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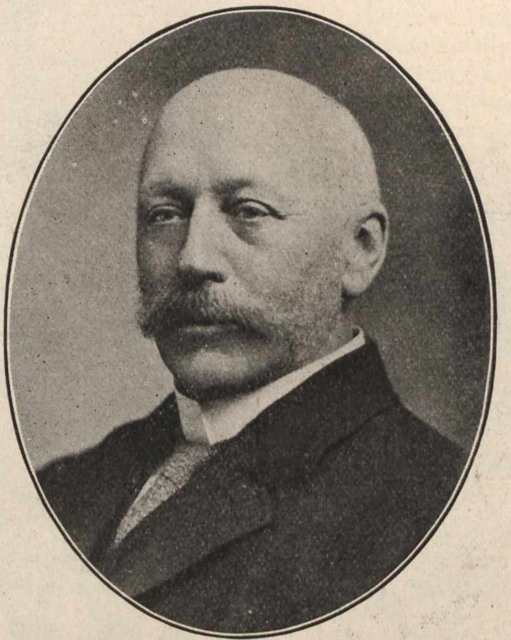
We judge ourselves by what we feel capable of doing; but the world judges us by what we have already done.

Longfellow.



EDWARD HENRY KEATING, C.E.

M. Inst. C.E. (London); M. Am. Soc. C.E.; M. Can. Soc. C.E.; Fellow of Imperial Institute, etc.

Soon after the accession of King Edward to the throne, murmurs were heard from time to time that at the Royal garden parties and receptions, noted artists, musicians, and even actors—men whose function it is to minister to the mere sensuous pleasures of life—were prominent; but that engineers—men whose **creative** power and mechanical skill had built up the great industries and commerce of the Empire, and given to the people thereby, comforts and privileges which a king had not a hundred years ago—were conspicuous by their absence. This inability to recognize in true perspective the services rendered by the engineers to our modern civilization, will be specially noted by the future historian, as a remarkable sociological phenomenon of the times in which we live. As with honors, so with wealth. In all industrial countries millionaires are springing up like mushrooms; but, although it is the engineer who has designed and forged the golden keys which have unlocked the doors of nature, and unearthed her riches, it is the business men—your John D. Rockefeller's and Andrew Carnegie's, not your James Watt's and Henry Bessemer's—who are reaping the exceeding great rewards. The Wordsworthian formula of "plain living and high thinking" seems to have been specially prepared for the engineer. His consolation prize is the proud consciousness of having made two blades of grass grow where only one grew before: of having contributed to the progress and advancement of humanity.

These thoughts crowded upon us as we took up our pen to sketch briefly the career—rich in experience—of the distinguished civil engineer whose portrait appears above.

Edward H. Keating was born at Halifax, N.S., in 1844. Educated at the Free Church Academy and Dalhousie College, Halifax, and studied engineering under Geo. Whiteman, C.E., Provincial Government Engineer; also under Sir Sandford Fleming, the chief engineer of the Intercolonial Railway. Since embarking in professional engineering he has filled the following positions viz., assistant engineer Pictou Extension Railway, N.S.; chief draughtsman, Windsor and Annapolis Railway, N.S.; contractor's engineer, European and North American Railway, N.B.; chief engineer in charge of exploration on the C.P.R. From 1872 to 1890 he was city engineer and chief engineer of the waterworks, Halifax; also resident chief engineer of the Halifax graving dock, and in 1890 became city engineer of Duluth, Minn. In 1892 he was appointed city engineer of Toronto, and the following year added to his duties that of waterworks engineer, resigning in 1898 to become general manager of the Toronto Railway Company, which position he held for seven years, resigning to undertake investigations into several projected engineering enterprises in the Dominion and in the Republic of Mexico, some of which have been taken up and are now in course of construction. He designed the waterworks for the towns of Moncton, N.B.; Windsor, N.S., and Dartmouth, N.S., besides extensive improvements in the waterworks and sewerage systems in a number of important cities. In 1903 he was appointed chairman of the Royal Commission to enquire into and report upon the construction of a graving dock for the port of Montreal. He has also been called upon as expert to advise various municipalities on questions relating to water supply and drainage, viz., Ottawa, Hamilton, Victoria, B.C., etc. In 1900 he was elected president of the Canadian Society of Civil Engineers, a signal proof of the esteem and high regard in which he was held by the competent engineers of Canada.

Just at a time when Canada is on the threshold of a great forward movement industrially, it is fortunate that she has skilled engineers of wide and varied experience like Mr. Keating to advise on her important engineering projects and enterprises. Recently he has entered into a partnership with Mr. D. J. Russell Duncan, a well-known civil and mechanical engineer; for the carrying out of a general engineering practice, with offices in the Home Life Building, Victoria Street, Toronto.

If ever an engineer was worthy of a crowning success in his business life it is Mr. Keating, and "The Canadian Engineer" wishes him and his partner every success in their new undertaking.

EUROPEAN HYDRO-ELECTRIC DEVELOPMENT

ITALIAN PLANTS AT ROME AND NAPLES.

By Charles H. Mitchell, C.E.

IV.

THE ROMAN PLANT AT TIVOLI.

To write of modern twentieth century electric power installations in the ancient city of Rome, seems almost a romance; but like the ancient city, which was ever seeking new things; modern Rome has risen to the requirements of the present age, and is evidently determined not to lag behind the rest of the world—in which at one time she reigned supreme. It is quite true, that Rome has one of the largest hydro-electric plants in Europe; that she has a most modern electric lighting system; and that she has hundreds of up-to-date electric cars—veritable hill climbers—traversing her narrow streets, crowding across her fountain splashed squares, and clanging past the grim Colosseum, the silent Forum and radiant St. Peter's.

As a user of electric power, Rome has but little demand beyond lighting and traction. Notwithstanding her population of 450,000 there are few factories, and most of the power used in motors is in very small units. The lighting and traction using about 10,000, and 4,000 H.P., respectively, form almost 90 per cent. of the total requirements. One company, the "Societa Anglo-Romana" operates the gas, electric light, and traction systems; for all of which it has a monopoly until 1928. Previous to 1892 all electrical energy used in Rome, was generated by steam as the motive power; but subsequently a small hydraulic plant at Tivoli, eighteen miles east of Rome, was constructed and operated by the

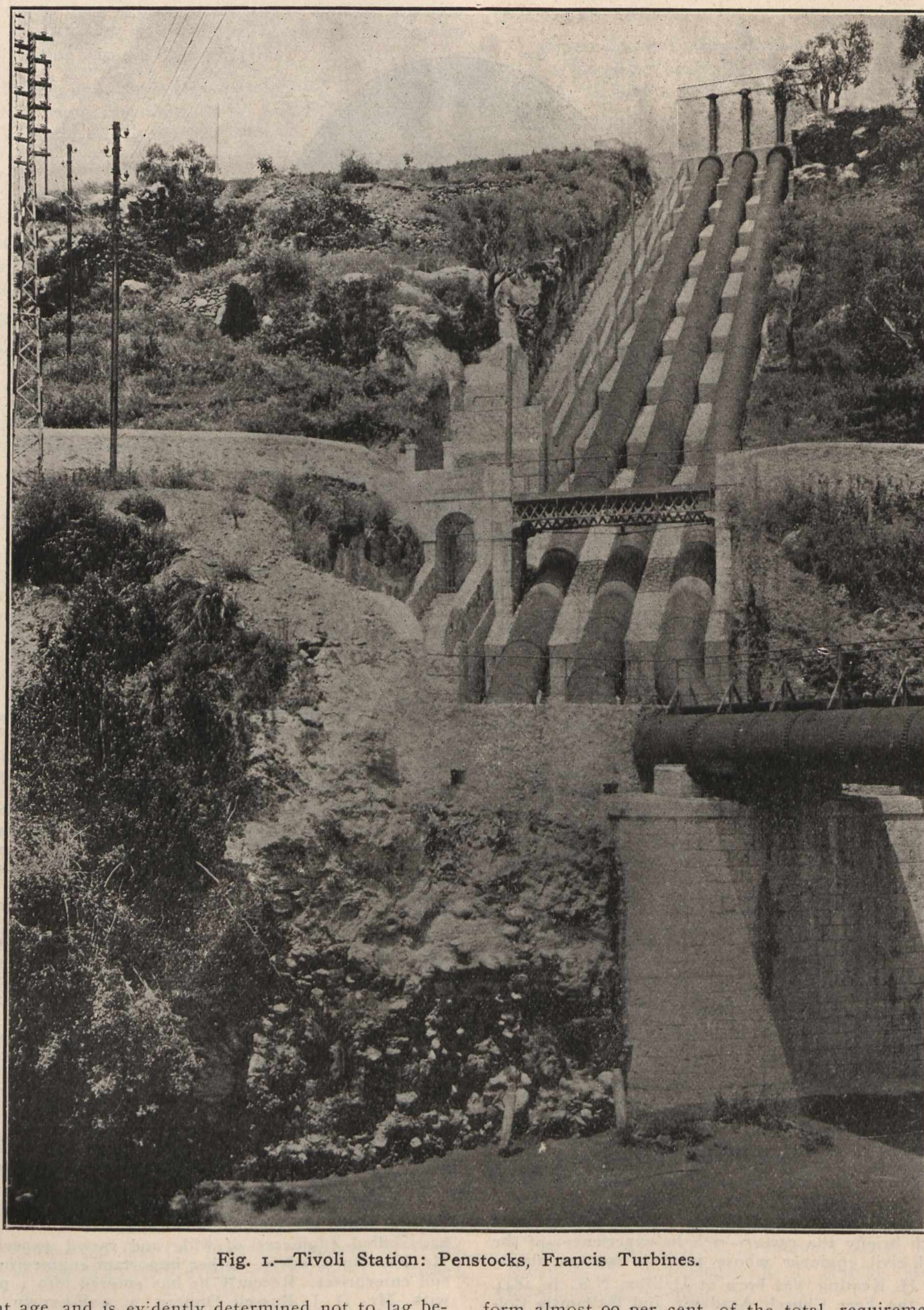


Fig. 1.—Tivoli Station: Penstocks, Francis Turbines.

company. In 1900, a modern hyro-electric power plant, on the same site, was completed and commenced operations; while in 1902 this plant was extended to its present capacity, viz., a minimum of 12,000 H.P. In addition to this, the company still operates two steam plants at Rome having 5,000 H.P. By the present autumn, the same company will have in operation a second hydro-electric plant at Subiaco, about 35 miles east of Rome, generating 5,000 H.P. under 225 ft. head, with three-phase generators of novel pattern, wound to 30,000 volts, thus not requiring transformation for transmission.

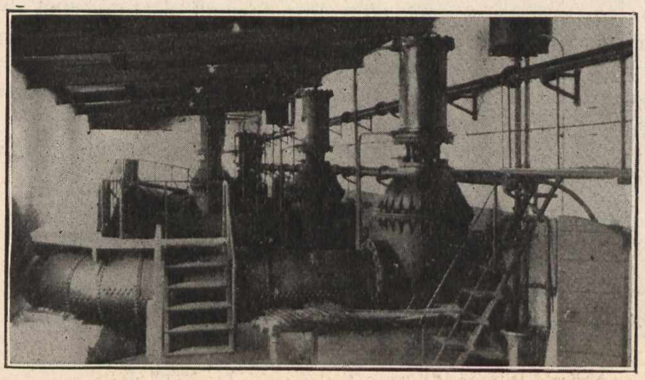


Fig. 2.—Tivoli Station: Hydraulic, Penstock Gate Valves.

