which will diminish, by the amount so supplied, the work being done by the current. However, that quantity is in the nature of a possible correction, while the heat of the chemical reaction produced is the principal factor.

We must remark at the outset that the chemical work done means the whole change from the system before electrolysis to the system after electrolysis. There is no division of the chemical work of the current into that required for assumed primary reactions and that for assumed secondary reactions. Only changes taking place at the surface of the electrodes, however, affect the energy requirements; chemical reactions taking place away from immediate contact with the surface of the electrodes neither absorb energy from the circuit nor deliver energy to it—they are purely incidental and independent chemical phenomena.

(*Continued.*)

CONCRETE ON THE PACIFIC COAST.

Some of the Lessons that the Recent Disaster Has Taught the Building World, and the Plans for the Foundation Work that will Support the Rebuilt Cities.

The accompanying pictures are of timely interest in that they were taken by Frank B. Gilbreth, the New York contractor, in San Francisco, Oakland, and Seattle only a few days before the recent earthquake disaster. They show the effect of the teredo and limnoria on wooden piles exposed to the salt water on the western coast, and offer still another conclusive argument for the use of reinforced concrete for foundation work in the rebuilding of the destroyed cities.

Fig. 1.

Creosoted wooden piles, showing the effect of the Teredo and Limnoria; from a photograph taken at San Francisco a few days before the earthquake.

Figure 1 shows a creosoted wooden pile in San Francisco almost entirely destroyed by the teredo and limnoria. In the vicinity of Puget Sound, Mr. Stewart, assistant chief engineer of the Great Northern Railroad, states that a stick of timber, rough sawed, will last about eight months; a peeled pile will last a year; a pile with the bark on will last a year and a half, and a cresoted pile from fifteen months to fifteen years. Such piles, however, even when driven under the same conditions, will be attacked entirely differently by the teredo and limnoria. All of the accompanying pictures show piles that have been coated with a coal tar or creosote compound.

Referring to the recent disaster, Mr. Gilbreth, who has many large structural enterprises under way on the western coast, states:

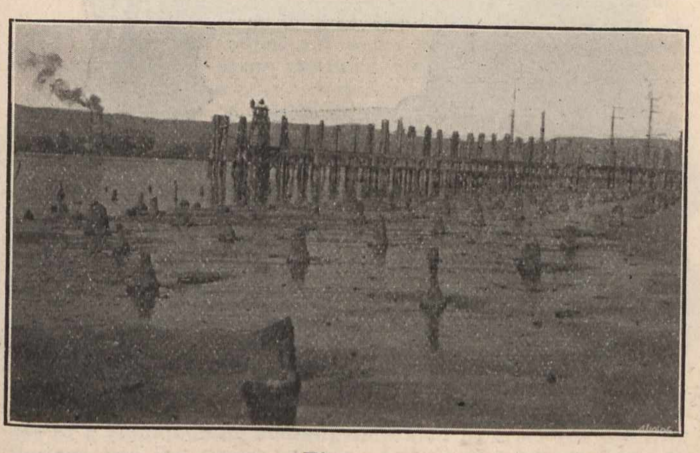


Fig. 2.

The remains of a wharf at Oakland, Cal., destroyed by the Teredo and Limnoria. Concrete piles will hereafter be largely used in rebuilding such structures.

"While it is practically impossible to put up any structure which is able to withstand an earthquake shock of great intensity and varying motion, it is possible to erect buildings capable of weathering a shock such as the recent one in San Francisco. The great devastation resulted more from the flame than from the earthquake itself, and this fact emphasizes the importance of using reinforced concrete for fireproof structures. It is safe to say that if the business section of the city had been constructed of reinforced concrete the fire resulting from the upheaval would never have gained headway."

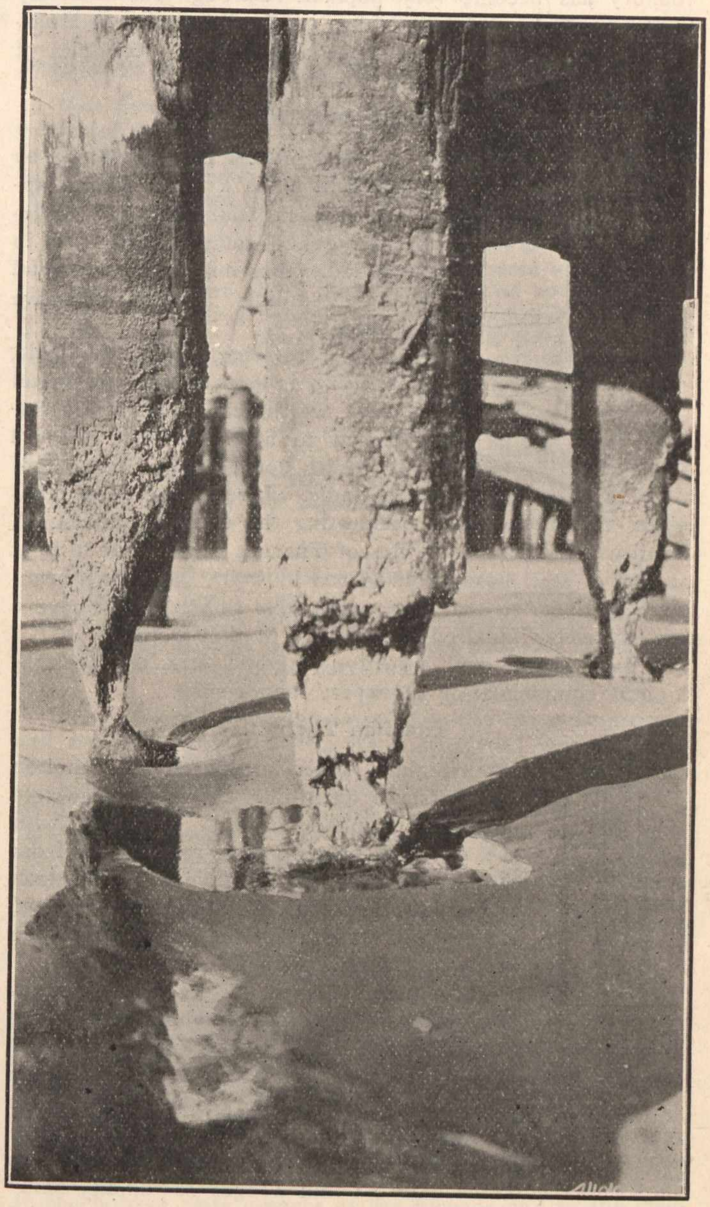


Fig. 3.

Detail of wharf piles shown in Fig. 1.

Fig. 4.

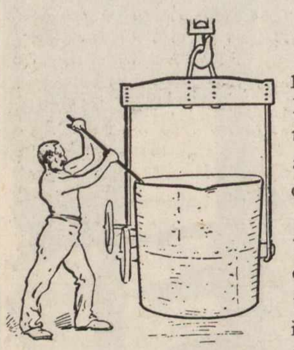
Remains of another wharf at Oakland, Cal., showing destructive action by marine insects.

The Columbia Improvement Company, of Seattle, for which Mr. Gilbreth, is building a $500,000 plant, has already taken warning from the San Francisco cataclysm, and in building a half-million power house has ordered a monolithic concrete construction to ensure the maximum stability.

FOUNDRY ECONOMIES.

Within the last few years the use of "Thermit" in the foundry has become very popular. Through the courtesy of the Goldschmidt Thermit Co., 334 St. James Street, Montreal, we are enabled to describe and illustrate examples of its application in common foundry practice.

Reviving Dull Iron.

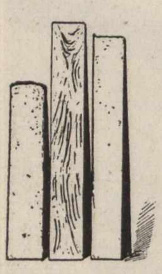


The intense heat developed by Thermit finds a very natural application in foundries for superheating and reviving dull iron in the ladle, thus improving the metal and guarding against defective castings.

For reviving iron in the ladle, Thermit is put up in cylindrical cans, which can be readily attached to an iron rod. The rod is thrust down to the bottom of the ladle, where the reaction takes place, the intense heat permeating the entire contents. A small can containing 1½ lbs. of Thermit is sufficient to melt 40 lbs. of steel borings in an 800 lb. ladle, in making semi-steel castings, so that one can is also sufficient to revive a ten or twelve hundred-pound ladle of dull iron.

This simple and effective method has received the highest commendation of expert foundrymen.

Titanium Thermit.

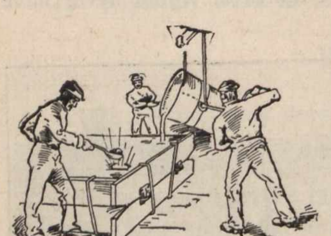


Titanium, when introduced into molten iron in small quantities, exerts a remarkable purifying or poling action. It unites with the nitrogen present and removes it from the metal, increases the fluidity of the iron and produces casting of exceptionally dense, close grain. It is, therefore, of especial value in casting engine cylinders and valves.

A special Thermit is prepared, containing small additions of Titanium, and packed in cans smiliar to the "semi-steel" or reviving cans. It is introduced into the ladle as before. The actual temperature of the metal is not much increased, but the ebullition of the reaction distributes the Titanium through the ladle.

The greater fluidity of iron thus treated is strikingly shown in the sketch of three thin wedges or "fluidity bars." The centre bar is a "fluidity wedge-pattern" from which two moulds were made. The first bar was poured in one of the moulds from **untreated iron.** The third bar was cast from the same ladle of iron immediately after treatment.

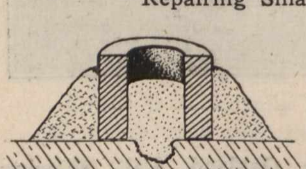
Riser Thermit.



It is often advisable to superheat or revive iron in the "risers" in making long or intricate castings. This result is easily secured by simply dropping a small package of Thermit and a pinch of ignition powder into the riser as the metal appears. The intense heat is communicated into the mould and effectually prevents cold-shuts and other defects due to dull metal.

Liquid steel will ignite Thermit. Liquid cast iron requires ignition powder.

Repairing Small Flaws in Castings.



For making very small repairs, the so-called "pouring cup" is employed—a shallow vessel, open at the bottom, which is placed directly over the flaw. The Thermit is then put into the cup and ignited. The flaw is fused out and replaced with Thermit steel. This is a simple, cheap and effective method of repairing flaws in steel castings and forgings.

The Thermit process of repairing flawed castings must not be considered as one of concealing imperfections. It is a true washing out of imperfections and replacing with perfect steel.

The ease with which intensely hot metal may be obtained anywhere almost at a moment's notice, the simplicity of equipment and manipulation have firmly established this practice in some of our most prominent steel foundries.

Repairing Steel Castings and Forgings.

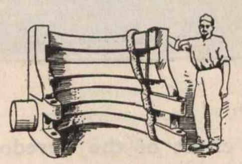
A most promising field for Thermit lies in repairing flaws in steel castings and forgings. The superheated Thermit steel literally washes away the flaw, fuses the metal, amalgamates with it and leaves it perfect.

In making large repairs, where considerable quantities of Thermit are needed, the conical or "Automatic" crucible is used, supported on a tripod or stand, and tapped from the bottom, as already described and illustrated.

Where smaller quantities of Thermit are required, a flat-bottomed crucible is used, handled by tongs, like the small foundry ladle. After ignition, the slag is decanted or poured off and then the steel run into the mould.

The illustration shows this method as employed in repairing a flaw in a large steel ingot.

General Repair Work.



Thermit finds an extensive field in general repair work of steel, and even of cast iron. The accompanying sketch of an enormous steel gun-cradle welded by Thermit illustrates the possibilities of this method.

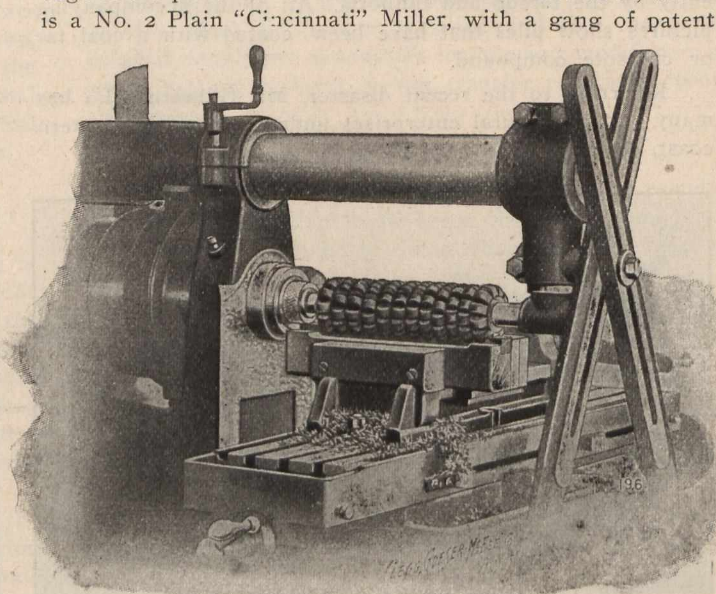
❧ ❧ ❧

MACHINE SHOP NOTES FROM THE STATES.

By Charles S. Gingrich, M. E.

XXVI.

The Ohmer Fare Register Co., Dayton, Ohio, use in their device a malleable iron bar, one edge of which has a series of grooves its entire length. The bars are 12 in. long, and while all the grooves are arcs of a circle, they are of varying sizes and depths. Their method of finishing this edge of the piece is shown on the enclosed illustration, which is a No. 2 Plain "Cincinnati" Miller, with a gang of patent



relieved cutters 3½" diameter, forming a gang 12" wide, so that with the bars held in a vise adapted for the purpose, the entire edge of the piece is milled at a single cut.

The total amount of time required for the operation is, of course, very small, but would be exceedingly tedious and difficult if attempted on any other machine except the miller. It is a job for which one might say, the milling machine is especially adapted, and because of the great length of the cut it serves to illustrate what can be accomplished on comparatively small machines.

OFFICIAL PRELIMINARY REPORT

OF THE DOMINION GOVERNMENT.

On the Experiments Made at Sault Ste. Marie, in the Smelting of Canadian Iron Ores by the Electro-thermic Process.

[Through the courtesy of Dr. Eugene Haanel, Dominion Superintendent of Mines, we are enabled to place before our readers an authentic detailed account of the "Soo" experiments: which "contains all the information needed by a business man to form a judgment as to the feasibility of the commercial introduction of electric smelting in the production of pig iron." Editor.]

INTRODUCTION.

The only experiments which the members of the Commission appointed by the Government in December, 1903, to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel in operation in Europe * were able to witness in the electric smelting of iron ores were those made by Dr. Heroult at La Praz and Mr. Keller, of Keller, Leleux & Co., at Livet, France. The first was a mere trial, furnishing no reliable quantitative results; the latter more extended experiments continued for a number of days were made with a very porous hematite containing 3.21 per cent. of manganese and only 0.02 per cent. of sulphur; an ore, therefore, easily reduced and easily desulphurized. Two sets of experiments were made at Livet. In the first experiment 0.475 H.P. years were required per ton of 2,000 lbs. of pig-iron, corresponding to an output of 5,769 tons per 1,000 H.P. days. In the second experiment 0.226 H.P. years were required per ton of product, corresponding to an output of 12.12 tons per 1,000 H.P. days. In this experiment, moreover, most of the iron produced was white, for which cold working is required and consequently less energy consumed.

The difference in output of these two experiments was so great, being more than double that of the first in the second experiment, that no conclusion could be drawn as to the amount of energy required per ton of product, and Mr. Harbord, the metallurgist of the Commission, was compelled to adopt 0.350 H.P. years, the mean of the two experiments, as the probable energy required per ton of product. This would correspond to an output of 7.827 tons per 1,000 E. H. P. days.

Before, therefore, a sound judgment could be formed as to the practicability of the electro-thermic process for the smelting of Canadian ores it was desirable to establish with some degree of exactitude the amount of electric energy required per ton of product, and also the following important points referring to Canadian conditions, which were either not taken up or were left in doubt by the Livet experiments:—

1st.—Can magnetite, which is our chief ore, and which is to some extent a conductor of electricity, be successfully and economically smelted by the electric process?

2nd.—Can iron ores with comparatively high sulphur content, but not containing manganese be made into pig iron of marketable composition?

3rd.—The experiments made at Livet with charcoal as a reducing agent in substitution for coke having failed, could the process be so modified that charcoal, which can be cheaply made from mill refuse and other sources of wood supply, useless for other purposes, could be substituted for coke? This is especially important since charcoal and peat-coke constitute home products, while coal-coke for metallurgical process requires to be imported into the Provinces of Ontario and Quebec.

The settlement of these questions was of such paramount importance for the formation of a judgment as to the feasibility of introducing electric smelting of iron ores as an economic process in those Provinces of Canada which lack coal for metallurgical coke, but are abundantly supplied with water-power and iron ore deposits, that the experimental investigation of the subject by the erection of an electric smelting plant was authorized.

Location of Plant.

The Lake Superior Corporation at Sault Ste. Marie, Ont., offered, on the recommendation of Mr. Clergue, the use of a commodious building in which to erect the electric furnace and the power of one of their alternators free of expense for four months. At the same time the use of an office, their well-equipped laboratory, the services of their chemist and machinery necessary for preparing the charge for the furnace were offered on reasonable terms. It was deemed that these advantages could not be secured elsewhere, and the offer was, therefore, accepted and the plant ordered to be erected, under the superintendence of Mr. Erik Nystrom, member of the staff of the Mines Branch, in the building provided for this purpose.

*Report of the Commission Department of the Interior, Ottawa, 1904.

Description of Experimental Furnace and Electrode Holder.

The furnace was designed by Dr. P. Heroult, who had consented to make the experiments. It consisted of an iron casing bolted to a bottom plate of cast iron 48" in diameter. The casing was made in two cylindrical sections to facilitate repairs. To render the inductance as small as possible the lines of magnetic force in the iron case were prevented from closing by the replacement of a vertical strip of 10" width of the casing by a copper plate. Carbon paste was rammed into the lower part of the furnace up to the bottom of the crucible. The lining consisted of common fire brick, which from the bottom of the crucible up for a distance a little above the slag level was covered with carbon paste to a thickness of a few inches. The crucible, therefore, consisted entirely of carbon.

The lining of the furnace was given the shape of a double cone set base to base. Changes in the dimensions of the interior were made from time to time, as indicated by experience, but for the majority of the experiments they were as follows:—

Diameter of bottom of crucible	24"
Height of lower cone	11"
Height of upper cone	33"
Diameter of joint base of the two cones.......	32"
Diameter at top of furnace	30"

The electrodes, manufactured by the Heroult process and imported from Sweden, were prisms of square cross-section, 16" x 16" by 6 ft. long. The contact with the cables carrying the electric current consisted of a steel shoe riveted to four copper plates, which ended in a support for a pulley. The electrode with its contact was supported by a chain passing under the pulley, one end of the chain being fastened to the wall, the other end passing over a winch operated by a worm and worm-wheel. This formed a convenient arranagement for regulating the electrode by hand

Electrical Machinery.

The electrical energy was furnished by one phase of a 3 phase, 400 K. W., 30 cycle, 2,400 volt, alternating current generator coupled by belt to a 300 H.P., 500 volt, direct current motor. A current of 2,200 volts was delivered to an oil cooled transformer of 225 K. W. capacity, designed to furnish current to the furnace at 50 volts. The transformer was placed in a separate room in the furnace building, close to the furnace. From the transformer the current was led to the bottom plate contact of the furnace and to the electrode contact by conductors consisting each of 30 aluminium cables, 5/8" in diameter.

The measuring instruments consisted of a voltmeter, an ammeter, a power factor meter and a recording wattmeter. The transformer and electric meters were manufactured by the Westinghouse Electric and Manufacturing Company.

An additional voltmeter reading from 10 to 80 volts, supplied by the Keystone Electric Company, which proved very satisfactory, was also placed in circuit to serve as a check.

Experiments.

A number of experiments required to be made to adjust the capacity of the crucible of the furnace to the energy available and to determine the shape to be given to the interior of the furnace to insure easy passage of the charge into the reducing and melting zones. After this, attempts were made to utilize the calorific energy of the carbon monoxide resulting from the reduction of the ore, which in all experiments so far recorded had been wasted. To accomplish this, air under pressure was introduced into the furnace about 12" below the upper level of the charge. The carbon of the charge, in the form of coke dust, was mixed with fire clay and briquetted to prevent it from being consumed by the air blast. It was hoped that by thus utilizing the carbon monoxide in preheating the charge and partially reducing the ore the output would be materially increased.

It was found, however, that the great heat evolved by the combustion of the carbon monoxide caused the charge to become sticky and to hang. Nor could this be remedied by stoking, the space between the walls of the furnace and the electrode being too narrow. Moreover, the electrode, although it had been protected with asbestos and iron sheeting, was found after the experiment to have been badly corroded. The furnace was not at all adapted for these experiments and further attempts in this direction were abandoned. The experiments, however, showed that with a differently constructed furnace, in which the electrode is isolated from the charge, the output might be greatly increased by the introduction of an air blast.

The official experiments were begun about the middle of January, the furnace being in operation night and day, with some few intermissions, until the 5th of March. During that time about 150 casts were made, yielding about 55 tons of pig iron.

The following classes of ore were treated:—

1. Hematite (Nagaunee).
2. Magnetite from the Wilbur mine, Ont. (Wm. Caldwell, Esq.).
3. Magnetite from the Blairton mine, Ont. (Pierce Co., Marmora.).
4. Magnetite from the Calabogie Mining Co. (J. G. Campbell, Esq., Perth.).
5. Magnetite from the Calabogie Mining Co. (J. G. Campbell, Esq., Perth.).
6. Magnetite from the Calabogie mine (T. B. Caldwell, Esq., Lanark.).
7. Roasted pyrrhotite from Lake Superior Corporation.
8. Titaniferous iron ore from Quebec. (J. G. Scott, Quebec.).

The materials for the charge: ore, flux and carbon, were crushed to pass through a ¾" ring and roughly mixed. The composition of the charge in each run as given in this preliminary report was slightly modified from time to time by varying the percentage of charcoal and flux.

*Run No. 8.

Ore treated	Hematite.
Reducing agent	Briquettes.
Flux	Limestone.

**Analysis of Raw Material.

Hematite:		Limestone:	
SiO_2	5.42	SiO_2	1.71
Fe_2O_3	88.90	$Fe_2O_3 + Al_2O_3$	0.81
Al_2O_3	2.51	$CaCO_3$	92.85
CaO	0.61	$MgCO_3$	4.40
MgO	0.30	P	0.004
Mn	0.16	S	0.052
P	0.044		99.826
S	0.002		
Loss on ignition	2.48		
	100.426		

	Per cent.
Metallic iron	62.23

The briquettes were made of 80 per cent. coke dust and 20 per cent. fireclay.

Briquettes:

	Per cent.
Volatile matter	4.05
Fixed carbon	69.73
SiO_2	15.26
$Fe_2O_3 + Al_2O_3$	8.92
CaO	0.90
MgO	0.30
S	0.84
	100.00

The charge, which was slightly modified for subsequent charges by increasing the amount of briquettes and decreasing the limestone, had the following composition:—

	Pounds.
Ore	200
Briquettes	60
Limestone	50

Analysis of Iron Produced.

	Cast No. 28, Grey Iron:	Cast No. 30, Grey Iron:
Total carbon	4.85	4.35
Si	0.87	1.03
S	0.018	0.019

Analysis of Slag Produced.

SiO_2	34.40
Al_2O_3	15.73
CaO	43.53
MgO	2.00
Fe	1.35
S	0.55

$$\frac{\text{slag (obtained)}}{\text{iron (obtained)}} = \frac{1162}{2665} = 0.44$$

Length of run	12 hours.
Mean volts on furnace	38.5
Mean amperes	4850
Power factor	0.919
Pig-iron produced	2665 lbs.
Watts = 38.5 × 4850 × 0.919	171812

$$\text{Electrical horse-power} = \frac{171812}{746} = 230.3$$

$$\text{Output of pig-iron per 1,000 E. H. P. days} = \frac{2665 \times 24 \times 1000}{12 \times 230.3 \times 2000} = 11.57 \text{ tons.}$$

E. H. P. years of 365 days per ton of pig = 0.236

Subsequent experiments indicate that had charcoal or coke been used as a reducing agent instead of briquettes, thereby greatly reducing the amount of slag produced, the output would have been considerably increased.

Run No. 13.

Ore treated	magnetite from Wilbur mine.
Reducing agent	charcoal.
Flux	sand.

Wilbur Ore:	Per cent.		Charcoal:	Per cent.
SiO_2	6.20		Moisture	14.06
Fe_2O_3	55.42	Fe = 55.42	Volatile matter	28.08
FeO	23.04		Fixed carbon	55.90
AlO	2.56		Ash	2.54
CaO	2.00			100.58
MgO	6.84		Sulphur	0.058
P_2O_5	0.023	P = 0.01		
S	0.01			
CO_2 & undet	3.907			
	100.000			

The sand used was common furnace sand, of which no analysis was made.

Composition of Charge.

	Pounds.
Ore	400
Charcoal	125
Sand	27

Analysis of Iron Produced.

	Cast No. 49, Grey Iron:	Cast No. 53, Grey Iron:
Total carbon	5.18	4.65
Si	1.30	1.41
S	0.020	0.012
P	0.029	0.024

Analysis of Slag Produced.

SiO_2	35.84
Al_2O_3	31.80
CaO	14.39
MgO	16.22
S	0.26
Fe	0.35

$$\frac{\text{Slag}}{\text{Iron}} = \frac{4195}{12858} = 0.326$$

Length of run	61 hours, 25 min.
Mean volts on furnace	35.75
Mean amperes	5000
Power factor	0.919
Pig-iron produced	12858 pounds.
Watts = 35.75 × 5000 × 0.919	164271

$$\text{E. H. P.} = \frac{164271}{746} = 220.2$$

$$\text{Output of pig-iron per 1,000 E. H. P. days} = \frac{12858 \times 24 \times 1000}{61.4 \times 220.2 \times 2000} = 11.41 \text{ tons.}$$

E. H. P. years* per ton of pig = 0.2399.

Run No. 14.

Ore treated	Magnetite from Blairton mine.
Reducing agent	Charcoal.
Flux	Limestone. / Sand.

*Only those runs are given in this preliminary report which are of special interest.

**A redetermination for the final report of the composition of slags and iron produced renders the analyses here given subject to amendment.

*365 days.

Analysis of Raw Material.

Blairton Ore:

SiO_2	6.60	
Fe_2O_3	60.74	Fe = 55.85.
FeO	17.18	
Al_2O_3	1.48	
CaO	2.84	
MgO	5.50	
P_2O_5	0.037	P = 0.016.
S	0.57	
CO_2 & undet	5.053	
	100,000	

Charcoal and limestone same as in previous run.

Composition of Charge.

	Pounds.
Ore	400
Charcoal	125
Limestone	25
Sand	6

Analysis of Iron Produced.

Cast No. 80, Grey Iron:

Total carbon	3.73
Si	3.53
S	0.042
P	0.034

Analysis of Slag Produced.

SiO_2	33.80
Al_2O_3	10.20
CaO	21.78
MgO	30.50
S	2.05
Fe	0.25

$$\frac{\text{Slag}}{\text{Iron}} = \frac{4892}{11989} = 0.41$$

Length of run	65 hours, 30 min.
Mean volts on furnace	36.03
Mean amperes	4987
Power factor	0.919
Pig-iron produced	11989 pounds.
Watts = 36.03 × 4987 × 0.919	165125

$$\text{E. H. P.} = \frac{165125}{746} = 221.34$$

$$\frac{11989 \times 24 \times 1000}{65.5 \times 221.34 \times 2000} = 9.92 \text{ tons.}$$

E. H. P. year per ton of pig = ... 0.276

Run No. 15.

Ore treated	Magnetite from Calabogie.*
Reducing agent	Charcoal and charcoal brace.
Flux	Limestone.

Analysis of Raw Material.

Calabogie Ore:

SiO_2	3.80	
Fe_2O_3	56.24	Fe = 59.38
FeO	25.76	
Al_2O_3	3.73	
CaO	2.00	
MgO	3.42	
P_2O_5	0.85	P = 0.371
S	0.20	
CO_2 & undet	4.00	
	100.00	

Limestone and charcoal the same as in previous runs. The charcoal brace used was of poor quality, being wet, high in ash and mostly fines.

The composition of the charge, when using charcoal, was:—

	Pounds.
Ore	400
Charcoal	125
Limestone	30

When using charcoal brace, the composition of the charge was:—

	Pounds.
Ore	400
Charcoal brace	145
Limestone	40

*Calabogie Mining Company.

During this run the alternator had to be stopped on account of repair of motor. The furnace was then considerably cooled and some time was consumed before it was again in working condition.

First Part of Run.—Analysis of Iron Produced.

	Cast No. 89, Grey Iron:	Cast No. 90, Grey Iron:
Total carbon	3.53	3.43
Si	0.95	1.17
S	0.024	0.016
P	0.554	0.457

Analysis of Slag Produced.

SiO_2	24.30
Al_2O_3	27.16
CaO	36.06
MgO	10.74
S	1.67
Fe	0.25

$$\frac{\text{Slag}}{\text{Iron}} = \frac{1335}{4520} = 0.29$$

Length of run	23 hours, 50 min.
Mean volts on furnace	36.16
Mean amperes	5,000
Power factor	0.919
Pig-iron produced	4520 pounds.
Watts = 36.16 × 5000 × 0.919	166155

$$\text{E. H. P.} = \frac{166155}{746} = 222.72$$

Output of pig-iron per 1,000 E. H. P. days =

$$\frac{4520 \times 24 \times 1000}{23.83 \times 222.72 \times 2000} = 10.21 \text{ tons.}$$

E. H. P. years per ton of pig = 0.268.

Second Part of Run.—Analysis of Iron Produced.

	Cast No. 92, Grey Iron:	Cast No. 95, Grey Iron:
Si	0.73	0.95
S	0.011	0.012

$$\frac{\text{Slag}}{\text{Iron}} = \frac{892}{2722} = 0.33$$

Length of run	16 hours, 15 min.
Mean volts on furnace	35.85
Mean amperes	5000
Power factor	0.919
Pig-iron produced	2722 pounds.
Watts = 35.85 × 5000 × 0.919	164730

$$\text{E. H. P.} = \frac{164730}{746} = 220.81$$

Output of pig-iron per 1000 E. H. P. days =

$$\frac{2722 \times 24 \times 1000}{16.25 \times 220.81 \times 2000} = 9.10 \text{ tons.}$$

E. H. P. years per ton of pig = 0.301.

Run No. 16.

Ore treated	Magnetite from Calabogie.*
Reducing agent	Charcoal.
Flux	Limestone. Quartz.

Analysis of Raw Material.

Calabogie Ore:

SiO_2	6.06	
Fe_2O_3	58.00	Fe = 59.85
FeO	24.78	
Al_2O_3	1.00	
CaO	0.40	
MgO	6.00	
P_2O_5	0.046	P = 0.020.
S	0.17	
CO_2 & undet.	3.544	
	100.000	

Charcoal:

Moisture	2.20
Volatile matter	20.60
Fixed carbon	74.40
Ash	2.80

Limestone same as in previous runs.

Composition of Charge.

	Pounds.
Ore	400
Charcoal	125
Limestone	45
Quartz	5

*Calabogie Mining Co., Shaft No. 4.

Analysis of Iron Produced.

Cast No. 102, Grey Iron:

Total carbon	4.20
Si	1.75
S	0.005
P	0.047

Analysis of Slag Produced.

SiO_2	30.90
Al_2O_3	12.30
CaO	40.09
MgO	12.91
S	1.48
Fe	0.56

$$\frac{\text{Slag}}{\text{Iron}} = \frac{2556}{7150} = 0.36$$

Length of run	38 hours, 20 min.
Mean volts on furnace	36.5
Mean amperes	4993
Power factor	0.919
Pig iron produced	7150 pounds.
Watts = 36.5 × 4993 × 0.919	167483

$$\text{E. H. P.} = \frac{167483}{746} = 224.50$$

Output of pig-iron per 1000 E. H. P. days =

$$\frac{7150 \times 24 \times 1000}{38.33 \times 224.50 \times 2000} = 9.97 \text{ tons.}$$

Run No. 17.

Ore treated magnetite from Calabogie mine.*

Reducing agent ...... Charcoal.

Flux .... { Limestone. Quartz.

Analysis of Raw Material.

Calabogie Ore:

SiO_2	4.00	
Fe_2O_3	55.31	Fe = 58.29
FeO	25.20	
Al_2O_3	2.24	
CaO	2.40	
MgO	4.00	
P_2O_5	0.95	P = 0.415
S	0.45	
CO_2 & undet	5.45	
	100.00	

Charcoal same as in Run No. 15. Limestone same as in previous runs.

Composition of Charge.

	Pounds.
Ore	400
Charcoal	125
Limestone	20

Occasionally small quantities of sand were added.

Analysis of Iron Produced.

	Cast No. 111, Grey Iron:	Cast No. 113, Grey Iron:
Si	1.49	1.55
S	0.016	0.015
P	0.500	0.520

Analysis of Slag Produced.

SiO_2	26.96
Al_2O_3	20.64
CaO	27.40
MgO	15.50
S	1.41
Fe	0.21

$$\frac{\text{Slag}}{\text{Iron}} = \frac{3263}{8303} = 0.39$$

Length of run	43 hours, 5 min.
Mean volts on furnace	36.79
Mean amperes	5000
Power factor	0.919
Pig-iron produced	8303 pounds.
Watts = 36.79 × 5000 × 0.919	169050

$$\text{E. H. P.} = \frac{169050}{746} = 226.6$$

Output of pig-iron per 1000 E. H. P. days =

$$\frac{8303 \times 24 \times 1000}{43.08 \times 226.6 \times 2000} = 10.20 \text{ tons.}$$

E. H. P. years per ton of pig = 0.268.

*T. B. Caldwell, Esq.