The falls of Tivoli are at the base of the Sabine Hills, and are formed by the Anio which here passes through a romantic ravine, having a fall of 360 ft., and an aggregate of some 530 ft. within two miles. Great engineering works were constructed at and around these falls by the ancients, also in the beginning of the last century; when, owing to destructive floods, at and above the town, new relieving spill tunnels were driven. For centuries, a considerable manufacturing community has existed at these falls, operating its mills by water-power, with wheels of all descriptions. The town itself has still several paper mills, but its manufacturing interests are small.

The hydro-electric plant is situated in the gorge where it debouches into the wide valley. It is situated beneath the famous Villa d' Este, 300 years old, one of the most beautiful gardens of Italy, and is within a few minutes of Hadrian's Villa, the greatest of ancient royal homes.

Water is brought to the forebays on both sides of the river, high up on the cliffs. The older waterway is by means of ancient canals on the town side; the new one on the opposite side consisting of a canal a mile long. Water obtained by the older canals, provides two heads of 530 and 346 ft., from different points, while the newer system gives only 165 ft., being obtained by a dam built in the gorge above the lower cascades of the. falls. The dam is of masonry, built on rock foundation, arched up stream in plan to a radius of 280 ft., and has a crest length of 240 ft. It is 50 ft. high, of overfall ogee type, having a width of 12 ft. on top, and 45 ft. on the base. The new canal has a capacity of 350 cubic feet per second, and terminates in a forebay 120 x 110 ft. and 19 ft. deep, divided into two parts by a wall with submerged arches, to assist in obstructing debris.

Penstocks built at different times under the various heads are 3'-0", 5'-0", and 4'-4" diameter, respectively. Of these the first serves two units, the second, three; and the third set (three in number) serve one unit each—see Fig. 1. They are built of steel plate, with inside and outside lap rings. The three new penstocks are made of 5/16" plates at the top, and 7/16" at the lower end; while for the 80 ft. spans across the river, they are ¾" plates, and double riveted. In addition to gates at the forebay, each penstock has a gate valve before connection to the turbine, operated hydraulically. (See Fig. 2.)

The substantial construction of these works is indicated in the method of carrying the penstocks down the river bank, a most generous expenditure of heavy masonry, ornamental bridges, stairways and portals, which would appal American investors. The bridging of the river, however, by the penstocks, without auxiliary support is an example of the utilitarian side of European engineering, instances of which one meets every day alongside the aesthetic features. This leads one to consider whether in newer America, where all is utility we do not too often entirely forget the aesthetic. Are we not also sometimes inclined to reduce our substantiability in design to a minimum, in our desire to be economical, and in our effort to rush through what might be termed semi-temporary construction in order to secure quicker financial returns?

In the generating station, which is of stone masonry, are seven power units on horizontal shafts, four of which were installed in the first construction, under the higher heads, using Girard turbines, and three in the extension installation using Francis type turbines. These are arranged in a long central hall (see Fig. 3) having the penstocks and tail race on one side and the switchboards and offices, etc., on the other.

All the turbines are built by Gang & Co., of Buda-Pesth, and are nominally of about 3,500 H.P. each. The Francis type installed in 1902, are examples of a system frequently built by this company, and, while generally similar to most turbines of this class now manufactured in European shops, have the distinction of being regulated by gates in the draft tube, on the lower side of the runner. This type is not a novelty, there being several similar installations both in Europe and America, but the arrangement is sufficiently out of the ordinary to merit special description. Referring to Fig. 4, which shows a vertical section of the turbine through the shaft, the following are explanatory notes:—

K—The cast iron wheel case "Snail Shell" type for incoming water, connected to penstock.
S—Distributor between case and runner, fixed vanes.
R—Runner, Francis vanes, attached on end of main shaft Y.
O—Draft tube.
A—Governor centrifugal regulating fly-wheel, "Hartung" type.
B—Dash pot with glycerine, to regulate oscillations.
C—Connections to governing valves, servo-motor, and hydraulic governing relay.
N—Adjustable fulcrum for controlling lever Z.
U—Cylinder connected to Servo-motor for actuating piston of gate stem X.
X—Gate stem attached to cylindrical gate.
Q.—Cylindrical gate piston, reciprocating horizontally, to open or close outlet from runner R. Diagram shows gate wide open.

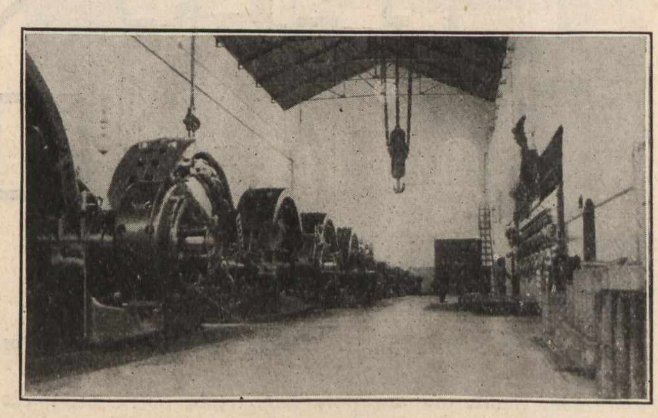


Fig. 3.—Tivoli Station: Interior.

The same general principle is used on the Girard units, but, owing to the nature of the turbines, which are outward discharge, the gate operating mechanism is differently applied. All these units are connected in parallel with conspicuous success; results, all the more remarkable, because of two types of turbine operating under three different heads, and having a transmission line with mixed and extremely varying load.

The generators are 3,300 K.W. rated capacity at 10,000 volts, three phase revolving field type, each having its exciter carried on the outboard end of the main shaft. The internal diameter of the armature is 13 ft. and the inductor weighs 24 tons. While the units are three phase, they are operated about half the time as mono-phase; on account of a large single phase distribution system, which had existed for many years previously in the city of Rome. It is explained that this system, even with its complicated switching devices and additional outlay in large generators, was found preferable, and at present cheaper, than to reconstruct the extensive underground wiring systems in the city. This explains the discrepancy in rated capacity between the turbines and generators.

Each unit has its own division on the switchboard, and the leads after leaving the bus bars pass through fuses to high tension oil switches, thence on to the line at 10,000 V. The transmission line, carried on steel lattice poles about 160 ft. apart, consists of two circuits 18 miles in length. Its course is, for the most part, alongside the canal across the Campagna Romana, which supplies modern Rome with water from the hills at Tivoli. While the poles are of steel, it is to be noted that the cross arms are of wood, a point on which Professor Mengarini, the technical director of the company is very positive as being necessary to good insu-

baldi's Italian army made the breach, and their famous entrance through the walls of the sacred city in 1870: the whole suburb in this locality is now a crowded modern city, with imposing buildings; so quick has been the growth of late years.

The Porta Pia sub-station reduces the line voltage as required for the different divisions of current demanded in the city. Lighting current at 2,000 V. is conducted to the underground cable systems for public arc lighting; mixed motor power and domestic lighting also at 2,000 V. is carried to numerous secondary sub-stations, whence it is stepped down to the consumers' tension, usually at 110 V.; the traction current is, after transformation, converted by rotaries to 500 volts D. C. There is also another portion of line current which is passed directly through four rotary converters for D. C. traction use, without the use of static transformers. In conjunction with the traction current a large accumulator battery is installed in this station, and is

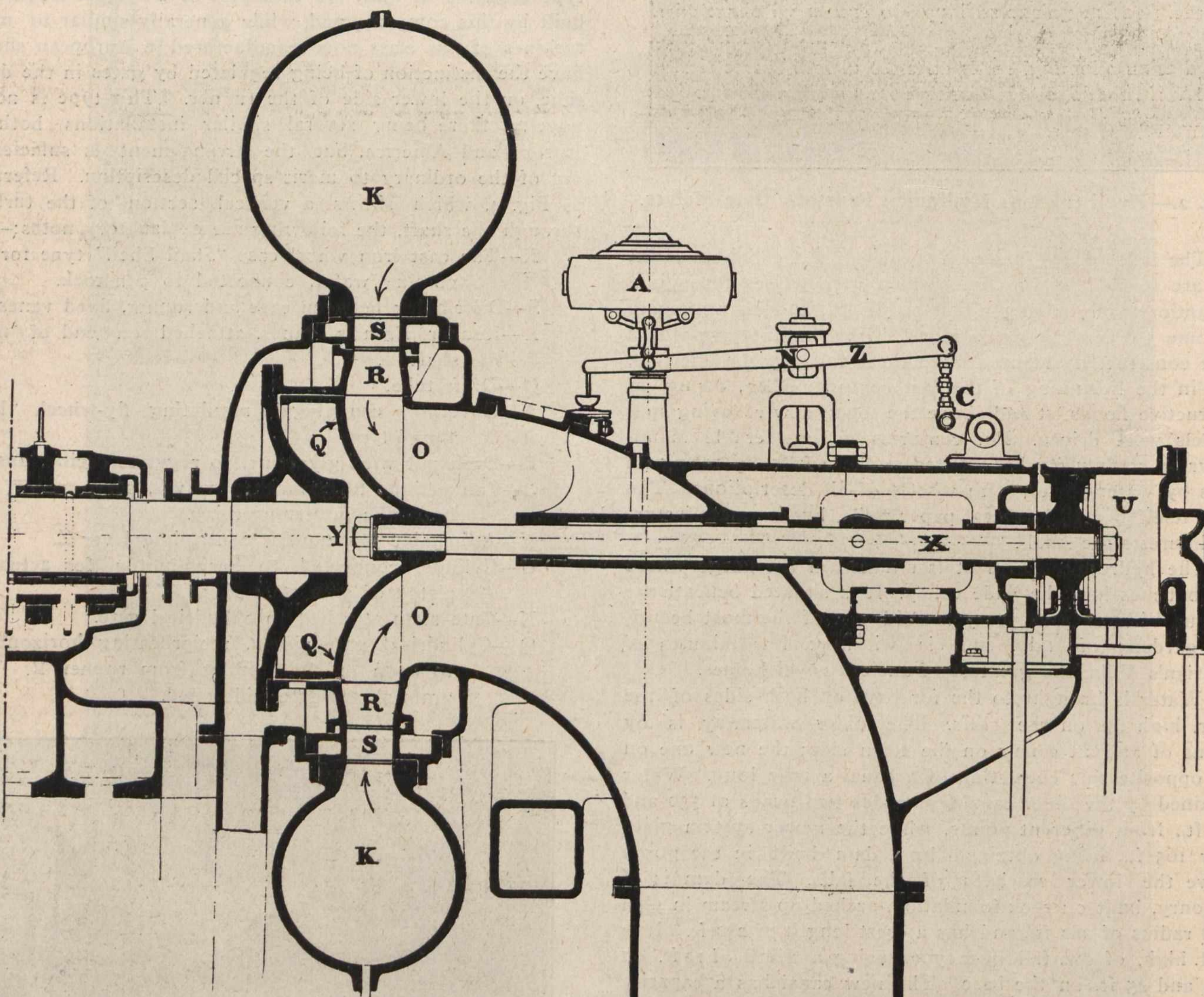


Fig. 4.—Tivoli Station: Francis Turbine, With Draft Tube Regulating Gates.

lation. The insulators are porcelain triple petticoat, made by Richard Ginori, and instead of having their parts cemented, are sealed or "stuck together" in the burning oven: it is claimed in this, that all moisture is driven from the space between parts, that this space contains rarefied air, and that new moisture cannot enter. The insulators of this type for the new Subiaco line ("Modello 1905") for 30,000 V. are 9½" diameter and are tested to 60,000 V. At several points the line crosses railways and telegraph lines where safety devices are arranged to prevent accident from breakage of a high tension wire. Half-way is a switch and store-house having lightening arresters, and provided also with measuring instruments. Telegraph and telephone lines are carried on the same poles, alternated every 1,500 ft. to avoid induction.