Run No. 18.

Ore treated .... Roasted Pyrrhotite.

Reducing agent .... Charcoal.

Flux .... Limestone.

Analysis of Raw Material.

Roasted Pyrrhotite:

SiO_2	10.96
Al_2O_3	3.31
Fe_2O_3	65.43
CaO	3.92
MgO	3.53
S	1.56
P	0.016
Cu	0.41
Ni	2.23
Metallic iron	45.80

Charcoal and limestone same as in previous run.

The limestone in the charge was decreased from 120 pounds, when starting to 50 pounds. The composition then being:

	Pounds.
Ore	400
Charcoal	110
Limestone	50

Analysis of Iron Produced.

	Cast No. 125.	Cast No. 230.	Cast No. 233.
Total carbon	3.23	3.38	2.50
Si	4.90*	4.50*	6.32*
S	0.007	0.006	0.007
P	0.062	0.037	0.042
Cu	0.86	0.87	0.71
Ni	3.70	4.12	4.00

Analysis of Slag Produced.

SiO_2	16.44
Al_2O_3	13.86
CaO	53.25
MgO	8.80
S	5.28
Fe	0.65
Cu	trace
Ni	trace

$$\frac{\text{Slag}}{\text{Iron}} = \frac{5060}{7336} = 0.69$$

Length of run	56 hours, 20 min.
Mean volts on furnace	36.05
Mean amperes	5000
Power factor	0.919
Pig-iron produced (ferro-nickol)	7336 pounds.
Watts = 36.05 × 5000 × 0.919	165649

$$\text{E. H. P.} = \frac{165649}{746} = 222.05$$

Output of pig-iron (ferro-nickel per 1000 E. H. P.

$$\text{days} = \frac{7336 \times 24 \times 1000}{56.33 \times 222.05 \times 2000} = 7.038 \text{ tons.}$$

E. H. P. year per ton of pig = 0.389.

Run No. 19.

Ore treated .... Titaniferous iron ore.

Reducing agent .... Charcoal.

Flux .... { Limestone Fluorspar

Analysis of Raw Material.

Titaniferous Iron Ore:

SiO_2	7.12	
Fe_2O_3	30.30	Fe = 43.59
FeO	28.78	
Al_2O_3	7.00	
CaO	1.00	
MgO	4.14	
P_2O_5	0.064	P = 0.028
S	0.04	
TiO_2	17.82	
Cr_2O_3	2.50	Cr = 1.42
	99.684	

Charcoal and limestone same as in previous run.

*By increasing the limestone of the charge the silicon content of the ferro-nickel pig recently produced has been depressed to 2 per cent.

Composition of Charge.

	Pounds.
Ore	400
Charcoal	100
Limestone	50
Fluorspar	50

Analysis of Pig-iron Produced.

	Cast No. 136:	Cast No. 137:
Total carbon		3.50
Si	4.50	2.80
S	0.007	0.091
P	0.143	0.060
Ti (approx.)	1.00	1.30

Analysis of Slag Produced.

SiO_2	7.00
Al_2O_3	28.50
CaO	14.23
MgO	2.93
TiO_2	38.92
Fe	1.13
S	0.90

On account of the furnace being in a very bad condition the lining being eaten away by the limey slag used in the previous run the run had to be stopped and no figures as to output could be obtained.

The slag was very fluid and likely the fluorspar in the charge could have been reduced considerably or omitted altogether.

The iron obtained in cast No. 136 was probably mixed with some iron from the previous charge, when ore with high phosphorus content was used.

The Smelting of Magnetite.

It was expected that considerable difficulty would be experienced in the smelting of magnetite on account of its conductivity. It was thought that with the furnace in use, in which the electrode was immersed in the charge, the current would disseminate itself laterally from the sides of the electrode through the charge, preventing the current at the reducing and fusion zone from attaining such density as would be required for the high temperature necessary for reduction and fusion. With charcoal as a reducing agent no difficulty was experienced in this respect, nor was the inductance of the furnace increased by the presence of magnetite.

The Use of Charcoal as a Reducing Agent.

Since charcoal and peat-coke can be produced in the Provinces of Ontario and Quebec while metallurgical coke requires to be imported, it was of great importance to ascertain whether charcoal, without being briquetted with the ore, could be used instead of coal-coke. No difficulty whatever was experienced, in fact so admirably adapted was charcoal, when crushed to pass a ¾" ring, as a reducing agent in the electric furnace that coke and briquettes of coke with clay were abandoned, and all the experiments with magnetite and roasted pyrrhotite described were made with charcoal. Some of the charcoal available was of very poor quality, some of it being little better than charred wood, containing only about 56 per cent. of fixed carbon. This, and the fact that a considerable quantity of the charcoal was consumed on top of the furnace account for the large quantity of charcoal used per ton of product. A modification of the furnace, protecting the upper layer of the charge from the atmosphere, and the use of charcoal properly carbonized would decrease considerably the amount of charcoal which was actually used in the experiments and consequently reduce the cost of production as given.

Consumption of Electrode.

For the production of 42,711 pounds of pig-iron 384 pounds of electrode were consumed, the same electrode having been in commission for 13 days.

Consumption of electrode per ton of pig-iron:

$$\frac{384 \times 2000}{42711} = 17.98 \text{ pounds.}$$

During the time this electrode was in commission the material in the furnace was melted down several times, exposing the red hot electrode to the oxidizing atmosphere. The consumption of electrode was found to be greater for white iron than for grey iron, and since the 42,711 pounds of pig-iron produced included several casts of white iron, the consumption of electrode was also on that account greater than it would have been had only grey iron been produced.

Power Factor.

The power factor of the furnace was determined by Mr. Chas. Darrall, of the Canadian Westinghouse Company, of Hamilton, Ont., and was found to be 0.919. This high power factor is due to the construction of the furnace casing, which prevents the closing of the magnetic lines of force.

Since the true electric power is the apparent electrode power multiplied by the power factor, it is evident that any error made in the determination of the power factor which tends to decrease its value will appear to decrease the consumption of energy per ton of product. The large output of 12.12 tons per 1,000 E. H. P. days, i. e., the small amount of electric horse-power absorbed per ton of product in the second Livet experiments, was obtained in a furnace with the abnormally low power factor 0.564. Whatever doubt may be engendered as to the correctness of the figure obtained for the absorption of electric energy on account of this low power factor of the Keller furnace, such doubt cannot arise regarding the figures obtained with the Heroult furnace for the absorption of electric energy in the Government experiments on account of its remarkably high power factor 0.919.

Moreover, since the cost of alternate current generators increases with increase of capacity, furnaces with high power factors (which can utilize a high percentage of the capacity of the generators) will be more economical as regards the first cost of the electrical installation of an electric smelting plant than furnaces with low power factors.

Modification of Experimental Furnace for Commercial Production of Pig-iron.

Probably the largest unit which can at present be constructed on the model of the experimental furnace will not exceed 1,500 H.P. The construction of the experimental furnace to fit it for the production of pig-iron on a commercial scale will require to be modified in the following important particulars:—

(1) The top of the furnace requires to be modified to permit of the application of labor-saving machinery for charging.

(2) Provision requires to be made for the collection and utilization of the carbon monoxide produced by the reduction of the ore; this involves also the protection of the charcoal of the charge from combustion on top of the furnace.

The greater capacity insuring less loss of heat by radiation and the modification of the furnace to permit of the utilization of the carbon monoxide will materially increase the output beyond that ascertained by the experimental furnace. The experiments indicated that under **normal** conditions about 11.5 tons were produced by an expenditure of 1,000 E. H. P. days. (See runs Nos. 8 and 13.) It is, therefore, not unreasonable to assume that under similar conditions with a properly constructed plant the output per 1,000 H.P. days would certainly reach 12 tons. This figure has been adopted in calculating cost of production per ton of pig.

The protection of the charcoal of the charge from combustion on top of the furnace will materially decrease the amount of charcoal necessary for reduction and consequently lessen the cost of this item. This saving has, however, not been taken into account in the estimate of cost.

On account of the value of the product, the smelting of roasted nickeliferous pyrrhotite by the electro-thermic process, as carried out with the Government experimental plant, admits of immediate commercial application without other modification of the furnace than increase of its capacity.

Estimate for a 10,000 H.P. Plant* Producing 120 Tons of Pig Iron Per Day of 24 Hours.

Furnaces, contacts, overhead work	$24,500
Bins, chutes, elevators	14,000
Crushers	4,000
Hoists and regulators	10,500
Instruments	1,400
Cables for conductors	8,400
Building	10,500
Mixer and casting machine	10,000
Travelling crane and tracks	5,000
Ladles	1,500
Slag trucks	3,000
Ore bins	3,000
Repair shop	5,000
	$100,800
Charcoal plant	50,000
Power plant (assuming cost of developing one horse-power = $50.00)	500,000
	$650,800

*This estimate is given on the authority of Dr. P. Heroult.

Electrode plant . . .	6,000
Unforeseen expenditure . . .	43,200
	$700,000

Amortization, 5% }
Depreciation, 5% } 15% on $700,000 = $105,000.
Interest,..... 5% }

On a production of 43,200 tons per year of 360 days per ton of pig-iron . . . $2.43

Cost of Production Per Ton Pig-iron.

Ore (55 per cent. metallic iron) at $1.50 per ton....	$ 2.70
Charcoal, ½ ton at $6.00 per ton . . .	3.00
Electric energy, amortization, etc. . . .	2.43
Labor . . .	1.00
Limestone . . .	0.20
Eighteen pounds of electrode at 2 cents per pound....	0.36
General expenses . . .	1.00
Total . . .	$10.69

General Remarks.

The ores treated, with the exception of the hematite and the roasted pyrrhotite, contained a high percentage of magnesia, producing a very infusible slag. When the furnace had been running for some time this infusible material formed a scale around the crucible, the electric energy available not being sufficient to keep it in a molten condition. The crucible and lower part of the furnace were, therefore, partially filled up, preventing easy access of the charge to the reducing and melting zone. This slower feeding left the charcoal on top of the furnace exposed to the air a longer time, thus increasing the amount of charcoal required and decreasing the output. With a greater current than was available and consequent higher temperature, the formation of the scale would have been prevented and the output correspondingly increased.

The electric installation at our disposal was far from ideal for electric smelting experiments. Aside from the drop of voltage due to the frequent slipping of the belt connecting motor and generator, it was impossible to increase the current beyond 5,000 amperes at from 35 to 40 volts. This inelasticity of the system prevented the determination of the most suitable current and voltage for a given charge in the furnace.

Summary of the Results of the Experiments.

1st.—Magnetite can be as economically smelted by the electro-thermic process as hematite.

2nd.—Ores of high sulphur content not containing manganese can be made into pig-iron containing only a few thousandths of a per cent. of sulphur.

3rd.—The silicon content can be varied as required for the class of pig to be produced.

4th.—Charcoal, which can be cheaply produced from mill refuse or wood, which could not otherwise be utilized, can be substituted for coke as a reducing agent, without being briquetted with the ore.

5th.—A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite.

6th.—The experiment made with a titaniferous iron ore containing 17.82 per cent. of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5 per cent. titanic acid can be successfully treated by the electric process.

A DEMONSTRATION IN STEAM TURBINE DESIGN.

There was recently installed at the Kent Avenue Station of the Brooklyn Rapid Transit Company, a 5,500 kw. steam turbine, the makers of which claimed certain superiority of design in various details. It now transpires that for a considerable time this turbine has been operating under conditions tending to subject this construction to abnormal strains of an unforeseen and severe character, and the way in which the claims of the makers have been borne out under these conditions must necessarily be taken into serious consideration in future turbine design.

Previous to April 25th, the turbine had been in continuous daily operation since March 30th, on which date it had been opened up for inspection after operation under severe over-load conditions.

Summed up briefly, this turbine was run daily from March 30th to April 25th with a knife leaf wedged in between the rotor and stator and the latter part of the time with the shrouding of the blades grinding against the stator. Yet when opened up, no destruction of the parts had occurred and no distortion of the blading. Considering the high speeds and centrifugal strains involved, such a result is certainly as remarkable as it is unexpected.

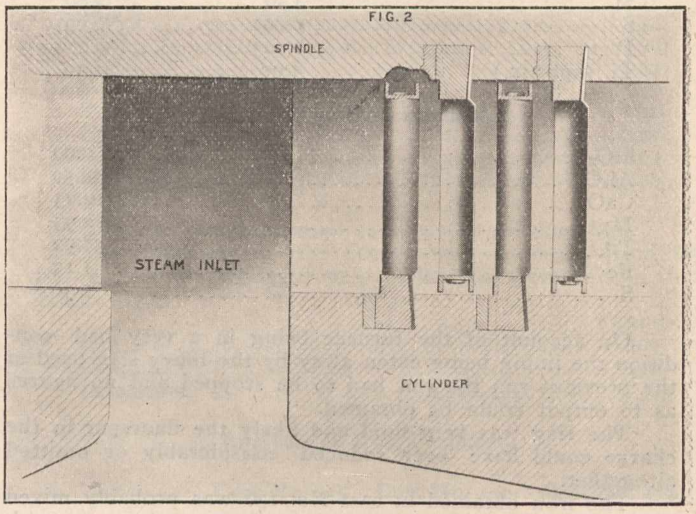


Fig. 1.

Such an operating condition as the above does not, of course, need to be taken into consideration in steam turbine design, but the above result would appear to establish without question that this form of construction overcomes entirely the difficulties and dangers arising from attempts to secure a minimum steam clearance between rotor and stator, a point upon which high efficiencies depend.

The steam turbine referred to is the product of the Allis-Chalmers Company, of Milwaukee, who have developed and control this form of construction.

The following is a brief description of the starting of the turbine and the subsequent mishap:

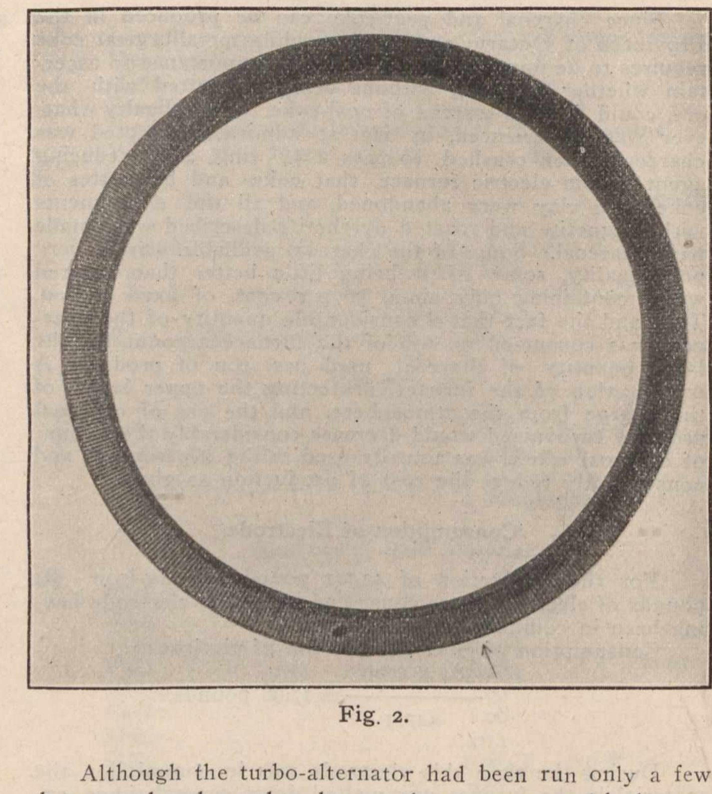


Fig. 2.

Although the turbo-alternator had been run only a few days at reduced speed to dry out the generator and had never been operated under load, it was promptly put into commission to meet urgent demands for power on March 27th, and as fast as additional boilers could be fired up load was increased until the peak for the first day was reached at over 4,000 k.w.

On succeeding days the demands of the service reached 7,000 k.w.

Service was resumed on April 1st for the morning and afternoon peak loads, and has since been continued daily without interruption excepting a short stop on the morning of April 25th, which was due to the incident referred to at the beginning of this article. The turbo-alternator has been, since starting, and is now daily and frequently carrying excessive over-loads, as for instance on April 21st an average of over 8,000 k.w. for one and one-half hours, and at one time on April 19th a rise to 9,000 k.w. for forty-five seconds, and a swing upward to 9,800 k.w. for fifteen seconds.

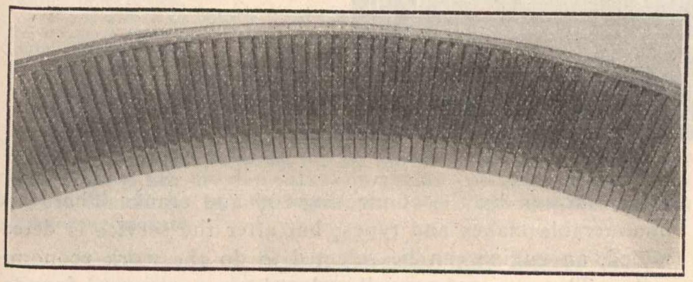


Fig. 3.

Shortly after starting up the turbine on the morning of April 25th a peculiar noise was heard in the turbine cylinder, and the turbine was, therefore, stopped and opened up.

It was found that a piece of steel had gotten between the spindle and the shroud of the first row of stationary blades, and, acting like a lathe tool, had cut into the body of the drum for a width of about ⅜" and for a depth of nearly 3-16", this cut being alongside of and opening into the groove which holds the first row of spindle blades as shown in Fig. 1.

This had loosened the caulking strip which held the ring of blades in place. For a distance of 5 or 6" this strip had come partly out of its groove, thereby loosening the ring of blades. This latter, under the influence of centrifugal force, had bent outward so that the channel-shaped shroud ring had rubbed hard in the bore of the cylinder. This rubbing had been so severe that the flanges of the shroud ring had worn almost down to heads of the riveting which holds the shroud ring to the blades.

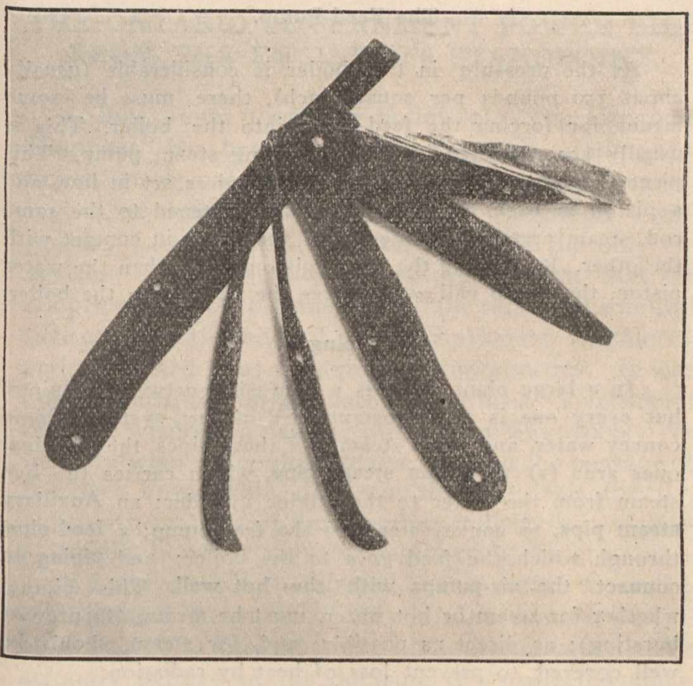


Fig. 4.

The fact which will most interest the user or prospective user of turbines is that under these severe conditions **not a single blade had come out or even become loosened** or injured in any way.

Seeing that it would be unsafe to attempt to hold blades in the damaged groove, and not wishing to keep the turbine out of service long enough to make permanent repairs, the erecting engineer removed this one ring of blades, closed the cylinder and immediately put the turbine back into service.

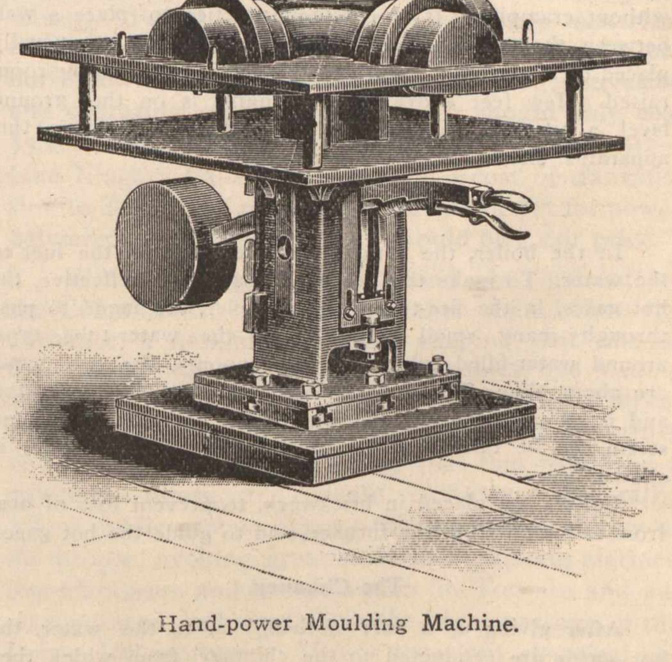
An examination of the removed ring of blades (Fig. 2) shows that one-half is as good as when put in, while the other half is damaged only as to the wearing away of the flanges of the shroud-ring, shown more clearly in the enlarged view (Fig. 3). With a new half shroud-ring this ring of blades would be in perfect condition.

An investigation as to the cause of the mishap showed that the piece of steel which had cut the groove in the shaft was apparently one of the leaves of a pocket-knife handle. A further seach discovered the remainder of the metal parts of the knife—a large jackknife—but the outer covering of the handle had disappeared. The large blade of the knife shows that it also had been rubbing hard. Fig. 4 is made from a photograph of the parts of this knife.

The turbine had not been opened up since March 30th, and the knife must have gotten into the turbine at that time or previously, as it would be impossible for it to get into the interior except when the turbine is opened up.

HAND-POWER MOULDING MACHINE.

The moulding machine illustrated above is one of the best labor-saving appliances on the market to-day. It is portable—can be carried to any part of the foundry floor; is strongly built, has few parts, and is easily operated; for the compound lever which controls the movements of the pattern-ram is provided with a balance weight, by means of which the muscular energy required to raise and lower the pattern is reduced to a minimum.

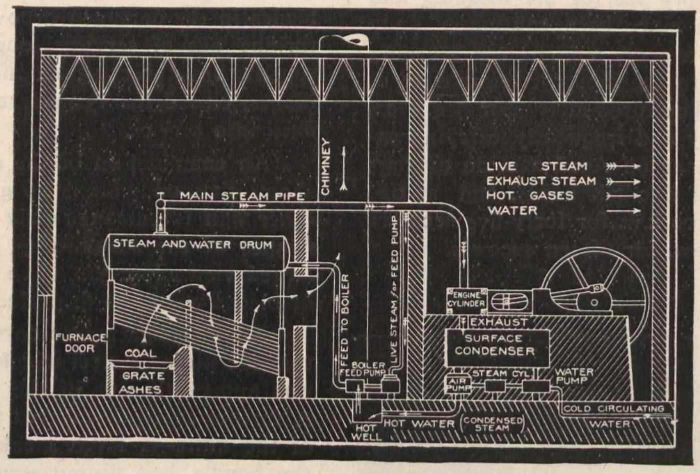


Hand-power Moulding Machine.

The frictional parts are so designed that they are adjustable, and can be easily replaced. The stripping-plate, resting on the stools, can be adapted for any form of pattern by simply inserting a babbitted filler-plate with filed contour to suit same.

One firm using this machine make thereon twenty 6" tees, crosses, and bends, and twenty 3" and 4" specials per day. This effective appliance is worthy of investigation by all Canadian foundrymen who have an eye to the economic production of castings.

EXTRACTS FROM AN ENGINEER'S NOTE BOOK



The Steam Power Plant.

The machinery in a power plant is required to furnish power for so many different purposes and under such varied conditions, that, even for a given rating, it varies considerably. Many factors must be considered in selecting the boilers and engines and their accessories.

Location of Plant.

The leading points to be considered under this head are: (1) **Cost of delivering coal to boilers; (2) Method of transmitting power;** and **(3) Cost of water for condensing.** As the handling of coal and ashes may be an important part of the running expenses, the plant should be located near a railroad; and in large plants, conveying machinery is often installed. The value of a nearby natural water supply is apparent when one considers that 15 to 20 per cent. of the fuel can be saved by condensing the exhaust steam from the engines. The quantity required is considerable, for over 400 pounds is usually necessary per H.P. per hour.

The building should be of brick or other fireproof material, and of sufficient size to contain the machinery without cramping. It is common practice to place a wall between the engines and boilers. The boilers are usually placed on the ground level, and the floor of the engine-room raised a few feet above. If the engine is on the ground level, a pit must be made for the condenser, because this apparatus should be below the engine.

Boilers.

In the boiler, the heat is transferred from the fuel to the water. To make the heating surface more effective, the hot gases, in the fire-tube type of boiler, are made to pass through many small tubes, or, in the water-tube, type, around water-filled tubes. As to economy, the two types are about alike. The fire-tube boiler is a reliable generator, and is often preferred; the water-tube boiler is safer, and steam can be raised more rapidly. A water-tube boiler is shown here.

Boilers are placed in brickwork, to prevent loss of heat from radiation from the furnace, and to guide the hot gases.

The Chimney.

After giving up a part of their heat to the water, the hot gases are conducted to the chimney, from which they escape into the atmosphere. The chimney also aids the draft. Draft is dependent upon the difference in weight of the cool air (atmosphere) and the heated gases in the chimney. Therefore, in general, the higher the chimney, the greater the draft. From 100 to 250 ft. is the usual height.

The Engines.

It is the duty of the engines to transform the heat energy in the steam into power. Steam is admitted to each side of the piston alternately, driving it back and forth in the cylinder. This back-and-forth motion is converted into rotary motion by the connecting rod and crank. There are innumerable makes and types; but after the service is determined, an engine can be selected to do the work economically. The engine is usually placed on a concrete foundation, and so arranged that the cylinder is near the boiler; this allows a short main steam pipe.

The Condenser.

In most power plants the exhaust steam from the engine is condensed; that is, the latent heat is taken from it by cooling. This changes it from a gas (vapour) to a liquid. The great reduction in volume decreases the pressure against which the piston acts, and consequently reduces the amount of steam supplied to the cylinder. The condenser is merely a shell containing many small tubes. Cold water circulates within these tubes; and, as the steam strikes the cold surfaces, it is condensed.

An air-pump sucks the condensed steam (water), and any air that may have been in the steam, from the condenser, and sends the water to the "hot well." This well is simply a reservoir for storing hot water until it is delivered to the boiler.

The Feed-Pump.

As the pressure in the boiler is considerable (usually about 150 pounds per square inch), there must be some means for forcing the feed-water into the boiler. This is usually accomplished by a direct-acting steam pump. This piece of apparatus consists of two cylinders set in line, and a piston in each. As the pistons are fastened to the same rod, steam pressure on one moves the water in contact with the other. By making the steam piston larger than the water piston, the pump will easily force the water into the boiler.

Piping.

In a large plant there is a confusing network of pipes, but every one is an important part of the system. Some convey water, and some steam. Of these pipes, the principal ones are: (1) the **Main steam pipe,** which carries the live steam from the boiler to the engine cylinder; an **Auxiliary steam pipe,** to convey steam to the feed-pump; a **feed-pipe,** through which the feed goes to the boiler; and **piping to connect the air-pumps with the hot well.** This piping, whether for steam or hot water, must be strong (to prevent bursting); as direct as possible; and, for steam, should be well covered, to prevent loss of heat by radiation.

Circulation.

Let us assume the water to be in the boiler. After being converted into steam, it passes through the main steam pipe to the engine cylinder, where it drives the piston. After doing its work, it goes to the condenser, where it is condensed to hot water. The water is then pumped to the hot well, from which it is drawn by the feed-pump and is forced into the boiler, there to be evaporated again into steam.—[Technical World.]

The Canadian Engineer.

ESTABLISHED 1893.

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PRINTED AT THE OFFICE OF THE MONETARY TIMES PRINTING CO., LIMITED, TORONTO, CANADA.

TORONTO, CANADA, JUNE, 1906.

CONTENTS OF THIS ISSUE.

THE ONTARIO GOVERNMENT POWER BILL FROM THE ENGINEER'S STANDPOINT.

Since June, 1905, the policy of "The Canadian Engineer" has been to steer clear of all public questions, having only an indirect bearing upon Engineering. Our defence of the Stationary Engineers' Compulsory License Bill in March last, was the only exception. In justification, we set up the plea, that the adoption of such a measure, would raise the intellectual and moral standard of our Stationary Engineers, and safeguard lives in populous communities. It was our pleasure to congratulate the Ontario Government on their wisdom in passing this Bill in May, 1906. We heartily wish we could applaud them on the passage of the Beck Power Bill. It is true this Act deals directly, only with matters of finance; but indirectly it strikes a deadly blow at private engineering enterprizes—such as have made the United States great. Coercive, high-handed measures of this kind, are never justifiable, except in face of grave and serious cause. We strongly believe in the doctrine of "projected efficiency," and deem any Government worthy of support, that subordinates the uncontrolled rivalry between aggregates of capital to the larger meaning of the social process as a whole. The old conception of the State as an irresponsible and almost brainless Collossus, organized primarily towards the end of securing men in possession of the gains they had obtained in an uncontrolled scramble for gain, divorced from all sense or responsibility, is as dead as a door nail. The mining royalties of England—backed by the unjust land laws passed by eighteenth century barons, and which have so seriously handicapped British iron and steel industry, is a glaring object-lesson of the one-sided political conceptions of the past. The policy of conserving the rights not only of the present, but future generations, to the best use of the resources of nature, is the genius and glory of Canadian Statesmanship; and so far as the Beck Power Bill has this laudable aim in view, it has our unhesitating support. When, however, it is proposed to put its coercive powers into force, to compel the great Hydro-Electric Power Companies at Niagara Falls, to sell electrical energy in Toronto and vicinage at a figure ludicrously low, and altogether inequitable, we just as strongly oppose; for, if the coercive clauses are enforced, on the basis proposed, it will strangle these important engineering industries in their very infancy, and inevitably divert capital away from the Dominion at a time when it is needed to develop our immense natural resources. As we write, news comes to hand from Ottawa, that the Minister of the Interior has authorized an investigation of the iron ore resources of the Dominion, in order to meet the numerous enquiries from home and abroad. At the present time, therefore, any legislative action having a tendency to hinder the legitimate development of the industrial resources of the country, can only be described as the rankest folly. If it is urged that the Power Bill is only a sort of sword of Damocles, threatening destruction unless rock-bottom rates are charged, then it is a piece of grandmotherly legislation which may have serious consequences. Reliable evidence coming to hand indicates that the "Beck Bill," has already caused much disquietude and uneasiness among British investors; and is bound to check investments in other directions where capital is much needed. Crediting the Ontario Government with the best intentions, what is their plea for this exceptional legislation? From what we can glean, it is this: that the figures gathered by their Hydro-Electric Power Commission, show that electrical energy can be developed at Niagara Falls for $8 per horse-power, which figure would cover money invested and operating expenses; and that it should only cost $5 for transmission to Toronto; hence, taking $12—(the Niagara Falls, N.Y. rate—?) + cost of transmission to Toronto, a reasonable flat rate of $17 for power delivered in the "Queen City," would be a fair price.

With these figures in one hand, the Chairman of the Commission, holds in the other hand before the Province, a newspaper report, alleging that one of the enterprising Niagara Falls companies, had made a five years' contract, to supply the Toronto Street Railway Company, with electrical energy in quantities at $35 per H.P.; and assuming that this would be a minimum figure to Toronto consumers generally, enters public protest against this proposed robbery of the people; evoking great excitement, among alarmed manufacturers and business men, in Toronto and adjacent towns, culminating in the hasty passage of the Power Bill aforesaid. If it is true that electrical energy can be delivered at a reasonable profit in Toronto at $17; but that the private supply companies—privileged to use Niagara's hydrostatic forces—propose to charge $35; or 100 per cent. more than is equitable, then, the case for the enforcement of the compulsory clauses of the Government Act is made out.

We believe, however, that the figures published by the Commission, are from an engineering standpoint, astoundingly fallacious; and purpose proving this in our next issue. In the meantime, we advise our subscribers to read the address of Mr. Frederic Nicholls, on page 233, for the business ethics of this great question; and for the Engineer's view, the figures cited in the series of articles appearing in our columns, on European Hydro-Electric plants, from the pen of C. H. Mitchell, C.E.—the Canadian authority on this important subject.

EDITORIAL NOTES.

The Steam Turbine: Our Protest Justified.

In our May number we copied a newspaper report, in which the general failure of the steam turbine was implied, because it was alleged, some U.S.A. Naval Engineer had seen **broken blades taken out of the turbines by the shovelful.** The very remarkable experience, (see p. 226), at the Kent Avenue Station of the Brooklyn Rapid Transit Company, with a 5,500-K.W., Allis-Chalmers steam turbine, in which a knife had been accidentally dropped among the blades, should discount waggon loads of newspaper gossip like that quoted. Although the engine ran for nearly a month under this adverse condition, no destruction of the parts had occurred, and no distortion of the blading." This is a case where shovelfuls of loose broken blades might very reasonably have been expected. We once more affirm, that the steam turbine is here to stay; even knives can not put the Parsons' engine out of business.

Electric Smelting: Sweden Following Canada's Example.

Through the courtesy of Dr. Eugene Haanel, Dominion Superintendent of Mines, we are enabled to give the following communication received at the Department of the Interior, from Sweden, May 17th:—

The Stora Kopparbergs Aktiebolag, in Sweden, has voted a sum of 100,000 kronor, (about $28,000), to be expended during two years, in making experiments with electric smelting of iron ores. The same company has also made a contract with the inventor (Mr. Gronvall), for the erection of an electric furnace with a production of 10,000 tons a year.