The transmission line leads to Porta Pia, to a sub-station located on the northern side of the old city wall. This station, by the way, is situated at the point where Gari-

automatically thrown in or out to the amount required, by a very ingenious switching device, designed by Professor Mengarini. From a card of 24 hours performance of this apparatus, presented to the writer March 4th, 1906, the maximum variation of voltage shown on the lighting circuits is under 3 per cent. and the normal fluctuations rarely exceed 1 per cent. This is on a line interconnected, through the main transmission line, with a street railway system, in a city "built on seven hills" some of which are very steep. In this connection, Professor Mengarini pointed with pride to the incandescent 16 C.P. lamps in his office, at 6 p. m., which were as steady as any the writer has seen on the continent.

The auxilliary steam stations at Cerchi and Ponte Molle are in constant operation interconnected and, at times, in parallel with the hydraulic station.

Power prices in Rome are set forth at length in the "Regolamento per l'uso dell' Energia Elettrica." In general the prices run as follows: For small motors, about 6 to 8 cents per kilowatt hour; for large motors, on a 12-hour day basis, about $20 per H.P. year, and on a 24-hour day basis, about $35 to $40 per H.P. year. For lighting the price varies between 12 and 14 cents per kilowatt hour. The price of coal, however, is very high, being about $8 per ton.

The Neapolitan Plant at Olevano.

Southern Italy has never been looked upon as a favorable field for investment in the modern sense, and from an

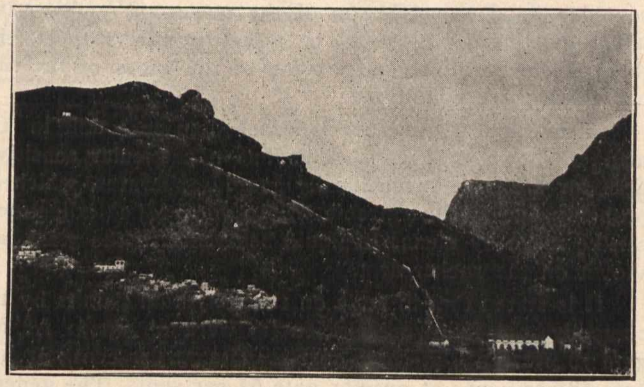


Fig. 5.—Olevano Station: General View.

engineering point of view there has been little of interest beyond the railroads. As for manufacturing there has been small inducement except in the absolute necessities, because of the actual absence of coal or other fuel. But history here as elsewhere within the past twenty years, is repeating

Fig. 6.—Olevano Station: Penstock 40-inch Diameter.

itself, and the water-powers have suddenly sprung into value, with the result that the twentieth century Italian financiers and engineers are turning to the south some of the energy already displayed in the north. Though called by the Italians "white coal" (carbone bianco) it cannot be a correct term in the French or Swiss sense, as there are no glaciers: nevertheless there are many streams of high head, and copious amounts of water.

As an example of this recent activity in development, the installation of the Societa Meridionale di Elettricita of Naples is taken as exhibiting interesting features. This installation first put into operation in January, 1905, is situated at Olevano, a little village in the Appenine mountains, about 50 miles south of Naples and 10 miles inland. The present capacity of the plant is 6,000 H.P., and arrangements are made for extension to 9,000 H.P. The power is transmitted to various towns northward as far as Naples, including particularly Salerno, Nocera, Castellammare, Torre Annunziata (Pompeii), and Torre del Greco (Herculaneum). The uses are mainly for lighting and mixed power in small units, such as fabric weaving, machine and wood working shops; but more than all, for the maccaroni factory, which is the flour mill of Italy. The network of wires extends widely among the towns at the base of Vesuvius, but fortunately suffered injury at only a few places during the recent disastrous eruption.

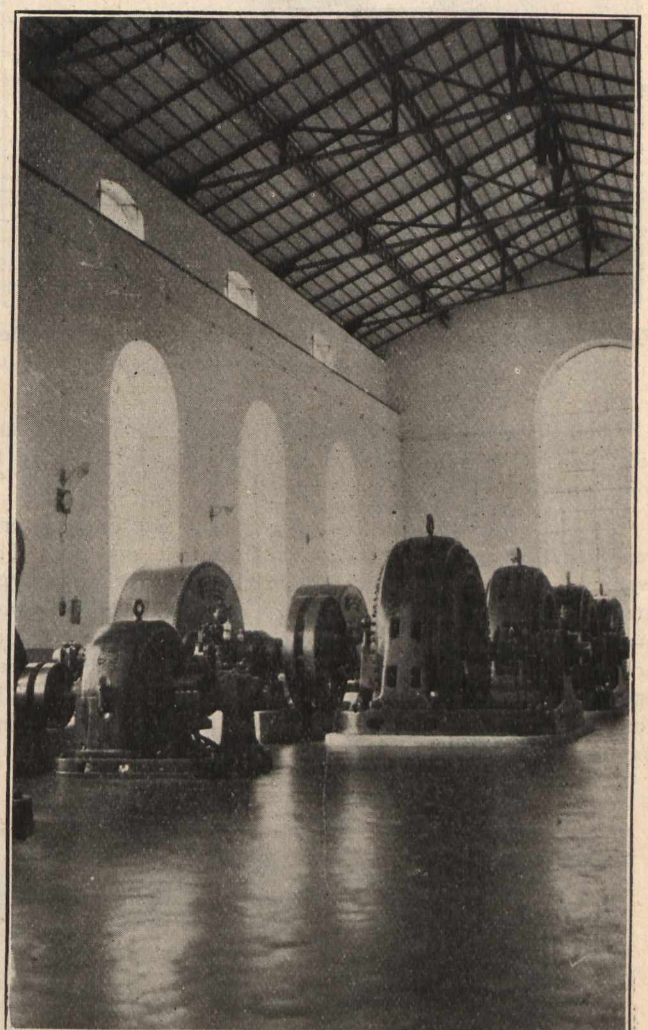


Fig. 7.—Olevano Station: Interior.

The plant is located on the Tusciano River, a mountain torrent in a valley rich with olive and fruit trees. (See Fig. 5.) The water is picked up at a high level, and brought by a small canal and tunnels a distance of about 3 miles to a sand box and forebay on the mountain side above the station. As the ultimate amount of water obtainable is only about 105 cubic feet per second, of which 70 cubic feet is now available, the headworks are of small dimensions. The water carries sand and is highly impregnated with lime, being a milky color, a feature which has given some trouble to wheels under the high head.

The penstock to the generating station is 40-inch minimum interior diameter, and is about 2,000 ft. long. It is carried down the mountain on 65 concrete saddles, and is supported by 17 heavy anchorages at the bends; the lowest portion is at an incline of 60 degrees where it is also supported by special structural steel towers. (See Fig. 6.) The lower end is horizontal, and distributed to 5 power and 2 exciter units; ultimately there will be 8 power units. This pipe is of sufficient size to supply water for all units at a maximum velocity not exceeding 12 ft. per second, and is, of course, provided with a relief valve at the lower end, as well as with a drain valve. The thicknesses of sheets used in this penstock are as follows, heads being figured from forebay:—

200 ft. head	¼"	thick
300 " "	5/16"	"
380 " "	⅜"	"
450 " "	7/16"	"
550 " "	½"	"
750 " "	9/16"	"
860 " "	⅝"	"
960 " "	¾"	"

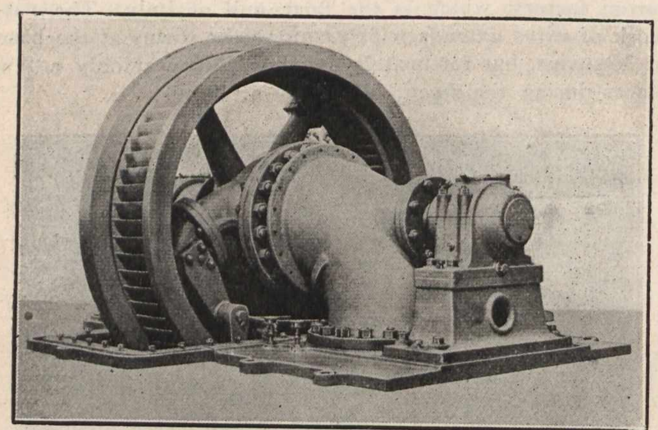


Fig. 8.—Olevano Station, Impulse Wheel, Showing Nozzles. (Case Removed.)

The plate rings are 5'-6" long, and are "inside and outside" lap. The penstock was built in sections about 33 ft. long, and bolted up on the ground.

In the generating station (Fig. 7) the five units at present installed are each of 1,200 H.P. output capacity. The water wheels are of a special horizontal shaft, impulse type, manufactured by Piccard Pictet & Co., Geneva, Switzerland; and are under 960 ft. static, and 930 ft. working head. They are rated nominally at 1,400 H.P., run at 500 R.P.M., and each uses about 14 cubic feet per second of water. The runner, 4'-8" diameter, consists of two heavy cast iron rims, having the steel vanes set between: this is mounted in a

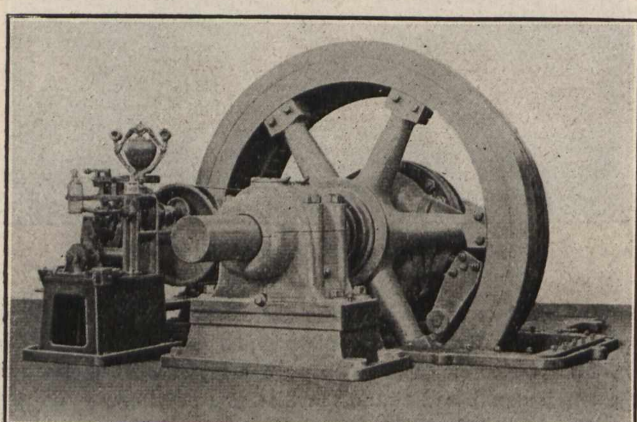


Fig. 9.—Olevano Station: Impulse Wheel With Governor. (Case Removed.)

spider attached to the shaft. The water is introduced through a pair of nozzles at 90 degrees with each other, which are formed in one casting bolted to the end of the supply pipe; the nozzles lie up to the inner periphery of the runner and the latter discharges outwards similarly to the Girard turbine. The discharged water is caught in a tail pit below and the whole (pit and runner) is covered with a casing (see Fig 8), which shows the casing removed. The nozzles are opened and closed by a bronze tongue or throttle deflecting within the opening on a shaft which is linked up to the governor.

In the earliest nozzles on this type of wheel, the manufacturers had formed the whole nozzle head and tongue of bronze, an expensive feature in large units, especially when renewals are frequently required. Later types, however, such as the present, are built merely with bronze lips and tongue; as it is found that these—especially the lips—are cheaply and quickly renewed. The writer saw, and obtained a photograph of the eroded nozzle from one of the wheels in this installation, which had been in use 12 months: it presented a good object lesson of the power of sanded-water under high head. It is to be noted in this respect, that there is comparatively no erosion of the vanes of the runner under these conditions.