Commenting on this important movement in Sweden, Dr. Haanel says:—

From this you will see that the iron men in Sweden have been thoroughly awakened on the subject of electric smelting. Sweden, in fact, is in the same position as Ontario, Quebec, and Manitoba, possessing abundant water-powers, and iron ore deposits, but without metallurgical coal. The firm which is undertaking these experiments is one of the oldest and largest iron producing corporations in Sweden, having been incorporated in the twelfth century. When such a firm—which includes some of the ablest ironmasters in Sweden—appropriates $28,000 for experiments in electric smelting of iron ores, we may pass over the crude criticisms of "The Times" with a smile.

In view of this forward movement in Sweden, and our own successful experiments at Sault Ste. Marie, the Blast Furnace plant at St. Catharines, seems like turning back the clock.

San Francisco: Opportunity to Remedy a Great Engineering Mistake.

The advocates of buildings erected with a framework of structural steel, have been greatly elated by the fact, that after the earthquake, the only public buildings left standing were those made of concrete steel. As a consequence, the larger part of the buildings to arise on the ashes of the old city will be constructed of steel. Another engineering lesson is, that the outcry made sometime ago, about the rapid oxidation and decay of steel has been considerably discounted by the fact, that uncovered parts of steel structures encased in concrete, have been found in good condition; proving the value of concrete even as a preservative. On the other hand, wooden foundations, and indeed, all timber structures located in or next the Pacific Coast soils, have suffered badly from these pests—almost as destructive as the white ants of Africa—the Teredo and Limnoria. The illustrations by F. B. Gilbreth on page 219, show the terrible ravages of these minute organisms on wharves, etc. That the New San Francisco will consist of buildings in which orthodox wood, brick, and stone will be largely displaced by concrete, is a foregone conclusion. Our aim in this note, however, is not to particularize the materials of which the new city will probably be built; but to draw attention to an idea with regard to the orientation of the buildings and general civic plan, which should be of interest to Engineers generally, and to Municipal Engineers in particular. In the planning of the old city, a fatal error was made in the lay out, and it seemed that a splendid opportunity of making a city of surpassing scenic beauty was lost forever. The best statement of the case, was that made by Horace Bushnell* in 1864:—

It is another requisite in the planning of a city, that it be so arranged as to serve the purposes of convenience. Rectangular blocks and structures have so great an advantage in this respect, that squares and parallelograms must and will predominate in all well-planned cities. In this rectangular form architects and builders are best accommodated. The rectangular plan also furnishes most easily, and is well nigh indispensable to an elegant and attractive interior. The shops of trade require the same. Conceding then so much, in regard to the better convenience of the rectangular form, it becomes a problem, requiring only to be the more carefully studied, how, or by what means, it may be so far modified as to save it from the insufferable tameness and stupidity of a mere gingham city, of the Babylonian or Philadelphian type.

Not seldom will convenience itself require a deviation, as where there is some circulinear sweep of low ground along which a principal avenue will most naturally trace itself, covering some principal sewer of drainage. Sometimes there will be a steep-faced bluff, round the foot of which a quay, or general landing place for merchandise, may sweep, conforming to its lines. Sometimes there will be round-sided hills in the background, rising it may be, into rocky summits, such as would command a fine outlook over the city and harbor, if only the ascent could be made easy for accommodation of residences. To lay a covering of squares, on the faces of such bluffs and rounded hills, would even be absurd; for the ascent of their heights can be made only by straight lines that are very oblique, and cut each other diamond-wise, or by a spiralling in curve lines that cut each other in acute angles. By the neglecting of this very obvious expedient, the noble background of the fine city of San Francisco is sacrificed and for ever lost. Lying in a capacious bowl of concave between the hills and the bay, the city is laid off, as it should be, in parallelograms, with only here and there a deviation from uniformity, and, as everything passing on the concave length of every street is visible, of course, in every part of it, there is a wonderful vivacity in the circulations. But as soon as the rectangular form, pushing up the steep hill-sides, reaches a point where the ascent for carriages is no longer possible, the whole space above, which ought to have been covered with residences of the highest character, loses value, and is occupied only by cheap tenements, such as mules and footmen, climbing up as best they can, are able to furnish with supplies. So far, the rectangular plan is the enemy of all convenience. Nay, it is even the final destruction of the finest possibilities of beauty. Had the engineers of San Francisco, when reaching a certain point, deflected

*Work and play: "City Plans," p. 180.

their straight lines, running them into spirals that cut each other obliquely, the plan which now runs out, in the background, into a weak and crazy-looking conspicuity, would have crowded itself in a summit of ornament ascended by easy drives, and looking down from its terraces on all the activity of a populous and beautiful city.

It will be interesting to observe, whether the well reasoned and highly suggestive theory of the famous New England scholar and thinker, , is carried out in the rebuilding of the new city at the Golden Gate.

BOOKS RECEIVED.

The Wiring Handbook, with Complete Labor-saving Tables and Digest of Underwriter's Rules.—By Cecil P. Poole. New York: McGraw Publishing Company, 114 Liberty Street. Size, 8 x 4½, pp. 85, 32 pocket tables. (Price $1 nett.)

Standard Telephone Wiring.—For common battery and magneto systems. By James F. Fairman. New York: McGraw Publishing Company. Size, 7 x 4½, pp. 91, 74 illustrations. (Price $1 nett.)

Tables for Blacksmiths and Forgers.—Giving the allowances for the drawing down and staving of round, square and flat sections of all sizes. By John Watson. London, E.C.: Longmans, Green & Co., 39 Paternoster Row. Size, 6¼ x 4¾, pp. 88. (Price 2s. 6d. nett.)

Modern Steam Road Wagons.—Dealing exclusively with heavy steam motor wagons, giving an impartial analytical account of past and present practice. By William Norris. London and New York: Longmans, Green & Co. Size 9 x 6, pp. 172, 79 illustrations. (Price 7s. 6d. nett.)

Metallurgical Calculations.—Part 1, Introduction, Chemical and Thermal Principles, Problems in Combustion. By Joseph W. Richards, A. C.. Ph. D. New York: McGraw Publishing Co., 1906. Size 9¼ x 6¼, pp. 201. (Price $2 nett.)

Iron and Steel Manufacture, the Principles and Practice of. —This work gives sound instruction for technical students, metallurgists, etc. By Walter MacFarlane, F.I.C. London and New York: Longmans, Green & Co., 1906. Size 7¼ x 5½, pp. 249, 96 illustrations. (Price 3s. 6d. nett.)

Eminent Engineers.—Brief biographies of thirty-two of the inventors and engineers who did most to further mechanical progress. By Dwight Goddard. New York: The Derry-Collard Company. Size, 8 x 5¾, pp. 280, 32 illustrations. (Price $1.50.)

The Principles of Electric Wave Telegraphy.—By J. A. Fleming, M.A., D. Sc., F.R.S. London: Longmans, Green and Co., 39 Paternoster Row. Size 9 x 6½, pp. 671, illustrated. (Price, 24s., nett.)

Mechanical Draft.—A practical handbook for engineers and draftsmen. By J. H. Kinealy. New York: Spon and Chamberlain, 123 Liberty Street. Size 6⅞ x 4½, pp. 134, 13 illustrations. (Price, $2.00.)

[Note.—Several of the above books will be reviewed in subsequent issues.]

CATALOGUES AND CIRCULARS.

Harvesting Machinery.—The Robt. Bell Engine and Thresher Co., Limited, Seaforth, Ont. To those interested in harvesting and saw-mill machinery this catalogue will be found very valuable. It describes and illustrates traction, portable, and stationary engines; locomotive and stationary boilers, separators, wind stackers, feeders, and attachments; saw-mill machinery, belting, threshermans' and mill supplies. Size, 5½ x 9½, pp. 84.

Engines, Boilers, Etc.—E. Leonard & Sons, London, Ont. The Peerless Self-oiling, and the Leonard automatic engines, together with boilers, heaters, pumps, grates, etc., are lucidly described in catalogue 30-B. Size 9½ x 6¾, pp. 28.

Cobalt.—The Canadian Fairbanks Co., Montreal, P. Q. An excellent map of the district of Cobalt has just been issued by this company, and they announce that they will be pleased to send a copy to readers of "The Canadian Engineer."

Green Planing Mill Exhausters.—This is the title of a booklet issued by the Green Fuel Economizer Co., of Matteawan, N.Y., describing a new type of fan or exhauster for handling shavings, bark, wool, hair, sawdust, and other finely divided substances. Greater durability and freedom from clogging and lower consumption of power are claimed for the new construction. An interesting account is given of the manner in which these wheels are adjusted for running balance.

Spring Painting.—Joseph Dixon Crucible Co., Jersey City, N. J. "Spring Painting" is the title of a circular, which the Dixon people will send to all interested in the subject. Size 6¼ x 8½, pp. 4.

Small Power Motors.—Westinghouse Electric and Manufacturing Co., Pittsburg, Pa. Circular No. 1128 describes these motors, which are supplied in either alternating, or direct-current types. They are used extensively in connection with ice-cream freezers, coffee grinders, etc. Size 7 x 10, pp. 6.

Buyers' Reference.—This reference contains the names of all electric light and power central stations on this continent. The Buyers' Reference Co., Inc., 123 Liberty Street, New York, N. Y. Size 8¼ x 9¼, pp. 114.

Carbolite Carbolineum: The Ideal Wood Preservative.—The Carbolite Carbolineum Company, 302 Manning Chambers, West Queen Street, Toronto. We have before us a well written pamphlet setting forth the nature and qualities of a preservative for wood structures of all kinds: joints, beams, sills, trusses, ties, spiles, vessel hulls, paving blocks, foundations, etc. It is claimed that street-paving treated with this preparation will last —according to traffic, for 8 to 10 years; railway sleepers from 10 to 15 years, according to amount of mechanical destruction caused by lifting and adjusting of the track. The reason assigned is, that it agglutinates and hardens wood, thus increasing the wearing qualities and preventing rot and decay. The material is made in Canada, and the testimonials in its favor are of an unusually convincing character. Send for the pamphlet which is 9⅛ x 5¾, pp. 14.

ENGINEERS' CLUB OF TORONTO.

During the month of May only two regular meetings were held.

May 10th.—**The Ontario Government Power Bill.** A general discussion took place on this subject, and the report of the "Commission" was shown to be valuable to Engineers, especially as regards the figures showing the comparative amount of power now used by the different municipalities.

May 17th.—**Business Meeting.**—It was unanimously decided to discontinue the regular weekly meetings during the summer months. The annual outing was also discussed, and arrangements will be made for a trip to Buffalo, via boat and electric car, the date has not yet been decided, but will be announced as soon as the Committee arrives at a conclusion.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the annual meeting, held at the Engineers' Club on May 11th, the following officers were appointed: Chairman, R. G. Black; vice-chairman, K. L. Aitken; secretary, R. T. MacKeen. A resolution was passed to the effect that a meeting be held on the second Friday of each month, during the season 1906-7, at the Engineers' Club Rooms, 96 King Street West.

A list of the members of the Toronto branch has just been issued, in the form of an attractive pamphlet, a copy of which may be obtained by applying to the secretary.

The man that has a thing to sell
And goes and whispers it down a well,
Is not so likely to collar the dollars
As the fellow that climbs a tree and hollers.

AN EVENTFUL DAY AT NIAGARA FALLS

Corner-stone Laying of the Power House of the Electrical Development Company of Ontario.

Friday, May 8th, 1906, will be a red-letter day in the memory of over one hundred manufacturers and business men of Toronto; for on that day, through the courtesy of the Electrical Development Company of Ontario, they travelled by special passenger train and street cars to the brink of the Horseshoe Falls, and there witnessed the corner-stone laying of that company's new power house by the Lieutenant-Governor of Ontario, His Honor William Mortimer Clark, K.C.; and, also, two special stones by the president, Sir Henry M. Pellatt, and the managing director, Mr. Frederic Nicholls.

The new power house, when completed, as per Fig. 2, will be a noble structure, in the Italian Renaissance style, constructed of light granite, and will present a handsome appearance from the park. We are indebted to "The Canadian Electrical News" for the graphic picture of the stone-laying by the Lieutenant-Governor. Next to him stands Mr. Frederic Nicholls, then Sir Henry M. Pellatt, with Mr. E. J. Lennox, the architect, resting his left hand on the front of the stone.

Fig. 1.
Lieutenant-Governor Laying Corner-stone.

Immediately after the ceremony the party, escorted by the genial secretary of the company, Mr. H. G. Nicholls, and the treasurer, Mr. D. H. McDougall, inspected the interior of the partially constructed power building, then walked along the top of the immense concrete gathering-dam wall, protecting the fourteen-acre cofferdam against the turbulent waters of the White Horse Rapids, which dash along at twenty miles an hour; then across the 428 ft. diverting boom with its twenty-three arches, each 20 ft. high by 14′—6″ wide, into the power house again, where the party descended by elevator 150 ft. to the 416 ft. wheel-pit, and walked through one of the unique branch tail-race tunnels out into the main 26 ft. tunnel (grade 5.5 ft. per 1,000 ft.), trudging by torchlight nearly a mile out to a point underneath the Horseshoe Falls, where the seething waters could be heard thundering and splashing against the temporary barricades. From thence along the temporary construction drift and up a shaft by primitive elevator to the open air near the edge of the Horseshoe Falls.

The chief impressions of the trip were:

(1) That the building of the colossal gathering-dam is one of the finest engineering feats in the world; for the depth of the fierce rapids was found to be 26 ft. instead of 11 ft., as estimated.

(2) The forked branch tail-race tunnels, which straddle the wheel-pit, enable the turbines to discharge right and left, minimizing the chance of eddies and cross currents; and providing wisely for repairs by alternately shutting off one side or the other.

The turbines rest on the solid rock, thus reducing vibration, and consequent up-keep.

(4) That the tail-race is 400 ft. shorter than existing Niagara tunnels, while the operating head is 10 ft. greater than any of the contingent installations: engineering features evidencing that this magnificent plant, with its provision for eleven 13,000 H.P. turbines, capable of developing electrical energy equal to 125,000 H.P., and involving an outlay of some $10,000,000, is an enterprise almost startling in its audacity, but which so far has been carried out with conspicuous success, and when completed will be one of the best examples in existence of the technical skill and resource of the modern civil, mechanical, and electrical engineer.

Following this technical inspection came a social trip, in special street cars, along the brink of the great Niagara Gorge, down to the Whirlpool Rapids, then through the streets of Niagara Falls city to the famous ex-Carmelite Hospice, situated on the plateau overlooking the Horseshoe Falls, where an elegant luncheon was served. Sir Henry M. Pellatt presided, and toasts were proposed and replied to as follows: "The King," which was given enthusiastically, with musical honors; "The Lieutenant-Governor of the Province of Ontario," responded to in a noble speech by His Honor William Mortimer Clark, K.C., who hoped **these gentlemen will be permitted to enjoy the legitimate fruits of their enterprise;** declared that **we owe a deep debt of gratitude to these gentlemen for all they have done, and all that they may yet do for the development of this**

country; sketched the progress of science in the search for motive power, which he showed had triumphantly culminated in the development of electrical energy from the mighty hydro-electric forces of nature, concluding with an eloquent plea, that material progress should go hand-in-hand with moral well-being, since it is that on the observance of law and order rest our civil and religious liberties.

The toast to "The Electrical Development Company" was proposed by Mr. Byron E. Walker, general manager Canadian Bank of Commerce, and responded to by Sir Henry M. Pellatt, who predicted that **before this year has run its course the mighty Niagara will be developing its force in Toronto—delivering power at the cheapest rates it is possible to deliver it, taking into consideration our just obligations to our shareholders and bondholders, who have invested of their fortunes in this enterprise.**

The responsive speech of Mr. Frederic Nicholls was of such intrinsic historic interest that we give it almost verbatim:—

Mr. Nicholl's Speech.

Mr. Nicholls, on rising to speak, was given an ovation, one that spoke much for the admiration of those present for the part he has played in the industrial development of Canada. His speech was interesting as a review of the way in which the mammoth schemes his syndicate has under weigh were conceived, and for the announcement he made of its plans for the future.

Some years ago, he said, Col. Shaw, then American Consul in Canada, realized the possibilities of Niagara, and obtained a franchise for ninety-nine years, securing the sole right of developing power within the limits of the Queen Victoria Park. Afterwards he succeeded in persuading some British capitalists to look into the situation. The report of their representatives was more or less favorable, but the project seemd so chimerical that the British capitalists turned it down.

Later, he met Col. Shaw at an hotel in Buffalo, sat up all night with him, and before morning had drafted a contract for the transfer of the franchise, and repaying to Col. Shaw the money paid by him to the Government and a quid pro quo for his efforts.

Then he set out to raise the necessary capital. In spite of his fervent faith in the future of Canada, he found it a discouraging task. Capital would not believe in the merits of his proposition. Then he came across a group of capitalists who have done a great deal for the development of the country, consisting of such men as Sir William C. Van Horne, Mr. E. B. Osler, and Mr. William Hendrie. They and a few others were induced to develop the first water-power at Niagara, for the purpose of operating the Niagara Park and River Railway. The railroad was constructed and successfully started. It was with gratification that he recalled the pride he felt then that the Canadian General Electric Company had supplied what was considered a large generator of 200 H.P. To-day the same company had supplied for the present works the largest generator in the world, of 1,500 H.P.

In carrying out the present enterprise they had many bad quarters of an hour. Very few people realized the difficulties they had encountered, the work, for example, of building the huge coffer dam to hold back twenty-six feet of Niagara's sweeping torrent, and of laying bare fourteen acres of the river bed. Many a time he and Sir Henry Pellatt had come over expecting to see the whole thing washed away. They took their reputations in their hands and invested millions upon millions of dollars.

"And do you suppose," asked Mr. Nicholls, "that the men who provided this money could be induced to take the risk for a mere paltry bank interest on the par value of the bonds? (Applause.) We see a great deal in the newspapers about watered stock. If these writers knew the difficulty of interesting capital in such a venture they would moderate their arguments. No; capital can never be found to develop a country unless it can be given some commensurate return based on the risk it has run.

Fig. 2.
Power House as it will appear when completed.

"I do not wish on this occasion, to touch on delicate ground. This much I will say, because I am proud of a certain Canadianism. On behalf of the men associated with me I may say that they have invested their money not merely with the spirit of making gain, but with a higher spirit, a sense of pride in performing a useful work in the development of Canada. We know that the production of this power will bring many new industries to Canada which will employ thousands of workmen."

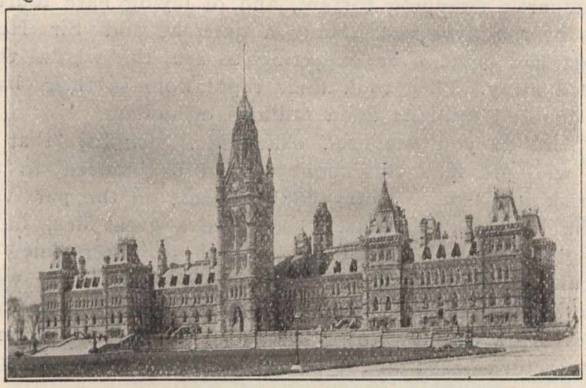
After tracing the process of organizing the Toronto Railway Company, the Toronto Electric Light Company, and other branches of the syndicate, he made special mention of a few of the latest enterprises. The Canadian Shipbuilding Company was erecting a vessel for Upper Lakes traffic of 10,000 tons burden, and was building one of the most modern passenger vessels on the Upper Lakes for the C.P.R. They were also building a new iron and steel blast furnace on the Niagara Peninsula in order to cheapen the cost of their raw material.

They were contemplating the construction of an electric railway along the power line from Niagara to Toronto; also the construction of a new trans-Niagara steel bridge.

"Our motto is," said Mr. Nicholls, "the development of Canada; of this part of Ontario in particular, and of Canadian industries in general. We ourselves will use a large portion of the power we will develop at Niagara."—"The News," Toronto, May 9, 1906.

A toast to the Mayor of Niagara Falls, N.Y., proposed by Mr. W. R. Brock, director Dominion Bank, and replied to in a slashing speech by Mayor Cutler, terminated this memorable function. The party then returned at five o'clock by special train to Toronto, with enlarged vision of the great engineering works they had seen; and to a man determined to see that fair play was given to the captains of industry, who have risked their reputations and encouraged the investment of capital in the commercial interests of Canada.

INTERNATIONAL PATENT RECORD

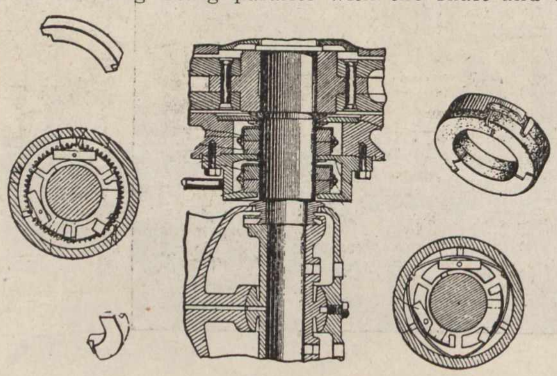


Dominion Houses of Parliament.

CANADA.

Specially compiled by **Messrs. Fetherstonhaugh and Dennison,** Patent Attorneys, Toronto, Montreal and Ottawa.

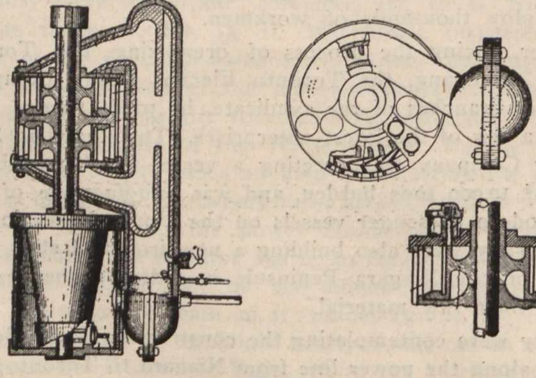
Packing for Rotary Steam Engines.—Canadian General Electric Co.—96,769.—The invention consists of pairs of segmental rings arranged to break joints, the abutting ends of the segments being rabbetted together, the meeting surfaces of one ring being parallel with the shaft and in the



96,769.

other ring radial thereto, segmental metallic holders overlapping the joints and having ribs engaging with grooves in said rings, and spring means for compressing said rings on the shaft to take up the wear.

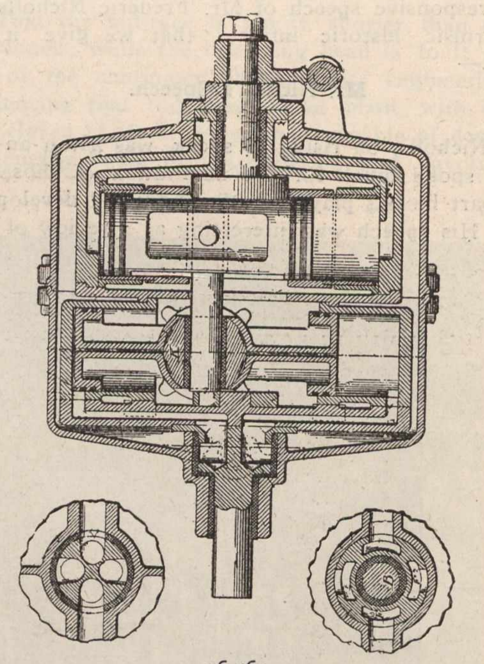
Turbine Engine.—Walter Rowbotham.—96,456.—A turbine, comprising an outer casing, a rotor portion within said casing, having a series of radial blades, an inner rotor portion, having a series of nozzles tangentially arranged and rotating within said outer part and in the opposite direction,



96,456.

an air compressor driven by one of said rotor parts and supplying air in compression to a heating chamber, the said heating chamber having a deflector chamber in communication with the supply port of the engine.

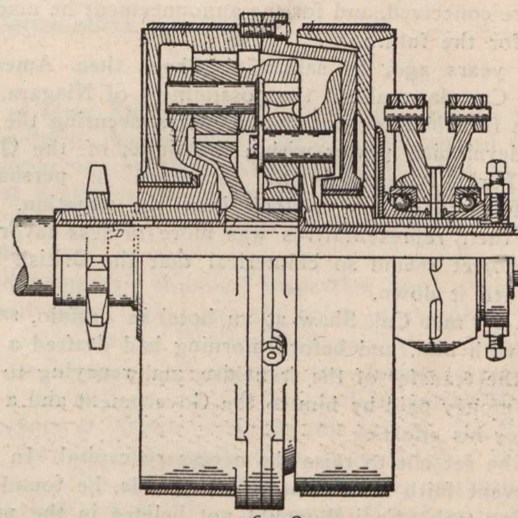
Multiple Cylinder Engine.—James T. Halsey.—96,569.—A rotating cylinder frame, having a shaft fixedly secured thereto and to a rotary valve, the ports of which connect through the frame to the cylinders, a pair of cylinders fixed to the frame opposite to each other, a laterally sliding



96,569.

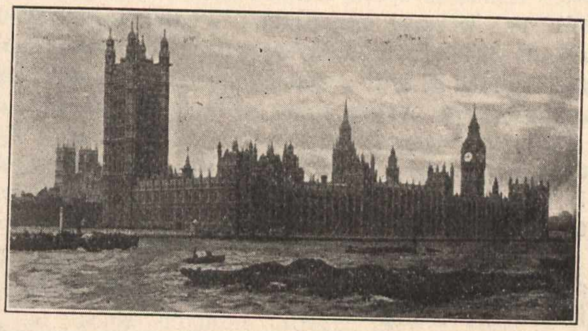
cylinder supported on slides and lying at right angles to the said fixed cylinders, a pair of pistons secured to the sliding cylinder and working in the fixed cylinders, and a piston working in the sliding cylinder and secured to a fixed crank around which the cylinders and pistons rotate.

Transmission Gear.—Olds Motor Works.—96,418.—This is essentially a driven wheel revoluble on a shaft, two differential gears fixed to the shaft, a head secured to the driven wheel, having an internal rack surrounding one gear and carrying a planetary pinion engaging the other gear, a housing enclosing both trains of gears having an annular rack engaging the pinion journalled in the said head and carrying a pinion engaging the rack on the said head and the



96,418.

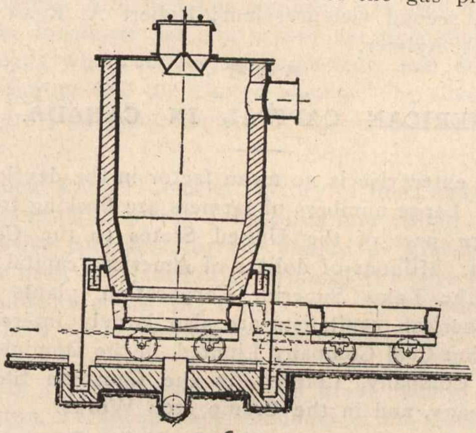
other gear. The heads arranged within and without said housing are movable longitudinally, but rotatably in fixed relation to each other and the inner head has a projecting hub on which is mounted a revoluble cam by means of which the inner and outer heads are clamped yieldingly against the intermediate wall of said housing to lock the said gears.



British Houses of Parliament.

GREAT BRITAIN.

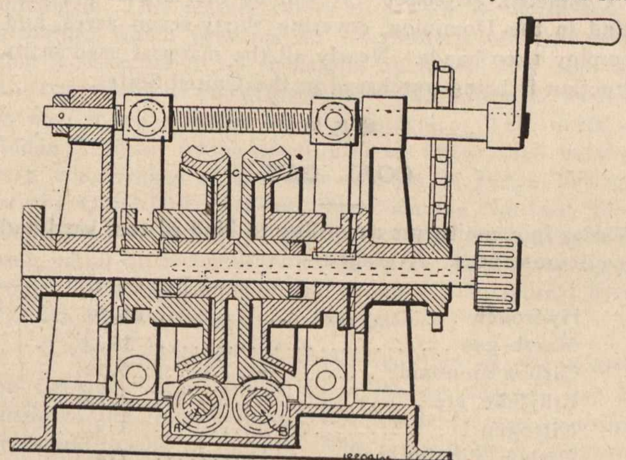
Grates for Gas Producers.—Blezinger.—9,065.—The grates of gas producers are made to travel on wheels, an empty grate being placed in front of the gas producer in



9,065.

such a way that it pushes away the full carriage under the producer with its entire contents of ash clinker and coal residues, whilst the empty wagon takes its place and receives the burning column of fuel now freed from clinkers and the like.

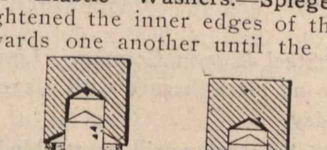
Apparatus for Imparting, Transmitting, and Reversing the Motion of Machinery.—Horsfall.—12,204.—The apparatus consists of a first-motion shaft A, having a second shaft B geared thereto, worms mounted respectively on said shafts



12,204.

which gear with worm wheels freely mounted on a third shaft, said worm wheels being each provided with a friction C clutch for causing the third shaft to rotate in either direction.

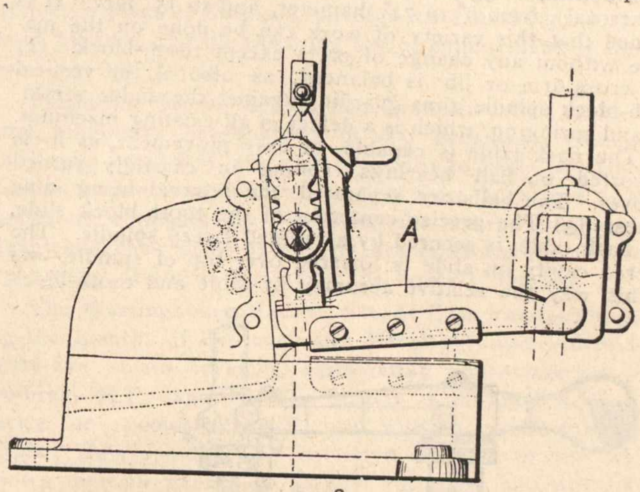
Spring or Elastic Washers.—Spiegel.—11,528.—When the nut is tightened the inner edges of the washer are approached towards one another until the projecting of the



11,528.

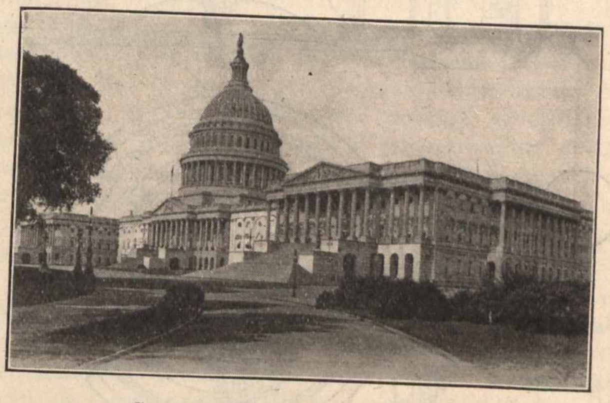
lower part comes into contact with the upper part, the washer, however, still retains its elasticity, thus ensuring rigid bolting.

Shears.—Vernet.—2,228.—Relates to shears in which the lever A carrying the movable knife is jointed at its front part and its rear part respectively to a slide block B adapted



2,228.

to be raised or lowered by lever mechanism, thus making it possible to ensure a variable inclination of the cut of the upper knife and a crossing of the lower knife, which is likewise variable.

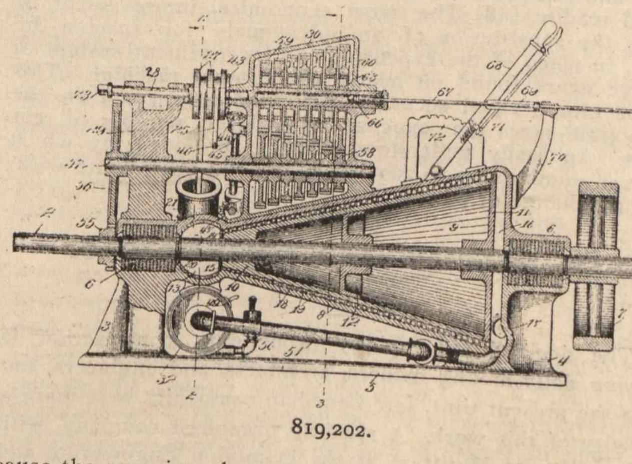


Capitol, Washington, U. S. A.

UNITED STATES PATENTS.

Specially selected and abridged by **Messrs. Siggers and Siggers,** Patent Attorneys, 918 F. Street, N. W., Washington, D. C., U. S. A.