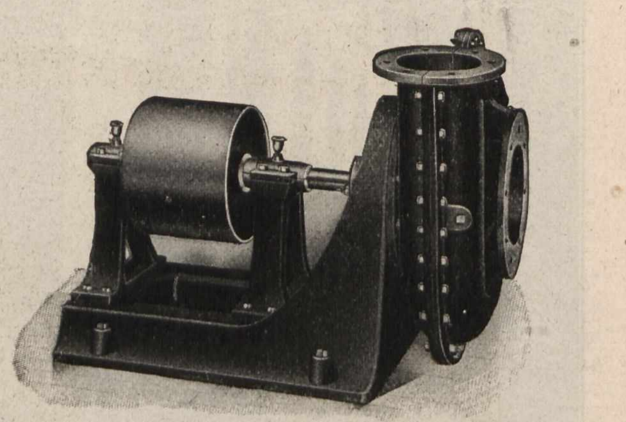
A mechanical governor is attached to each unit in the manner shown in Fig. 9. This has a particular sensitiveness for a simple mechanically geared apparatus, which is probably due to the extreme nicety with which adjustment can be made by means of liquid balancing in the glass jars shown on the rocker arm.

It is stated that in tests on these hydraulic units by the company, the following efficiencies were obtained: At full gate 76 per cent.; at three-quarter gate 73 per cent.; at half gate 68 per cent.; at quarter gate 62 per cent. The generators and electrical apparatus made by Westinghouse present no especially new features beyond the general modern practice of switching and isolation as designed by that house. The generators are three-phase wound to 3,000 V., and static oil-cooled transformers step up to 30,000 V. to the line, consisting of two trunk circuits which are carried on one line of structural steel poles about 180 ft. apart. The wires are 7 MM copper, and are 24 inches apart.

Prices for power in the cities named vary according to amount and distance from generating station. At Salerno, 16 miles distant, 200 H.P. is sold for $25 per H.P. year, on a 24-hour basis; larger blocks of power are sold nearer Naples at $30 per H.P. at 24 hours. There are two consumers near Naples using 800 and 1,000 H.P. each. Coal at Naples is about the same price as at Rome.

A SIDE SUCTION CENTRIFUGAL PUMP.

A side suction centrifugal pump, as built by the Smart-Turner Machine Co., Limited, Hamilton, Ontario, is shown herewith. This pump is so designed that by loosening a few bolts, the pump shell may be revolved on the hood of the frame, which enables the discharge to be taken off at

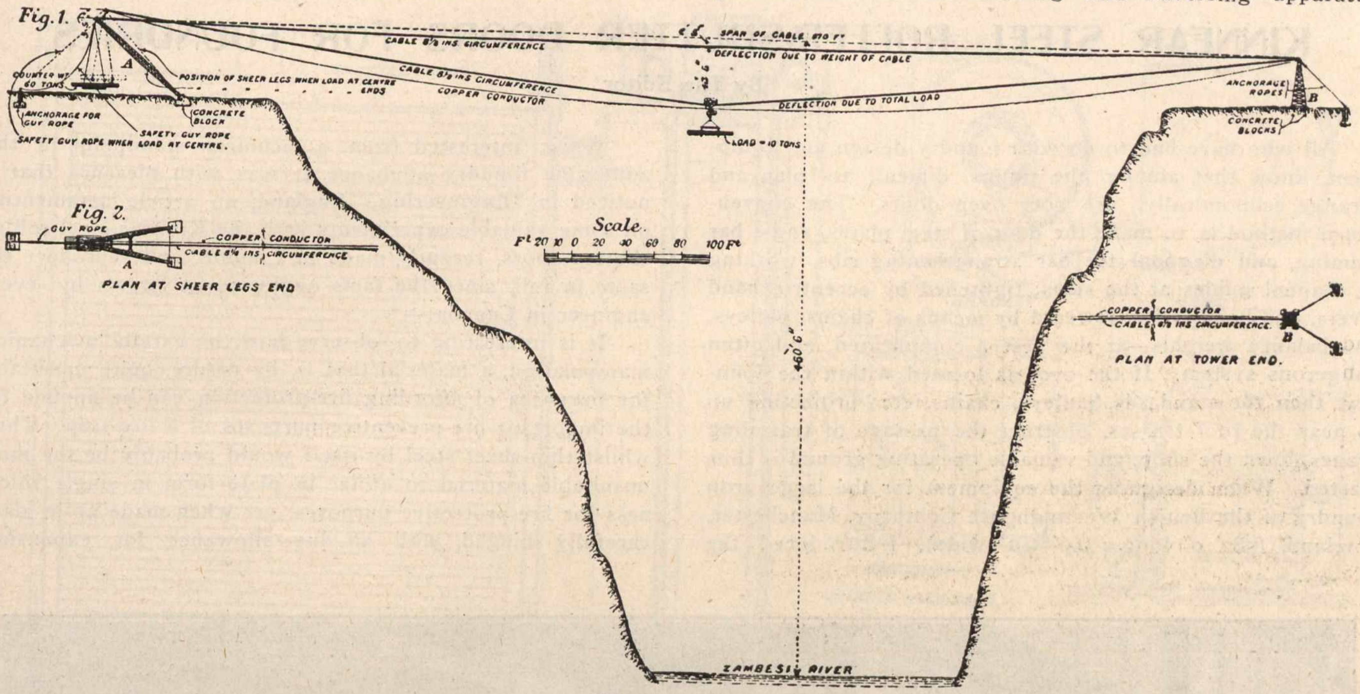


any desired angle. The runner or piston of the pump is of the hollow-arm pattern, which is the design on which the fame of the Heald and Sisco pump is mainly based. The construction is such that there are no dead spaces and the water is not thrashed by the arms, but is forced steadily toward the discharge.

It will stand very much more wear than the ordinary arm piston without allowing the water to slip back into the suction. These pumps are also designed for direct connection either to gasoline engines or electric motor.

ZAMBESI CABLEWAY

In December last we described and graphically illustrated, the now famous steel arch bridge across the Zambesi River at Victoria Falls, South Africa. We now through the courtesy of "Civil Engineering" London, England, have an opportunity of describing the cableway used in the erection of the bridge—an excellent example of how modern science triumphs over great natural obstacles and introduces the latest electrical appliances into regions which, until the advent of the engineer a few years ago, was but "a forest wilderness, with nothing to break the continuous thunder of the mighty water falls but the roar of the tawny lion, scream of the golden eagle, or shot from the gun of the dark-skinned hunter." In Fig 1 is shown a section of the Zambesi gorge, 650'-0" wide, with conveyer in position. The fixed tower is seen on the right hand, firmly secured with concrete blocks, while on the left of the river are the oscillating sheer legs at an angle of 45°, with 40-ton counterweight suspended from the apex, and the steel cable stretched between. This cable is made of the finest plough steel 8⅛" diameter, and having a sag of 43'-6", with a 10-ton load. The electrical conveyer suspended over the middle of the gorge is of the usual type, and fitted with a special self-contained hoisting and traversing apparatus, obviating the necessity of using runway ropes or carriers, the current being conveyed to the motor by a trolley wire running from the generating station on the bank. The complete hoisting and travelling apparatus is suspended from two wheels, which run on the rope. These wheels are of cast steel, with cast iron liners, turned to fit the rope, are easily removable, and do not unduly wear the cable. The difficulty of maintaining a uniform degree of tension on the rope was overcome by Messrs. Scott & Mountain, Limited, Newcastle-on-Tyne. In Fig. 3 is graphically portrayed their method of securing the steel rope at one end, while at the



Figs. 1 and 2.

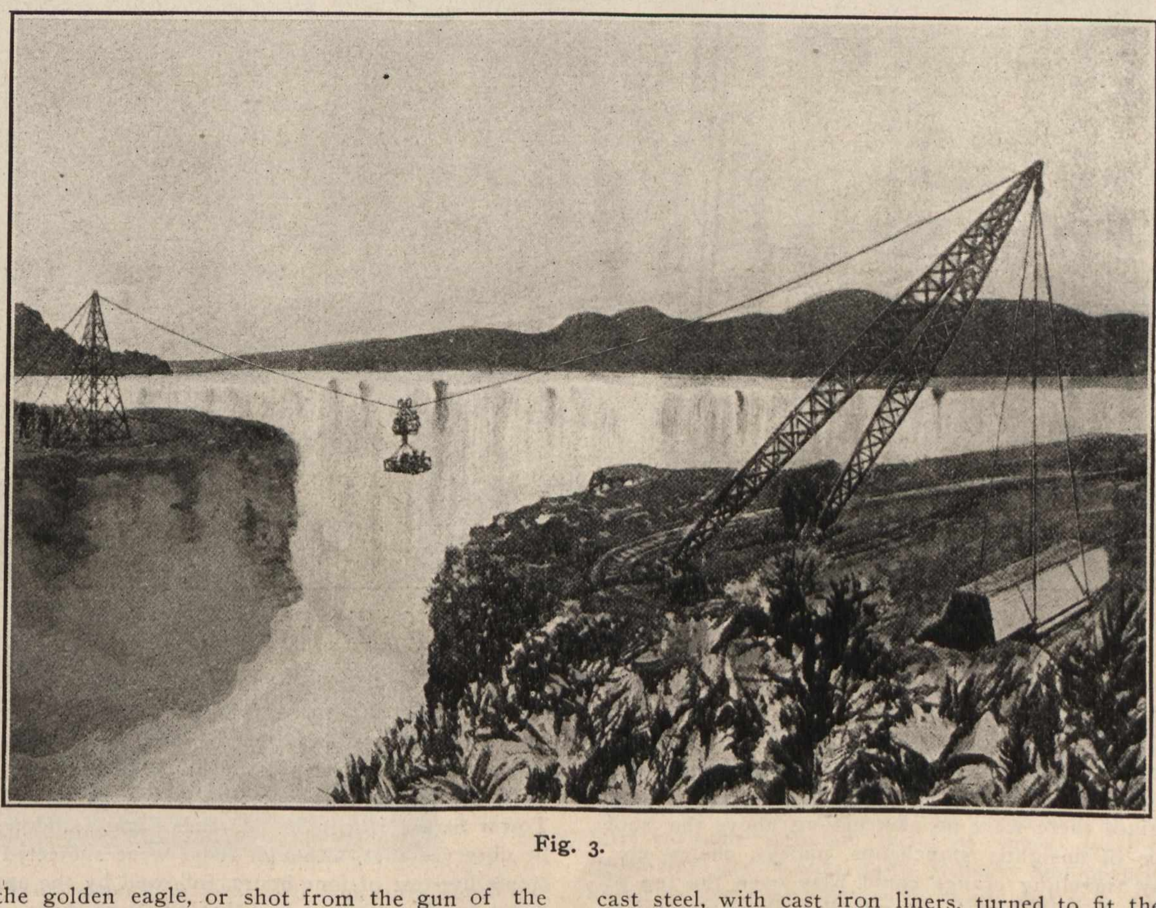


Fig. 3.

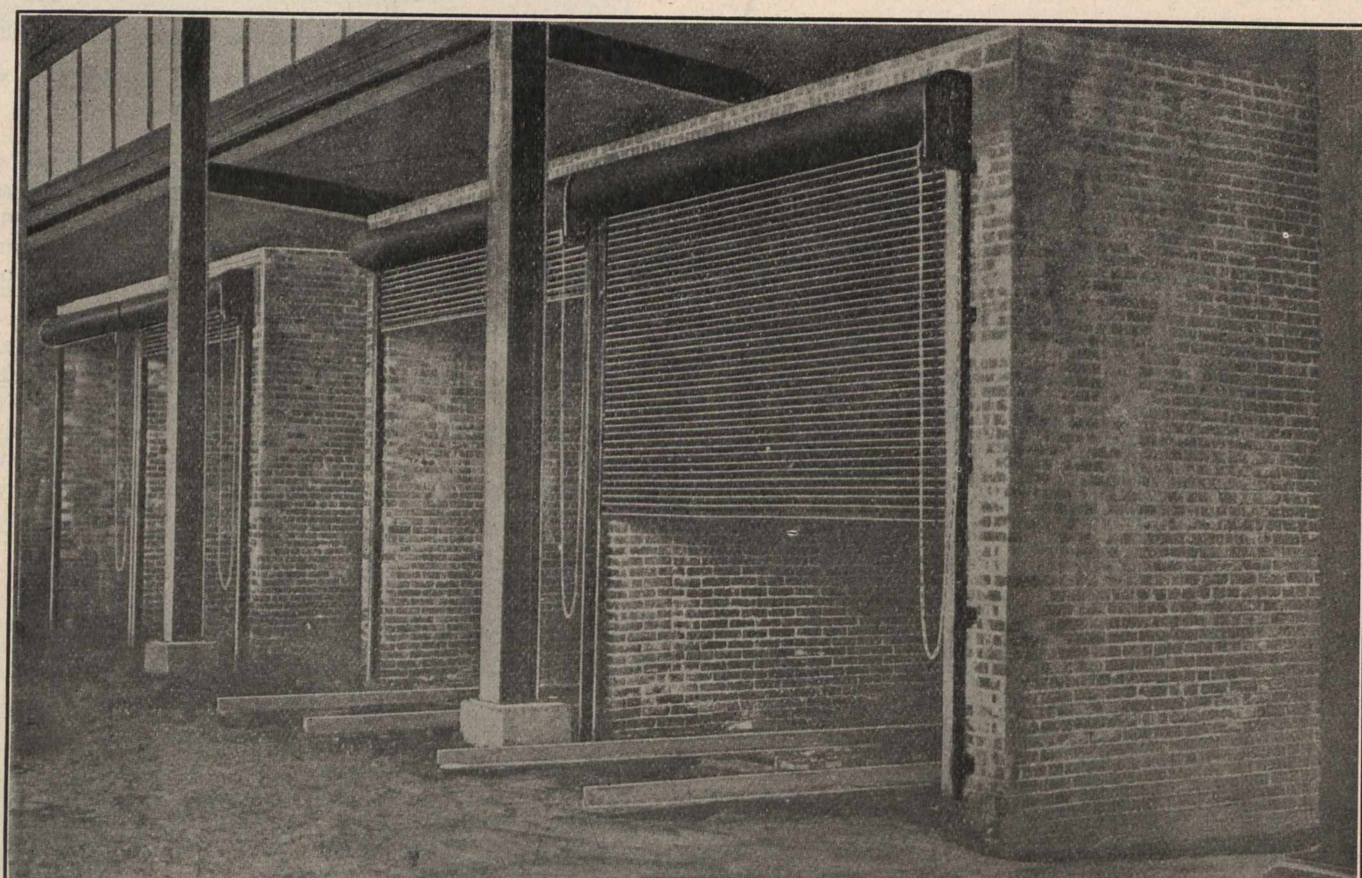
other it is free to adjust itself by means of sheer legs and counterweights.

When it was decided to construct the Cape to Cairo Railway it was found advisable to cross the Zambesi a short distance below the falls, where the river was 650 ft. wide between banks. Under these conditions it was manifestly impossible to erect scaffolding; hence, an arched bridge, built out from either side was designed. The conveyance of erecting material over the gorge was no easy problem in mechanics; but the cableway system of the form indicated above proved a complete success, and is an admirable example of modern British engineering.

KINNEAR STEEL ROLLER-SHUTTER DOORS FOR FOUNDRIES

By The Editor.

All who have had to do with foundry design and equipment, know that among the things difficult to plan and arrange economically, are core oven doors. The conventional method is, to make the door of steel plates, angle bar framing, and diagonal tee bar strengthening ribs, working in channel guides at the sides; tightened by eccentric hand levers, and hoisted and lowered by means of chains, pulleys, and balance weights—at the best a complicated, and often dangerous system. If the oven is located within the foundry, then the standards, pulleys, chains, etc., projecting up to near the roof trusses, obstruct the passage of travelling cranes down the shop, and valuable operating ground is thus wasted. When designing the equipment for the large iron foundry of the British Westinghouse Company, Manchester, England, (580′ 0″ long x 166′ 10″ wide), I introduced the



Core Ovens Provided With Kinnear Steel Rolling Doors On The Fronts.

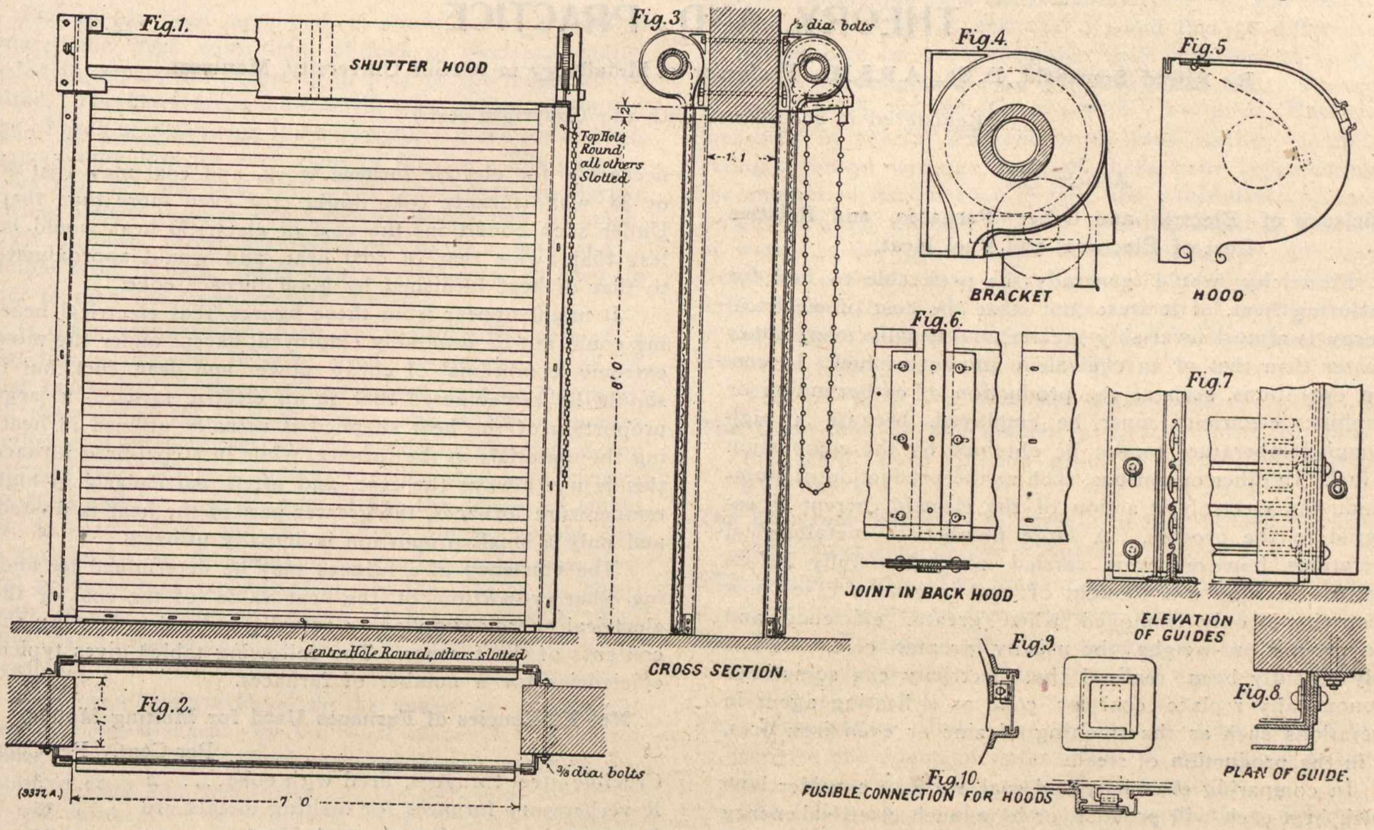
Kinnear steel rolling-shutter doors; backed by evidence of their safety and utility. They were adopted, hence six ovens, two, 10′ 0″; one 16′ 4″; and three, 12′ 6″ wide, respectively, were fitted with steel rolling doors, which proved a complete success; for they were easy to operate, did not warp; and since there were no obstructions above the roof in the shape of unsightly stancheons, pulleys, chains, etc., the side bay travelling cranes could pass over the top of the ovens, from one end of the shop to the other: a manifest economy in time and space. Upon my advice—based upon this English experience—the core ovens in the immense foundries of the Westinghouse Company at Trafford City, near Pittsburgh, were completely equipped with steel rolling doors.

Being interested from a technical standpoint in this admirable foundry appliance, it was with pleasure that I noticed in "Engineering," England, an article commenting on some valuable experiments with the Kinnear steel rolling shutter doors, recently made in London, and reproduce the same in full, since the facts ought to be known by every engineer in Canada:—

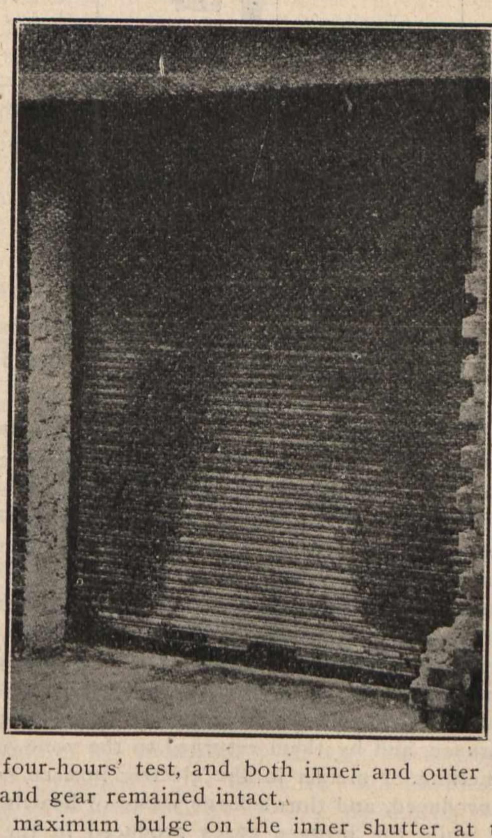
It is interesting to observe how, by careful mechanical manipulation, a material that is, by nature, quite unsuitable for purposes of affording fire-protection can be applied for the important fire-preventive purposes of a fire-stop. Thus, whilst thin-sheet steel by itself would probably be the most unsuitable material to utilize in plate form in single thickness for fire-protective purposes, yet when made up in slats, carefully hinged, with all due allowance for expansion, something remarkably good can be provided.