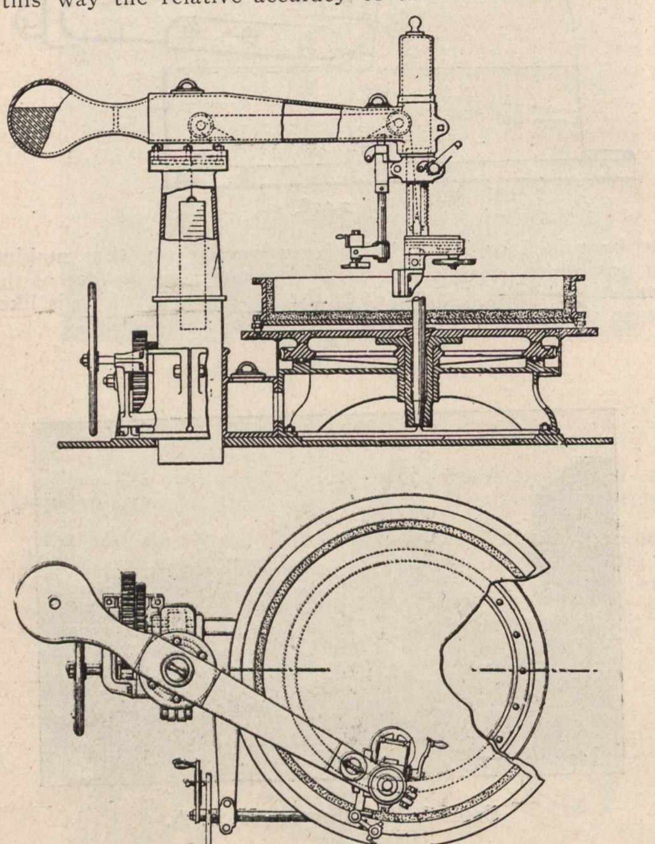
Gas Turbine-Operating System.—Henry F. Blackwell, New York, N. Y.—819,202.—The present invention pertains to an organization of devices designed for the conversion into power of the high velocity of discharge through small orifices of the products of combustion of a suitable fuel. It consists of an explosive-engine, a pumping element operatively connected with the shaft of the engine, a set of valves for the pumping element, a set of cams actuated from the engine-shaft and arranged to operate said valves to



819,202.

cause the pumping element to feed explosive mixture to the engine, a second set of cams actuated from the engine-shaft, and arranged to cause the pumping element to operate as a prime mover and thereby drive the engine-shaft, a third set of cams actuated from the engine-shaft and arranged to operate said valves to cause the pumping-element to feed air to said explosive-engine, and means for shifting the sets of cams to bring them into position to operate the valves.

Gear Moulding Machine.—Samuel Groves.—573,783.— This foundry appliance is designed for the moulding of spur, bevel, helical, staggered, or worm-toothed gearing (internal or external), from 6" to 72" diameter, and to 15" face. It is claimed that this variety of work can be done on the machine without any change of parts except tooth-block. (1) The cross arm or jib is balanced, as also is the vertical tooth-block spindle, thus guarding against the undue straining and springing, which is a defect in all existing machines. (2) The flask table is capable of easy movement, as it is supported on ball bearings, rolling in carefully turned grooves. The balls are separated, the interval being nine inches. (3) The precise centering of the tooth-block slide, and flask table, is secured by a tapered sweep spindle. The tapered cavity on slide is lowered over top of spindle, and in this way the relative accuracy of table and tooth-block



573,783.

slide is demonstrated. (4) The tooth-block pattern is lifted out of the mold by a permanent rack, but it can also be withdrawn from the sand horizontally, by means of an eccentric device, which is reversible—especially valuable in the making of helical or worm gears, with either internal or external teeth. (5) The lifting or lowering of mast and cross arm, is performed by means of trundle gearing. (6) By means of a tooth-comb device the sand of the tooth space is held down by a swing lever arm while the tooth-block pattern is being withdrawn. This overcomes the old trouble of sand pulling up under hand pressure. (7) The flask is supported upon four adjustable brass stools, having right and left hand threads, and hence can be lowered and raised readily. (8) The most economical improvement of all, is the substitution of an index plate for spacing the teeth, in place of the expensive and inconvenient system of change gears found on nearly every other machine. This device means equal accuracy, easier operation, and at the same time saves the expense of a large number of cut gears. An easily understood chart is provided, by which all even numbers up to 200 can be fixed in one minute without any change of parts.

NEW METHODS AND CONDITIONS OF BUILDING.

The demand for rapidity in building construction is growing daily among owners, architects, and engineers, but up to the present time, few Canadian companies have made a specialty of this work. A recently organized company, with headquarters at Montreal, is the Dominion Engineering and Construction Co., Limited, which has adopted progressive methods in engineering and construction work. The company does all its work on the Gilbreth cost-plus-a-fixed-sum system; which system, as perfected by the company's second vice-president, (Frank B. Gilbreth), has accomplished some remarkable results in speed, coupled with efficiency of construction. The working organization is based on economic lines, and its departments so systematized that a maximum of results is obtained with a minimum of effort. With this system, every man is enabled to do his best, and blunders and delays of the ordinary working force are eliminated. The Gilbreth system also enables the owner to tell what the work is costing him each day, and the contractor is enabled to keep posted as to the exact status of same. Speed under such a system is a natural result, and as the contractor's profit is fixed at the start, all motive to skimp the work is done away with.

The Engineering Company has been quite successful, and as Canadians have adopted their methods readily, they look upon it as a tribute to progressive Canadian methods in construction.

The directorate is made up of some of the best known men in the building world in Canada, namely, Randolph Macdonald, president; Henry Holgate, vice-president; Frank B. Gilbreth, second vice-president; Robert A. Ross, secretary; John A. Aylmer.

AMERICAN CAPITAL IN CANADA.

Yankee enterprise is no mean factor in the development of Canada. Large numbers of farmers are flocking from the northwestern part of the United States to the Canadian North-West. Millions of dollars of American capital are invested in the Lake Superior Corporation plants at the "Soo." American capitalists are also largely interested in the Dominion Coal Company Limited, in the Dominion Iron and Steel Company, Limited, in the Canadian Steel and Coal Company, and in the Cramp Iron Works.

Consul Worman reports that the Union Bag and Paper Company, of New York, which has for some time carried on business at Three Rivers, has just acquired the limits, mills, water power, etc., of the Gres Falls Lumber Company, covering some 1,200 square miles. The mills are at Three Rivers. The price paid has not been made public, but it is said that the figures run between $800,000 and $950,000. The Singer Sewing Machine Company, of South Bend, Ind., is building a branch factory at St. Johns, Quebec, that will cost, when completed, $1,500,000. It will be the largest plant of the kind in the Dominion, covering thirty-seven acres, and will employ 1,400 hands. Nearly all the material used in its construction is being purchased in the United States.

COAL GAS.

Varies in constituents according to kind of coal used and other circumstances. Average:—

	Per Cent.
Hydrogen	45.50
Marsh gas	35.32
Carbon monoxide	6.12
Ethylene, etc	4.10
Nitrogen	1.2
Carbon dioxide	1.2

INDUSTRIAL NOTES.

For the first time in the history of the Dominion Iron & Steel Company their four blast furnaces are now producing together.

The Hamilton Steel & Iron Company, Limited, has decided to erect a second blast furnace with a capacity of four hundred tons per day.

A sand lime brick industry will be established at Brantford, Ont. Necessary machinery will cost over $30,000. W. D. Schultz is interested.

The Canadian General Electric Co., Peterborough, Ont., will erect additional buildings to cost some $350,000, practically doubling their capacity.

The factory of the Hamilton & Toronto Sewer Pipe Company was totally destroyed by fire recently. Everything was burned, and the loss is estimated at $50,000.

The new radiator building being erected by the Taylor-Forbes Co., Guelph, will be three storeys high and 200 by 80 feet. The radiator plant for which this building will be constructed will be the largest plant of its kind under one roof in Canada.

The Lunkenheimer Company of Cincinnati, Ohio, who are the largest manufacturers of high grade engineering specialties in the world, on May 1st, opened a well-equipped branch store, at 66-68 Foulton Street, New York. Previous to the above date, the company maintained a suite of offices in the Havemeyer Building, 26 Cortlandt Street, through which offices the export trade of the concern was transacted.

Montreal Copper Company, Limited, who control the only copper refinery in the Dominion of Canada, are making great progress. Although this company has only been refining copper for about two years, they are now supplying all the railroads who use copper in Canada, and other large users in Europe and the United States. The Chinese Government are purchasing copper for use in their new coinage system.

The new Rubber Cement Factory of the Canadian Rubber Company of Montreal, Limited, is now in full operation, and exclusive contracts for the supply of Rubber Cement have now been concluded with some of the principal Footwear Manufacturers of the Dominion. This industry promises to be a very important one, and the plant of the Canadian Rubber Company is equipped with all the latest appliances for the production of high grade cement. Mr. A. D. Thornton, Technical Superintendent of the Company, devotes a good deal of his time to this special branch of manufacture.

A decision was handed down by Judge Seaman in the United States Circuit Court of Milwaukee, Wis., a few days ago, the effects of which are of the utmost importance to the entire electrical industry. This case involved a suit of the General Electric Co. against the National Electric Co., in which the former charged that a patent controlling certain features of construction in an electric generator was infringed. This feature refers to a form of ventilating the armature which prevents an overheating of the machine that is essential to its successful operation, and adds about thirty per cent. to its given capacity. This form of ventilation is now in general use by manufacturers. The decision of Judge Seaman, which is of greater importance because it is a concurrence of a similar opinion of Judge Thompson, of the Ohio District Court, restrains the National Electric Co. from the further manufacture of this ventilating feature, and, as all other forms now known to the electric business come within the claims of this patent of the General Electric Co. its importance may be appreciated.

The "Times" has published two excellent articles on Canadian water-power, in which an analysis has been made of the chief hydraulic developments now in progress from end to end of Canada. The array is most imposing as an indication of enormous industrial possibilities. We find city after city in possession of a water-power by which its electric railway is run, its streets are lighted, and its local factories are operated. Here is an illustration taken at random:—"About twenty miles from Vancouver, British Columbia, at Lake Beautiful, 10,000 horse-power is being developed and transmitted to the city. The power is used for commercial lighting, street lighting, and street railway purposes. Another large power is being laid out at Stave River, thirty-two miles from Vancouver. The plant will have a capacity of 30,000 horse-power, all of which will be consumed in Vancouver and the vicinity, including New Westminster, where there is now no hydraulic power. A portion of the power will be used to operate the suburban lines. The Dominion Government will also make use of the power to operate immense pumps for draining certain districts which, when the soil is dry, produce magnificent fruits."

The Brantford Screw works will probably move to some other town.

Fire completely gutted the Toronto Bolt and Forging company's plant at Swansea, on May 22nd, causing a loss of about $300,000, and the throwing out of employment of about three hundred hands.

Fairbanks, Morse & Co., San Francisco, Cal., now occupy temporary headquarters at 969 Broadway, Oakland, California, until they are able to return to their permanent location in San Francisco, where they were burnt out in the disastrous conflagration following the recent earthquake. Meanwhile, their many customers are receiving the customary prompt attention for which the house is famous.

The Westinghouse Machine Co., of East Pittsburgh, during the months of February and March received orders for thirty-five steam turbines, aggregating approximately 50,000-brake H.P. capacity. The largest is of 7,500 K.W. capacity, or 11,000-brake H.P., and will be installed by the Transit Development Co., Brooklyn. It is of the well-known multiple expansion parallel flow type, and will drive a direct-connected A.C. generator, running at 750 revolutions per minute, developing 10,000 electrical H.P. at full load.

The Electric Properties Company, incorporated May 10th, under the laws of the State of New York with a capital of six million preferred, and six million common stock, has been organized to acquire, finance and develop properties, either whole or in part, especially those in which electricity plays the principal part, such as power, electric traction and electric lighting enterprises, and to invest and deal in and to guarantee the securities of corporations operating such properties. It will also conduct through Westinghouse, Church, Kerr & Company, (all of whose capital stock is owned by the new company), a general engineering and construction business. It may also issue collateral trust bonds secured by the pledge of securities acquired in the course of business.

Mr. A. L. Mudge, who has been appointed Estimating Engineer of Allis-Chalmers-Bullock, Limited, Montreal, is one more Canadian, who, after experience in the great industrial establishments of the United States, has returned to take a responsible position at home. After graduating from McGill University in Mechanical Engineering in 1894, and in Electrical Engineering in 1895, he spent one and one-half years with the Canadian General Electric Co., Peterboro, and afterwards some time with the Royal Electric Co., Montreal. From 1899 to 1901 he was Electrical Engineer for the Grand Trunk Railway System from Portland to Detroit. From Montreal he went to Pittsfield, Mass., to take charge of construction work for the Stanley Electric Manufacturing Co. During the past two years he has been with the Allis-Chalmers Co., partly in the Bullock Electric Works, Cincinnati, and latterly in the head office, Milwaukee.

The Carnegie Steel Company has contracted with the Westinghouse Machine Co., of Pittsburg, builders of large engines and turbines, for some large blowing engines to be driven by blast furnace gas. For the purpose of conducting preliminary experimental work, an engine of 350-H.P. running at 150 revolutions, with 30-inch stroke was installed and has since made a remarkable record for itself under the severest possible tests for efficiency, reliability and durability. The two gas blowing engines, the largest ever built in this territory, are now under construction at East Pittsburg for the work at the Edgar Thompson Furnaces, Bessemer. These will be twin tandem units with slick air blowing "tubs" arranged in front or vis a vis, and with fly-wheel interposed between the two sides of the engine. Each of these blowing units will have a capacity of 25,000 cubic feet of free air per minute operating against a normal blast pressure of 18 pounds and running at a speed of 60 to 75 R.P.M.. When higher pressure is demanded by the furnaces the valve gear of the engine may be so altered as to deliver air under pressures up to 25 pounds per square inch in proportionately less quantity. These engines are of the heavy duty double acting type as standardized by the Westinghouse Machine Co., and will be among the largest ever constructed for use with blast furnace gas.

In order to secure adequate quarters for handling their rapidly increasing business, the Electric Cable Company, formerly of 42 Broadway, New York, moved May 1st, to 17 Battery Place, New York.

The Canada Tin Plate and Sheet Metal Company is erecting a large factory at Morrisburg, Ont. The company will employ from 350 to 400 men, and have an output of about 30,000 tons per year.

To fill the growing demands of the plant of the Dominion Iron & Steel Co., an important addition has recently been made to the motive power of the electrical department, which is under the superintendency of Mr. W. B. Boyd.

London Machine Tool Co., Limited, beg to announce that they have removed their plant to Hamilton, Ont., and are now installed in a new factory of the most modern type of construction, where facilities for handling machines up to the very heaviest and largest sizes are unexcelled.

The Canadian General Electric Company want a fixed assessment from the city. They promise to erect additional buildings, at a cost of between $300,000 and $400,000, which will practically double the number of men at present employed, who now number about one thousand.

Fairbanks, Morse & Co., Chicago, have recently sold a large number of their standard mine cars to the Republic Iron & Steel Company, Nassau Ore Company, La Rue Mining Company, and the Rhodes Mining Company, for use in these companies' large iron mines in Minnesota.

It is authoritatively announced that the Toronto and Hamilton Sewer Pipe Company will rebuild in Hamilton, and that the new works will be in every way larger and more modern than those recently destroyed by fire. The company has instructed W. T. Coleman, of New York, a former Hamilton man, to prepare the plans for an entirely new and modern building.

The tender for the new buildings to be put by the Crowe Iron Works on their new property in Guelph, was let yesterday to H. A. Clemens & Co., of Guelph, who undertake to have the buildings ready for occupation by August 15th. The Crowe firm will supply the steel structure, and Thos. Matthews will do the brick work, Dempsey Bros. the painting, and McCormick & Robinson the galvanized iron work.

The Canadian Rubber Co., of Montreal, Limited, have now placed on the market their new "Keystone" Side Wire Tire. This tire has many unique features not to be found in any other make, and the Canadian Rubber Company have exclusive control of the patent rights for manufacture and sale throughout the Dominion of Canada. Already a large amount of business has been booked, and the carriage and hack trade are displaying great interest in the new tire, which is adjudged by experts to be superior to anything yet put on the market.

The Canadian Westinghouse Company, of this city, has just secured a large and important contract from the Montreal Street Railway Company, it being that company's intention to provide additional facilities for a rapid and efficient service. The new equipment consists of one 1,000-kilowatt direct current engine type, 600-volt railway generator; three 500-kilowatt motor generator sets; 20 quadruple equipments of No. 101 B railway motors for cars, and 50 sets of air brakes with motor driven compressors. The contract will be turned out without delay.

The extent to which New York builders and contractors shall participate in the reconstruction of the Pacific Coast is indicated by a telegram which one prominent New York builder, Frank P. Gilbreth, sent to Mayor Schmidt, of San Francisco. Mr. Gilbreth has tendered the services of two of the most distinguished consulting engineers in the country, who are connected with his organization, Professor Lewis J. Johnson, of Harvard, and Professor Charles L. Norton of the Massachusetts Institute of Technology, both of whom have been distinguished for their work in the engineering field, particularly in the line of reinforced concrete work.

The Pacific Coal Co. has ordered two 150-horse-power boilers from the Robb Engineering Co., for their mine at Bankhead, Alberta.

The Logan Tanning Co., are improving the steam plant at their tannery, Pictou, N.S., and will install a 150 horse-power Robb-Armstrong Corliss engine.

The Dominion Iron & Steel Co. now holds the Canadian record for a twenty-four hours' output of rails, the department having produced for that period 806 tons. The former record was held by the Soo works, with an output of 802 tons.

MARINE NEWS.

The entire fleet and plant of the Great Lakes Dredging Co., of Port Arthur, including five dredges and four tugs, has moved over to Fort William.

The first iron ore cargo ever shipped from Escanaba to go north was taken out by the Canadian steamer Leafield last week. It went to Sault Ste. Marie, Ont.