We publish some illustrations, from the British Fire-Prevention Committee's Report No. III., of a set of two steel roller-shutter doors of the Kinnear type, put forward for test by Messrs. A. L. Gibson & Co., 20 and 21 Tower Street, Upper St. Martin's Lane, London; and it will be observed that, although these were subjected to the extreme fire-test of four hours, followed by the application of water for five minutes, and that although there was, through some untoward occurrence, an interval in the test during which water was applied to the shutter both back and front, these shutters allowed neither fire nor smoke to pass through, and the two shutters at the completion of the test were workable.

The two shutters were placed on the two sides of a 14-inch wall; they were of a roller type, and the roller from which they were hung was protected by a metal encasement of ingenious design, which prevented the fire from lapping over the top of the shutter The whole of the riveting was in slots, so as to allow for expansion. Altogether the shutters were extremely well thought out, with the object of affording fire-resistance.



The summary of the report on the set of two doors shows that it was only after two hours of intense heat that a newspaper, 12 inches away from the outer door, commenced to scorch, and that it was not until two hours forty-five minutes that this paper became alight. No flame passed through or around the outer shutter or over the hood dur-



ing the four-hours' test, and both inner and outer shutters, frames, and gear remained intact.

The maximum bulge on the inner shutter at the conclusion of the test did not exceed 1½ inches, which is, of course trivial; and the outer shutter remained in its alignment. Both the shutters, the report says, could be easily worked and raised at the conclusion of the test.

In a preliminary note, the directing member, Mr. J. Herbert Dyer, vice-president of the National Fire Brigades' Union, points out that these shutters are intended for vertical openings where iron doors would be heavy and cumbersome, and it is only too well-known how these heavy and cumbersome doors are wedged back and kept open all the year round, instead of being put into daily and nightly use. They are generally in the way where they are hinged or sliding; a roller-shutter, on the other hand, is stowed away in its encasing over the opening, and does not interfere with the wall space on either side.

A further test was conducted by the Committee with an almost identical single door, with the exception that the gear for raising and lowering it was of an automatic description. This single door withstood the fire and water test for 2½ hours, and the report shows that even with this single door no flame passed through or around this single shutter or over its hood during the 2½ hours of the test. The shutter and frame remained intact, and the maximum bulge was 1½ inches towards the fire side. Regardless of the fact that this door was worked on the automatic or spring principle, it could still be lifted 4' 6" high at the conclusion of the test. As in the case of the double-door test, there had been an interruption, and water had been applied on both sides approximately at half-time. It will thus be seen that even in a single form a very considerable fire resistance is afforded, and, as in the double shutters, this is, of course, entirely due to the ingenious provision to meet expansion.

These fire tests were conducted on the Committee's usual lines for classification purposes, and the sub-committee in charge comprised, besides the directing member named above, Messrs. Percy Collins (insurance expert), E. J. A. Fulkes (Royal Insurance Company), M. Garbutt (architect, Metropolitan Railway), Chas. E. Goad (Am. Soc. C.E.), Wm. Grellier (district surveyor), Ellis Marsland (district surveyor), and James Sheppard (North British and Mercantile Insurance Company).

Having regard to the very considerable number of tests with the different forms of wood doors of various thicknesses and makes, both ordinary and proprietary, followed by tests with armoured doors and iron doors, these additional tests with roller shutters of the Kinnear type should be of considerable value at a time when surveyors and insurance men are beginning to realize that the vertical hazard from fire is quite as important as the horizontal hazard, and that window and door openings require most systematic and careful protection from spread of fire.

Apart from the uses of such doors in ordinary party walls and window openings, it struck us that they should find application in the separation of some of the large risks associated with new motor industries—namely, those of the motor garage. These garages, with their large cubic extent, should be well sub-divided if the fire hazard is to be limited; and shutters of this description are probably what would be very serviceable.

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 III.

Efficiency of Electric and Other Furnaces, and Relative Cost of Electrical and Fuel Heat.

Electricity would generally be preferable to fuel for producing heat, if it were not that the cost of electrical energy is almost invariably greater, and usually many times greater than that of an equivalent amount of fuel. In certain operations, such as the production of carborundum or graphite, electricity must be employed, because a high enough temperature cannot be obtained by the combustion of fuel. In other operations, such as the production of aluminium, the electrolytic action of the electric current is essential to the process. A large number of metallurgical operations, however, were carried on successfully before electric smelting was thought of; and in certain cases now electricity is only employed when greater efficiency and convenience out-weighs the usually greater cost. It has only recently been realized that electricity can sometimes economically replace coal or coke as a heating agent in operations such as the smelting of zinc or even iron ores, or in the production of steel.

In comparing electricity and coal, we may consider how much heat each will produce, or how much electrical energy will be needed to produce as much as one pound of coal would yield on burning. One unit or kilowatt hour of electrical energy will produce 3,407 B. T. U. (British Thermal Units), and one pound of good quality coal will produce about 14,000 B. T. U. Thus four kilowatt hours are needed to produce as much heat as one pound of coal.

For small consumers, buying electrical energy for lighting at 10 cents a unit, and coal at $6 or $7 a ton, the cost of electrical heat would be more than one hundred times that of coal heat.

As a year consists of 8,766 hours, one kilowatt would yield, if operated continuously for that time, nearly 30,000,000 B. T. U., or one electrical H.P. year would yield 22,270,000 B.T.U.; and as 2,000 pounds of coal will produce about 28,000,0000 B.T.U., it will be seen that an electrical H.P. year produces about 20 per cent. less heat than a short ton of good coal; or one ton of coal would produce as much heat as 1¼ E.H.P. years. If an electrical H.P. year could be purchased for $30 and a ton of coal for $3.75, the cost of electrical heat, per B.T.U. would be exactly ten times the cost of coal heat.

In localities where water-power can be cheaply developed, and where transportation charges for coal and coke are high, it may be possible to produce electrical power at $10 or less per E.H.P. year in large amounts, as would be necessary for electric furnace work, and coal may cost $6 or $8, while furnace coke might cost even more than that. Under such conditions the cost of electrical heat would be less than twice that of coal heat, and would approximate to that of heat furnished by good furnace coke.

It might appear from these figures, that electrical heating could not be profitably employed, except under the most extreme conditions of cheap power and dear fuel, but it should be remembered that in an electric furnace, a large proportion of the heat supplied is actually utilized in heating the materials in the furnace, while in a coal-fired furnace this is not always the case, and often, particularly in high temperature furnaces, the greater part of the heat is wasted, and only a small proportion is actually utilized.

The **efficiency** of a furnace may be determined by finding what proportion of the heat value of the coal or the electrical energy supplied, is actually utilized in heating the contents of the furnace. The following table* gives typical efficiencies for a number of furnaces.

Net Efficiencies of Furnaces Used for Melting Metals.

	Per Cent.	Per Cent.
Crucible steel furnaces, fired with coke....	2	3
Reverberatory furnaces for melting metals	10	15
Regenerative open-hearth steel furnaces..	20	30
Shaft furnaces (foundry cupolas, etc.)....	30	50
Large electrical furnaces	60	85

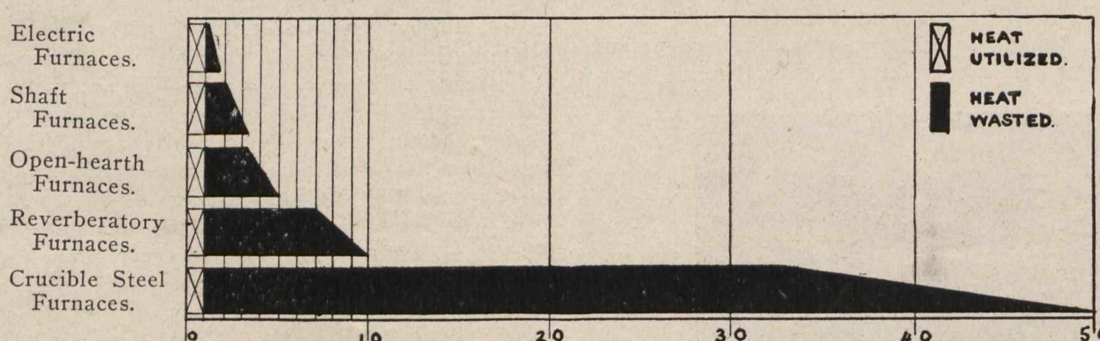


Diagram Showing Losses of Heat in Melting Metals.

These efficiencies relate to the melting of metals, but similar figures would be obtained for the same furnaces employed in smelting ores. In the crucible steel furnace and the reverberatory furnace, the greater part of the heat is carried away in the escaping gases, which are necessarily extremely hot, and in the crucible furnace the loss is additionally high on account of the slow transmission of the heat to the steel inside the crucible. In the open-hearth furnace, the loss of heat due to the escaping gases is very much less because the heat they contain is given to the brick-work in the regenerators or checker chambers, and returned from these to the furnace by the incoming gas and air. In shaft furnaces the heat of the furnace gases is largely absorbed by the solid materials in the upper part of the furnace, and by them returned to the zone of fusion. In the melting of metals in the electric furnace, no gases need be produced, and thus a large waste of heat is entirely avoided; while the furnace gases produced in the electric smelting of ores are very much less in amount than those

*The figures are taken from Prof. J. W. Richards' "Metallurgical Calculations," Part 1, p. 89.

from similar coal or gas fired furnaces. The amount of air that passes through most furnaces, in excess of that required to burn the fuel, increases the loss of heat by the furnace gases; and the incomplete combustion of the fuel is another serious source of loss in some furnaces. The large loss of heat by conduction and radiation from the furnace, is common to fuel and electric furnaces, and depends mainly upon the size and temperature of the furnace; the larger furnaces having, of course, a smaller relative loss.

Fig. 20 has been arranged to show, for each class of furnace, the heat equivalent of fuel or electrical energy needed to impart unit quantity of heat to the metal to be melted. The black areas indicate the loss of heat, the upper edge of each area showing the minimum, and the lower edge, the maximum loss for each class of furnace. The diagram shows that for **one** heat equivalent supplied to an electric furnace; a shaft furnace would require nearly **two**; an open-hearth furnace **three,** reverberatory furnace **six**; and a crucible steel furnace **thirty** heat equivalents of fuel, in order to melt the same amount of metal.

If these numbers are used to multiply the cost of a short ton of the coal or coke used, assuming it to be of about 14,000 B.T.U., the resulting prices may be compared with the cost of 1¼ E.H.P. years, and will give an idea whether coal or electrical heating would be cheaper in any particular case. Thus in making crucible steel with furnace coke at $5 and the E.H.P. year at $30, the coke used would cost $5 × 30 = $150, and the electrical energy would cost $30 × 1¼ = $37.50; thus making a good case for the electrical production of crucible steel. In the case of the open-hearth furnace, electrical energy at $10 an E.H.P. year would cost a little more than coal at $4 a ton, while it would correspond with coke at $6 to $7 a ton in a shaft furnace.

These numbers are based on the **mean** of the figures given by Prof. Richards for the usual efficiencies of certain classes of furnaces; and in any selected case it would be desirable to have the efficiencies of the particular electrical and fuel furnaces to be compared. The incidental expenses connected with each method of smelting should also be considered.

The results do, nevertheless, give a fair idea of the conditions under which electrical heat could commercially replace fuel heat. They show clearly, that in the production of crucible steel, electrical power should be able to replace coke as a source of heat. The writer pointed out, more than two years ago,† that the production of crucible steel in the electric furnace was technically and financially possible, and plants are now being started in Syracuse, N.Y., Sheffield, England, and elsewhere.

Having now considered, in a general manner, the efficiency of furnaces and the relative costs of electrical and fuel heating, the method of calculating these efficiencies may be discussed.

The Calculation of Furnace Efficiencies.*

The word **heat** is used popularly in two senses: thus "the **heat** of a furnace," meaning how hot the furnace is, is quite distinct from the **amount of heat** produced in the furnace per minute, or the **amount of heat** needed to turn a pound of ice into a pound of water. The first use is really a **quality** of the hot body, and to avoid confusion the word **temperature** should be used in such cases, while the word **heat** should be restricted to the second case, in which the **quantity** of heat is referred to. A definite quantity of heat can be supplied at a high or a low temperature, just as a definite quantity of air can be supplied at a high or a low pressure; and the addition of heat to a body raises the temperature, just in the same way that pumping air into a receiver raises the pressure.

Temperatures are measured, as is well known, by thermometers or pyrometers (the latter for high temperatures), and the scales of these instruments are based upon the temperatures of melting ice and boiling water, these being 0° and 100° on the Centigrade scale, and 32° and 212° on the Fahrenheit scale. The use of these two scales complicates technical literature, since the Centigrade is mainly used for scientific purposes, while the Fahrenheit is mainly used for ordinary affairs, and it is often necessary to state temperatures on both scales in order to be generally understood. The conversion from one scale to the other is simple if it is remembered that the temperatures 0° C. and 100° C. are the same as 32° F. and 212° F., and that 5° difference of temperature on the Centigrade scale correspond to 9° difference of temperature on the Fahrenheit scale: whence F.° = 1.8 C.° + 32; and C.° = 5/9 (F.° — 32). **Heat** is measured in several different units, thus further complicating technical writings, most of these units representing the amount of heat needed to raise the temperature of unit weight of water through 1°. By selecting different weights of water, as the pound, gram, or kilogram, and different temperature scales, it is easy to get six or eight different units of heat, thus entailing a large amount of trouble, both in the statement of amounts of heat and in changing these from one system of units to another.

The following heat units are usually used:

The Gram-calorie.—The amount of heat needed to raise the temperature of one gram of water 1° C. (from 0° C. to 1° C.)

The Kilogram-calorie.—The amount of heat needed to raise the temperature of one kilogram of water 1° C.

The Pound-calorie.—The amount of heat needed to raise the temperature of one pound of water 1° C.

The British Thermal Unit.—The amount of heat needed to raise the temperature of one pound of water 1° F. (from 60° F. to 61° F.)

The Evaporative Unit.—The amount of heat needed to convert one pound of water at 212° F. into steam at the same temperature (at atmospheric pressure).

The following are the relations between these different units:

1 Kilogram-calorie	=	1,000 Gram-calories.
1 Pound-calorie	=	453.6 Gram-calories.
1. British Thermal Unit	=	5/9 of a Pound-calorie.
1 " " "	=	252 Gram-calories.
1 Evaporative Unit	=	967 British Thermal Units.

The gram and kilogram-calories are the most convenient for scientific investigations, but in cases where the weights are given in pounds the pound-calorie or the B.T.U. must usually be employed.

The efficiency of a furnace is the ratio between the amount of heat usefully employed in the furnace and the heat value of the fuel or electrical energy supplied: thus, if 100 pounds of steel can be melted in a crucible furnace by the use of 150 pounds of coke, and if 300 pound-calories are needed to melt one pound of steel (this having been determined by experiment). and if one pound of coke can furnish 7,200 pound-calories (found by experiment), the efficiency of the furnace can at once be obtained:

$$\text{Efficiency} = \frac{\text{Weight of steel} \times \text{heat needed to melt 1 lb. steel.}}{\text{Weight of coke} \times \text{heat furnished by 1 lb. coke.}}$$

Or,

$$\text{Efficiency} = \frac{\text{100 lbs.} \times \text{300 calories.}}{\text{150 lbs.} \times \text{7,200 calories.}} = 0.028 = 2.8\%.$$

The statement that 300 pound-calories are needed to melt one pound of steel, means, that if to one pound of cold steel there could be added 300 pound-calories of heat, without any of the heat being lost, the steel would be heated to its melting point and melted. It is, of course, impossible to do this, but by pouring some molten steel into a vessel of water, and noting the rise of temperature of the water, the the number of calories given out by the steel in cooling can be determined, and this is obviously the same as the amount of heat needed to melt the steel. The number of calories

*For a full account, with examples, of the calculation of furnace efficiencies see Prof. J. W. Richards' "Metallurgical Calculations," Part I.

†The Electro-thermic Production of Iron and Steel, Trans. Can. Soc. Civil Engineers, Vol. XVIII, Part I, 1901, p. 72.

being equal to the product of the weight of water and its rise of temperature, corrections being made for the heat absorbed by the vessel and otherwise lost during the experiment.

The amount of heat needed to melt one pound of each of the common metals, and the temperature at which they melt, are given in the following table; the figures have all been obtained by experiment, with the exception of the heat of fusion of wrought iron, which has been calculated:

Table I.

Melting Temperatures and Heats of Melted Metals.

Metal.	Melting Temperature. C.	F.	Heat to melt 1 lb. Lb. cals.	B.T.U.
Lead	326°	618°	16	28
Zinc	419°	786°	68	122
Aluminium	654°	1209°	258	465
Brass (65% copper)	920°	1688°	130	234
Copper	1083°	1981°	162	292
Cast iron: White	1027°-1135°	1880°-2075°	245	441
Cast iron: Gray	1100°-1275°	2012°-2327°		
Tool steel (1% carbon)	1425°	2600°	300	540
Iron (Wrought iron or dead, soft steel)	1505°	2740°	343	617

Note.—The figures in the last two columns really represent the amount of heat given out by one pound of the metal in cooling from the molten state to 32° F. In heating the metal from 60° or 70° F. rather less heat will be needed, but, on the other hand, some additional heat will be required in order that the metal shall be thoroughly melted, and the heat actually needed to heat the metal to a casting temperature will be a little more than the figures in the table.

The amount of heat that can be produced from one pound of coke, can be determined by burning a small weighed quantity of the coke in a calorimeter; which is an instrument for measuring the amount of heat that is produced. The amount of heat produced by unit weight of a fuel, is known as its calorific power, and is usually measured in the corresponding heat units; that is, heat units containing the same unit of weight; as, for example, the number of gram-calories produced by one gram of fuel; the number of pound calories produced by one pound of fuel, or the number of B.T.U. produced by one pound of fuel. The first two of these results will obviously be identical, and may be called the Centigrade calorific power, while the last result will be 9/5 times as large, and may be called the Fahrenheit calorific power. Thus the calorific power of carbon is 8,100 on the Centigrade scale, and 14,580 on the Fahrenheit scale, meaning that one part by weight of carbon would give out as much heat, if completely burnt, as would raise the temperature of 8,100 parts of water 1° C., or 14,580 parts of water 1° F., so the result is the same, whatever unit of weight is selected. When, however, the fuel is measured by volume, as in the case of a gas, it will be necessary to state the calorific power as so many B.T.U. per cubic foot, or calories per cubic foot, or per cubic meter. Calorific powers are also sometimes stated in evaporative units, thus avoiding the use of either scale of temperature.

In many furnaces the carbon in the fuel is not burnt completely, and its effective calorific power is then less. The complete combustion of carbon produces the gas CO_2, containing two atoms of oxygen, while its incomplete combustion produces the gas CO, containing only one atom of carbon. The calorific power in the latter case being only 2,430 C. or 4,374 F., which is less than one-third of its calorific power when burnt completely. The iron blast furnace furnishes a good example of this loss of heat through the imperfect combustion of the coke: In order to thoroughly reduce the iron ore to metal a large amount of coke must be present in the furnace, and this can only be burnt to CO in the lower part of the furnace, thus obtaining far less heat from the same weight of coke than if it could be burnt completely to CO_2. The CO produced in the lower part of the furnace is, however, partly utilized, higher up, for the reduction of the iron ore, and the CO that finally escapes from the furnace is employed as a fuel for heating the blast and for raising steam.

In determining the calorific power of a fuel in a calorimeter, any aqueous vapour resulting from the burning of any hydrogen in the fuel, and any moisture in the fuel, will be condensed to water; and its latent heat of condensation will be included in the resulting calorific power. When the fuel is burnt in any metallurgical furnace, the furnace gases escape at too high a temperature to allow of the condensation of the vapour, and in calculating furnace efficiencies a calorific power should be used which does not include the heat of condensation of the water vapour, since this heat can never be obtained in the furnace. The observed calorific power should, therefore, be corrected by subtracting from it the heat of condensation of all the water vapour that is present in the fuel, or is produced by its combustion. The corrected value has been called the Metallurgical or Practical Calorific Power,‡ and should be used in the case of all furnaces from which the water, contained in the furnace gases, escapes in the form of vapour.

The following table contains the Metallurgical Calorific Powers of some of the commoner fuels, and some pure substances. The calorific powers of fuels cannot, however, be stated exactly, as they vary considerably.

Table II.

Calorific Powers.

(All water remaining uncondensed.)

		C. lb. Calories.	F. B. T. U.
Carbon (burnt to CO_2)	per lb.	8,100	14,580
" " " CO	"	2,430	4,374
Carbon monoxide	"	2,430	4,374
" "	per cu. ft.	191	344
Hydrogen	per lb.	29,030	52,254
"	per cu. ft.	163	293.5
Methane (Marsh gas, CH_4)	" "	537	966
Ethylene (Olefiant gas, C_2H_4)	" "	904	1,627
Wood (air dried)	per lb.	about 3,000	about 5,400
Peat	" "	3,000-4,000	5,400- 7,200
Charcoal (5 to 10 per cent. moisture)	per lb.	7,000-7,500	12,500-13,500
Oven coke	" "	6,900-7,400	12,400-13,300
Anthracite	" "	6,500-7,500	11,500-13,500
Bituminous coal	" "	7,000-8,000	12,500-14,500
Fuel oil	" "	9,500-11,000	17,000-20,000
Natural gas	per cu. ft.	460- 540	830- 970
Coal gas	" "	300- 360	550- 650
Water gas	" "	140- 180	250- 320
Producer gas	" "	55- 90	100- 160
Electrical energy, per kilowatt hour		1,893	3,407
Electrical energy, per E.H.P. hour		1,412	2,542
Electrical energy, per E.H.P. year of 8,766 hours		12,380,000	22,280,000

Note.—The figures in this table are, in many cases, lower than the calorific powers obtained experimentally in a calorimeter, the difference being the correction of 606.5 pound-calories per pound of water in the products of combustion; this amount of heat being needed to evaporate a pound of water at O° C. In calculating furnace efficiencies by means of this table, the furnace will thus be debited with the sensible heat carried by the water vapour as well as with that carried by the other furnace gases, but the heat of condensation of the water vapour will have been removed from the balance sheet.

‡Prof. J. W. Richards loc cit.

The calorific powers of the pure substances, forming the first part of the table, are those adopted by Prof. Richards; they will serve as data for calculating the calorific power of a gaseous fuel of known composition, and will enable approximate figures to be obtained for solid and liquid fuels. The coal and other solid fuels in the lower part of the table are supposed to be in the condition in which they would naturally occur: the wood being air dried, and containing some 20 to 25 per cent. of moisture, the peat also air dried and retaining 20 to 30 per cent. of moisture; the charcoal coke and coal have the usual amounts of ash and moisture. The figures given for coal and other fuels will not cover all cases, but are intended to represent the ordinary run of fuels. The calorific powers of gases, per cubic foot, correspond to dry gas at 32° F., and would be about 5 per cent. less at 60° F., and 7 per cent. less at 70° F. on account of the increase in volume of the gas: the presence of moisture would still further decrease the calorific power.