Capt. Thos. Donnelly, of Kingston, who is raising the "Eugene Zimmerman" sunk in the St. Mary's River, reinforces the statement of Capt. C. H. Sinclair that the masters of the steamers "Iroquois," "Umbria," and "Hutchinson," which struck near the Dyke in St. Mary's River, a short time ago, were not at fault. He says that the buoy at the spot had not been properly placed.

RAILWAY NOTES.

During four days, May 4th, 5th, 6th, and 7th, the Canadian Pacific carried 4,850 immigrants from Montreal to Calgary, Alta.

It is rumored in contracting circles that a partnership has been entered into between M. J. O'Brien, contractor of Renfrew, and A. R. MacDonald, the well-known railway builder.

A contract was signed recently, whereby J. G. White & Co., a New York engineering firm are to build a new high-speed inter-urban line, costing $2,000,000, between Rochester and Lockport, for a syndicate represented by Frederic Nicholls, E. R. Wood, and Sir Henry M. Pellat, of Toronto. The contract covers complete construction.

The Railway Commission of Canada has granted a concession for a railroad to be built in the Klondike region. The road will start at Dawson City and will run eighty miles into regions that are reached now only by dog sleds. It is hoped to have thirty miles of the road in operation within six months. The company is capitalized at $3,500,000.

The Hillcrest Railway, Coal and Coke Company is applying to Parliament for power to construct and operate a line of railway from a point near Morrisey, B.C., through Crow's Nest Pass to somewhere near Hillcrest Junction, thence to Cardston, Alta., with branch lines to Pincher Creek, as well as to certain coal deposits in a neighboring township and to the oil fields situated near Little Kootenay Lakes, Alta.; also for authority to operate coal mines and oil properties and to construct pipe lines, etc.

Now that the contracts have been signed for the Quebec section of the Transcontinental Railway, work is to be rushed from the Quebec Bridge at Cap Rouge, and continued along the Ste. Foye heights and Ste. Foye valley in order to connect with the C.P.R. as soon as possible, so that the material from Phoenixville for the Quebec end of the bridge can be shipped to the bridge site by C.P.R. The construction work further west will also be rushed in order that the headwaters of the St. Maurice may be reached, which will permit of the shipment of materials and supplies there, thus facilitating the construction of other sections through the northern portions of Quebec.

Sudbury expects the C.P.R. to spend $250,000 there this season in a new station 40 x 150 feet, freight sheds 50 x 300 feet, and extensive yard improvements.

The bridge over the Grand River on the Guelph and Goderich line has been completed and track laying has been resumed. A gang of men, numbering two hundred, are now at work laying the track to the west of the bridge.

The Canadian Pacific Railway Company has decided to offer five scholarships, covering four years' tuition in the Faculty of Applied Science of McGill University to apprentices and other employees of the company, under twenty-one years of age, and to minor sons of employees.

It is announced that Mackenzie & Mann intend to begin at an early date the building of a grain line from the mouth of the French River to Ottawa, and thence to Hawkesbury, where it will connect with the Great Northern, which runs from that point into Montreal. The distance from French River to Hawkesbury is 370 miles, and from the latter place to Montreal about 60 miles. The terminal at French River will necessitate wharfage equipment, elevators, etc.

MINING MATTERS.

The shipments from Rossland for the year have reached and passed the 100,000 mark, and the indications now are that they will be greater than they were last year.

At Banff, Alta., deposits of anthracite coal have been recently opened up by the Canadian Pacific Railway Company. The coal resembles that obtained from the famous Pensylvania mines, and will be supplied to the whole of Manitoba and the North-West.

The Cobalt district is to have a great ore smelter and refinery. It will cost about $600,000, and the Ontario Government has agreed to give the projectors, who are represented by E. J. H. Pauley, of Toronto, a free site at a convenient point on the Temiskaming Railway between Cobalt and North Bay.

LIGHT, HEAT, POWER, ETC.

The biggest electrical unit in the world is now running smoothly in the Ontario Power Company's wheel-pit and power-house. It is one of 12,500-horse-power to be added to the three of 10,000-horse-power formerly installed.

The Montreal Light, Heat & Power Co. recently sold the charter rights of the Standard Light and Power Co. for gas for the city of Quebec, to Mr. Emerson McMillen, of New York, President of the American Light and Traction Co.

It is stated that it is the intention of the recently organized New York and Ontario Power Company, with a capital of $2,000,000, to develop the magnificent power at Waddington, N.Y., and begin preparations for carrying the power to Prescott and Brockville via Ogdensburg.

The work of developing the water power at Kakabeka Falls, is advanced so as to give promise. It is stated that by June 1st, electrical energy will be ready for distribution.

The Montreal Light, Heat and Power Co. have secured another water-power at Cedar Rapids, near Montreal, and will have 5,000 horse-power from it in the city by November 1st.

The management of the Montreal Light, Heat & Power Company have completed arrangements for the construction of a large and modern power-house to be situated on the Soulanges Canal, about two and one-half miles from the village of Vaudreuil. The estimated cost of the new building and plant is one million dollars. This will be the largest outlay for improvements expended by the company at any one time for many years. The work of construction will be commenced at once, as the officials wish to have the building ready for the distribution of power into the city by November 1st, next.

PERSONAL

Dr. L. Ritter Ickes, the man who promoted and built the Grand Valley Radial road, running between Brantford and Galt, died on April 25th, in Seattle.

J. B. Tyrrell, the well-known geologist and mining engineer, has joined Mackenzie & Mann as their mining expert, with headquarters at Toronto.

B. W. Chipman, president of the Nova Scotia Telephone Company, and Secretary for Agriculture for Nova Scotia, died on April 24th, after an illness of several days.

Hugo B. R. Craig has resigned his position as city engineer of Kingston, to accept the post of resident engineer of the Grand Trunk Pacific Railway west of Fort William.

W. P. Chapman, C.E., of Hamilton, latterly division engineer James Bay Railway, Parry Sound district, has been given charge of construction of the Canadian Northern lines in Quebec.

Mr. J. W. Ball, who until recently was general foreman of the Canada Foundry Co.'s Screw and Nut Department, has been appointed general superintendent of the Standard Bolt & Screw Co., Toronto.

F. J. White, head roller in the Dominion Iron & Steel Co.'s rod mill, has severed his connection with that company to take the position of superintendent of the rod mill of the Morgan Spring Co., at Struthers, Ohio.

City Engineer Hanes, of Windsor, has resigned to become city engineer of Fort William at a considerable increase of salary. It is likely that he will be succeeded by Owen McKay, a civil engineer who has had considerable experience.

Mr. F. A. Paulin, late Chicago manager, for the India Rubber Company of New Brunswick, N.J., is now in charge of the tire department of the Canadian Rubber Co., of Montreal, Limited. Mr. Paulin is a Canadian by birth, having spent his early years in the carriage trade in Ontario. He has had extended experience during the past twelve years throughout the larger cities in the United States.

Messrs. E. H. Keating and D. J. Russell Duncan, Advisory Engineers to the Monterey Railway, Light & Power Company, and Monterey Water Works and Sewer Company, Monterey, Mexico, announce that they have opened offices at the Home Life Building, Victoria Street, Toronto, where they will carry on business as Civil Engineers. Special attention being given to Hydraulic, Municipal, Electrical and Industrial undertakings. Plans, specifications, estimates and reports prepared on enterprises and concessions, either foreign or in the Dominion.

MUNICIPAL WORKS, ETC.

Owen Sound Council will expend $45,000 on extension of electric light system, and $45,000 on extension of gas system.

Fort Frances is to have a complete and up-to-date system of waterworks, sewerage and electric light, to cost about $57,000. John Galt, C.E., of Toronto, is the consulting engineer, under whose plans the systems will be installed.

TELEGRAPH AND TELEPHONE

The Bell Telephone Company asks authority to increase its capital stock from $10,000,000 to $50,000,000, to provide for future development.

The Canadian Machine Telephone Company, Toronto, has been awarded the contract for installing the automatic system of telephones in the city of Edmonton, Alta.

NEW INCORPORATIONS.

Manitoba.—The Manitoba Sand and Dredging Co., Winnipeg; $10,000; L. Bellefeuille, H. C. Cook, C. A. Allen, J. W. Stewart C. W. St. John.

Neepawa Manufacturing Co., Neepawa; $50,000; D. R. Gardiner, J. Gardiner, W. J. Hamilton, R. Connell, J. Wemyss, J. H. Howden, J. Crawford, Neepawa, Man.

Ontario.—Dinorwic and Gold Mines Telephone Co., Toronto; $40,000; A. Blum, Brookline, Mass.; H. W. Scatergood, Philadelphia, Pa.; A. Campbell, Detroit, Mich.; J. G. Shaw, J. Montgomery, Toronto.

The Gillies Silver Mining Co., Haileybury; $500,000; J. F. Gillies, Haileybury; W. Lawson, Eganville; D. Stewart, New Liskeard; A. Enright, Douglas; W. Lawson, Quyon, Que.

The Cross Lake Consolidated Mining and Milling Co., Toronto; $1,000,000; F. Rielly, H. M. Murton, J. B. Bartram, G. Sutherland, E. Denton, Toronto.

The Mining and Lands Development Co., Toronto; $40,000; W. A. Preston, fort Frances; W. J. Elliott, R. D. Hume, J. C. McLachlan, W. T. Martin, Toronto.

The Windsor Dredging Co., Windsor; $40,000; A. F. Healey, A. B. Drake, A. Peltier, W. J. McKee, H. W. Allan, G. E. Brooks, Windsor; W. L. McGregor, Walkerville

The Cobalt Chartered Co., Haileybury; $350,000; F. Law, A. Lebeau, E. E. Belcourt, Montreal; J. N. Battey, H. Letourneau, Ottawa.

Roofers' Supply Co., Toronto; $200,000; A. Dods, R. B. Rennie, G. Duthie, A. Mathews, T. Douglas, H. Williams, H. Hutson, Toronto.

The McKinley-Darragh-Savage Mines of Cobalt, Toronto; $2,500,000; G. W. Spence, A. M. Duncan, A. A. Rogers, S. Whittaker, L. M. Heal, Toronto.

Cobalt and Hudson Bay Development Co., Haileybury; $100,000; J. E. Day, J. M. Ferguson, E. V. O'Sullivan, A. H. Day, J. J. O'Sullivan, Toronto; C. M. Daly, Guelph.

The Rapid Tool Co., Peterborough; $40,000; W. Rudkins, Wm. Quinn, W. Duncan, G. L. Hay, W. S. Davidson, Peterborough.

The Iroquois Cobalt Silver Mining Co., Haileybury; $100,000; C. A. Richardson, H. D. Graham, G. A. Bagshaw, P. S. Robarts, Haileybury; J. L. Wheeler, Emporium, Pa.

The Silver Cliff Mining Co., Ottawa; $2,000,000; W. D. Gregory, H. F. Gooderham, H. W. Barry, R. Weir, J. F. Boland, Toronto.

The Green Rock Mining Co., Sault Ste. Marie; $600,000; C. S. McLachlan, J. B. Kelly, W. H. Darcy, J. J. Lyon, G. F. Wheatley, R. Chadwick, Sault Ste .Marie, Mich.; R. Henry, Sault Ste. Marie. Ont.

The Eureka Silver Mining Co., New Liskeard; $100,000; B. Field, E. M. Goodman, J. L. Brown, R. Herron, H. Hartman, New Liskeard.

Silver Wonder Mining Co., Toronto; $300,000; L. MacKay, A. T. Struthers, W. H. Syms, T. A. Dark, A. Cooper, Toronto.

Silver Ledge, Toronto; $20,000; R. A. Montgomery, E. R. Lynch, A. Scott, E. Nash, K. Allen, Toronto.

The Buffalo Mines, Toronto; $1,000,000; A. M. Macdonnell, A. C. McMaster, T. H. Barton, F. D. Byers, L. Duff, Toronto.

The Silver Crown Mining Co., North Bay; $500,000; R. Handley, J. J. Connolly, C. J. Murphy, C. J. Roberts, W. P. Allum, Renfrew.

The Commercial Gas Co., Windsor; $40,000; E. Wigle, C. L. Meyer, Windsor; W. P. Hickey, E. Wigle, G. A. Brown, Leamington.

The Steep Rock Development Co., Fort Frances; $150,000; D. C. McKenzie, A. Mills, G. Webster, J. G. Scott, Fort Frances; T. Rawn, Atikokan, A. Snyder, Duluth, Minn.

The Detroit & Cobalt Development Co., Windsor; $25,000; J. L. Ernst, C. H. Gowman, A. G. Thomson, W. H. Lehman, T. Lemay, O. P. Gulley, Detroit, Mich.

The Montreal River Silver Syndicate, Toronto; $200,000; W. H. Nylie, Almonte, W. J. Aikens, R. T. Mussen, Dunnville, C. E. Calvert, N. B. Gash, Toronto; W. T. Henderson, Brantford.

Glen Lake Mining Co., Toronto; $500,000; A. M. Macdonell, A. E. McMaster, G. R. Geary, T. H. Barton, L. Duff, Toronto.

The National Brass & Mfg. Co., Toronto; $100,000; C. D. Fergusson, J. Gray, E. J. Saunders, H. A. Wright, L. Foulds, Toronto.

The Gilpin Cobalt Silver Mining Co., Toronto; $500,000; A. A. Daniel, R. F. Wilton, D. B. Gilpin, M. W. Mayer, G. T. Veale, Toronto.

Beaver Silver Cobalt Mining Co., New Liskeard; $500,000; A. Devine, Cobalt; K. Farah, New Liskeard; L. Vineberg, A. M. Bilsky, D. S. Friedman, Montreal.

The Sudbury Cobalt Mining Co., Sudbury; $300,000; J. T. O'Connor, D. M. Morin, L. O'Connor, N. F. Hillary, J. A. Mulligan, Sudbury.

Mining Development and Securities Co., Toronto; $150,000; W. H. Gates, E. S. C. Griffith, H. N. Barry, I. B. Lynn, J. F. Boland, Toronto.

The North Cobalt Land Corporation, Toronto; $40,000; G. Stevenson, W. J. Clark, M. Lambert, A. Bell, E. Robertson, Toronto.

The Findlay Mining Co., Windsor; $20,000; L. H. Broadwater, J. G. Kimmell, T. McManus, E. McManus, B. McManus, Findlay, Ohio.

The Dominion Cobalt Mining and Development Co., Cobalt; $450,000; R. K. Lindsay, W. J. Sanderson, J. T. Later, W. Williams, R. A. C. Manning, Winnipeg.

The Ohio Cobalt Mining Co., Haileybury; $60,000; H. H. Smith, W. B. Francy, R. M. Francy, H. G. Mooney, Toronto, J. C. Ross, B. R. Dawson, A. S. Buckingham, Steubenville, Ohio.

The University Mines, Toronto; $1,000,000; G. Glendinning, H. L. Kerr, A. C. Pratt, Toronto; W. J. Blair, New Liskeard; D. A. Dunlap, Haileybury.

Argentine Mining and Smelting Co., Toronto; $1,000,000; G. C. Loveys, J. M. Ewing, W. B. Raymond, F. Ford, J. F. H. McCarthy, Toronto.

International Electric Co., London; $100,000; F. H. Potts, A. R. Bickerstaff, G. Stevenson, E. McKenzie, R. K. McIntosh, W. H. Holland, M. G. Carrol, Toronto.

Central Foundry, Toronto; $200,000; H. L. Bowers, R. C. Donald, G. M. Howard, W. H. Innes, Toronto; H. F. Bush, Port Hope.

Dominion.—Toronto and Belleville Rolling Mills, Belleville, Ont.; $599,900; W. D. Morris, H. Micholson, G. E. Barber, R. G. Code, E. F. Burritt, Ottawa.

Jenkins Bros., Montreal; $200,000; A. B. Jenkins, West Orange, N.J.; E. T. Swain, East Orange, N.J.; A. E. Brady, Brooklyn, N.Y.; H. D. Gordon, East Orange, N.J.; W. R. Stavert, Montreal.

The Montreal Reduction and Smelting Co., of Canada, Montreal; $2,000,000; J. B. E. Leonard, B. Burland, L. J. Cartier, A. Robert, A. Tremblay, P. Theriault, J. E. Theriault, J. E. Theriault, O. Theriault, O. Lemire, P. Tetrault, J. M. Mitchell, J. H. Brown, O. Frechette, E. L. Patenaude, Montreal.

Canadian Iron and Foundry Co., Montreal; $2,000,000; E. M. McDougall, T. J. Drummond, G. E. Drummond, T. Brosseau, F. G. O'Grady, R. J. Mercur, Montreal; J. A. Kilpatrick, St. Thomas.

The Camaguay Tramway Co., Halifax, N.S.; $200,000; R. V. Sinclair, A. F. May, A. Macfarlane, W. H. Middleton, C. T. Moffat, Ottawa.

The General Supply Co., of Canada, Ottawa; $20,000; J. W. Smith, G. B. Greene, F. H. Chrysler, W. L. Larmonth, C. J. R. Bethune, Ottawa, Ont.