By the aid of Tables I. and II. it will be easy to obtain, approximately, the percentage efficiency of any furnace, whether fired by solid, liquid, or gaseous fuel, or heated electrically—if it is employed for heating and melting metals; and if the amount of fuel or electrical energy corresponding to the melting of a certain weight of metal is known. It will not be possible, however, to calculate in the same manner the efficiency of a furnace, such as an open-hearth steel furnace, in which the metal is kept molten for some hours in order to allow of certain changes being made in its composition. In such a furnace the efficiency can only be calculated in reference to the time during which the charge was being heated. During the remainder of the "heat" the furnace may remain for considerable periods without any marked rise of temperature, although fuel is constantly being used; thus making the calculated efficiency zero during such periods.

The efficiencies of metal-melting furnaces were first considered on account of the simplicity of the calculation. But it is equally possible to calculate the efficiency of a blast furnace, or an electrical ore-smelting furnace, in which the heat is used, not merely in melting a metal, but also in effecting the chemical work of reducing the ore to a metallic condition. The heat necessary to the formation of a large number of chemical compounds are known, and by means of these, it is possible to draw up a balance sheet, showing what amount of heat is needed for the chemical reactions, as well as for melting the metal and slag in the furnace. The efficiency can then be calculated as in the simpler cases.

It may be of interest, and practical value, to conclude this article by calculating the efficiency of a **Heroult electrical steel furnace,** operated at La Praz, France, for the Haanel commission in March, 1904.† The furnace—basic lined, was making steel by melting scrap with ore and lime.

The charge selected for calculation (number 660) consisted of:—

	Lbs.
Steel scrap	5,733
Iron ore	430
Lime	346

Other additions were made after the charge was melted, but for obtaining the melting efficiency it will only be necessary to consider the operation of melting this charge in the furnace.

The scrap charged had the following composition:—

Carbon	0.110
Silicon	0.152
Sulphur	0.055
Phosphorus	0.220
Manganese	0.130
Arsenic	0.089

Supposing that the iron ore in the charge contained 400 pounds of ferric oxide, it may be assumed, that during the melting of the charge, this was reduced to ferrous oxide by the oxidation of most of the metalloids and some of the iron in the original scrap. A rough calculation shows that the melted charge would consist of about 5,660 pounds of dead, soft steel, and 850 pounds of slag rich in ferrous oxide and lime, and that the reaction would produce some 24,000 pound-calories, which makes a small addition to the heat furnished by the electric current.

Assuming that a temperature of 1,520° C. is necessary for a complete fusion of the charge (see Table I.), about 344 calories will be needed to melt each pound of soft steel, or, in all, $344 \times 5{,}660 = 1{,}947{,}000$ lb. cals.

The slag will need about 600 calories per pound in order to melt and heat it to the same temperature, or, in all, $600 \times 850 = 510{,}000$ lb. cals.

The electrical power employed was 215 kilowatts during the first hour, and 342 during the remainder of the run; the current being supplied at about 110 volts. The time occupied in melting the charge was 5 1-3 hours, and the electrical energy supplied to the furnace during this time was 1,680 kilowatt hours.

The heat supplied by the electric current was:—

$1{,}680 \times 1{,}893 = 3{,}180{,}000$ lb. cals. (See Table II.)

In the operation of melting the charge the heat utilized may be taken as that needed to melt the steel and the slag, while the heat supplied to the furnace is supplied in part by the electric current, and in part by the reaction between the scrap and the iron ore.

Balance Sheet of Heat.

	Lb. cals.
Heat supplied to the furnace:	
1,680 kilowatt hours of electrical energy	3,180,000
Reaction between steel scrap and iron ore	24,000
Total	3,204,000
Heat utilized in the furnace:—	
To melt 5,660 lbs. of soft steel	1,947,000
To melt 850 lbs. of basic slag	510,000
Total	2,457,000

$$\text{Efficiency of furnace} = \frac{2{,}457{,}000}{3{,}204{,}000} = 0.767 = 76.7\%.$$

Note.—In making this calculation it has been assumed that no oxidation of the steel scrap took place except by reaction with the iron ore in the charge. Such an assumption would be quite wrong in regard to an open-hearth furnace, where the flame of burning gases constantly plays over the charge, but in the electric furnace the charge is largely protected from the air, and there is consequently less oxidation. If any considerable amount of iron were burnt in this way, its heat oxidation should have been added, in the balance sheet, to the heat supplied to the furnace; and this would lower the resulting figure for the efficiency.

After the charge was completely melted, the slag was poured off, and the steel further purified by the addition of fresh slags, made of lime, sand and fluor spar. After these were removed, the steel was recarburized in the furnace by additions of "carburite" (a mixture of iron and carbon) and ferro-silicon; some ferro-manganese was also added, and a little aluminium in the ladle.

The yield of ingots was 5,161 lbs. of tool steel of the following composition:—

Carbon	1.016
Silicon	0.103
Sulphur	0.020
Phosphorus	0.009
Manganese	0.150
Arsenic	0.060

Three hours were required for the purification and carburization of the steel, making a total of 8⅓ hours, and a total consumption of 2,580 kilowatt hours, or 0.153 E.H.P., years per 2,000 lbs. of steel ingots. At $10 per E.H.P. year, the cost of electrical energy for the ton of tool steel would be $1.53.

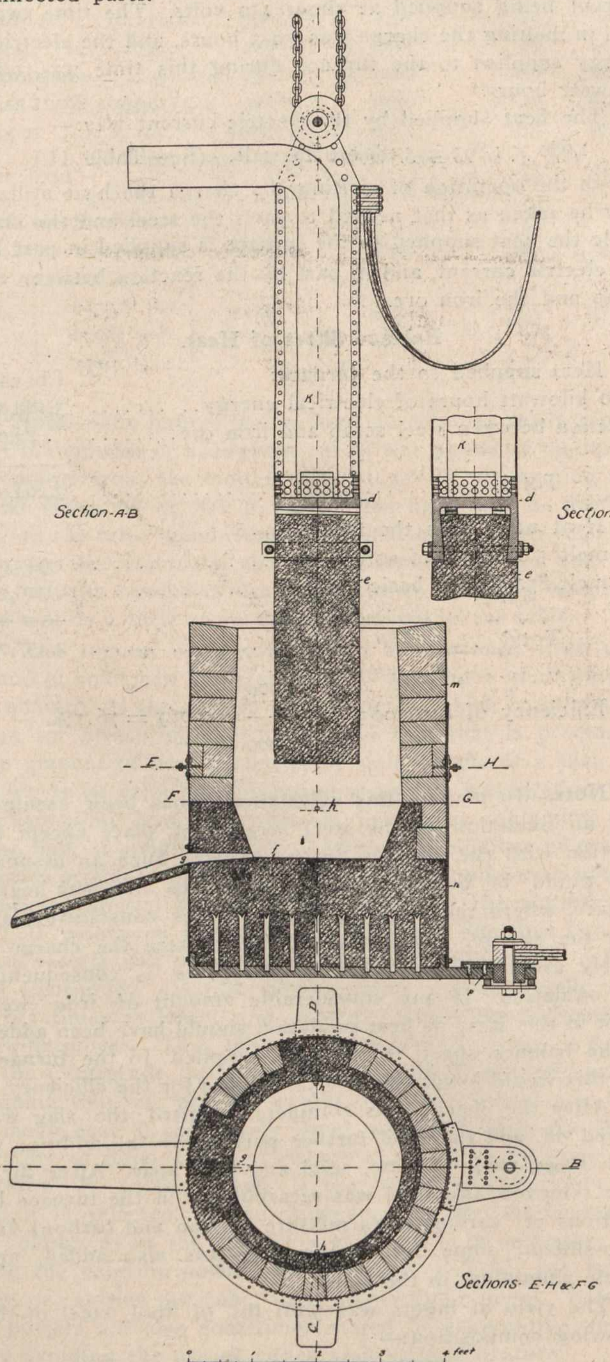
†Report of the Commission appointed to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel in Europe.

EXPERIMENTAL ELECTRIC FURNACE

(Resistance Type.)

As used in the Dominion Government experiments in the smelting of iron ores at Sault Ste. Marie by the electro-thermic process.

In our June issue we published **exclusively** the governmental official report, giving data in complete detail of the above-mentioned experiments, but without illustrations. Since then we find ourselves further indebted to Dr. Haanel for a sectional drawing of the electric furnace in which the highly refractory Canadian ores were successfully smelted into fifty-five tons of commercial pig iron, and now have pleasure in reproducing the same for the first time, together with his lucid description of its general construction and connected parts.



The furnace was designed by Dr. P. Heroult, and 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 induction 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" x 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 arrangement for regulating the electrode by hand.

Electrical Machinery.

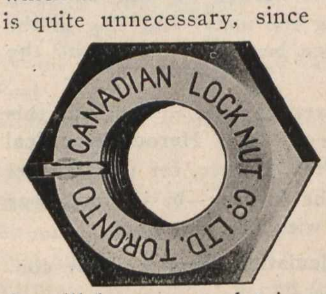
The electrical energy was furnished by one phase of a three-phase, 400 k.w., 30 cycle, 2,400 volt, alternating current generator, coupled by belt to a 300 H.P., 500 volt, direct current motor. A current of 2,200 volts was delivered to an oil-cooled transformer of 225 k.w. capacity, designed to furnish 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 thirty aluminium cables, ⅝" in diameter.

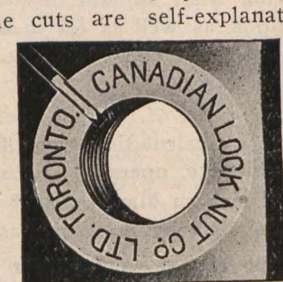
The measuring instruments consisted of a voltmeter, an ammeter, a power factor meter, and a recording watt meter. The transformer and electric meters were manufactured by the Westinghouse Electric and Manufacturing Company.

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.

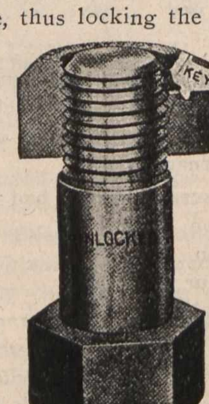
THE BURROWS PATENT LOCK NUT.

Lock nuts in galore have been invented, patented, and placed on the market, only to be scrapped after a short existence. This month we came across the one illustrated, which we believe has special merits. A lengthy description is quite unnecessary, since the cuts are self-explanatory.





As will be seen, a slot is cut in the nut and a small, hardened key inserted. As the key swings on a central pivot, a light blow on the side next the bolt with a small punch drives it into the thread of same, thus locking the nut. To



loosen the lock, it is only necessary to tap the key on the opposite end. This device is very simple, but from inspection of bolts which we saw it is qute effective in its works, and can be used many times without destruction to either nut or bolt.

VERTICAL COMPOUND GOLDIE-CORLISS ENGINE

21" AND 42" x 30"; SPEED, 150 R.P.M., DIRECT CONNECTED TO 600 K.W., 60 CYCLE, ALTERNATING CURRENT GENERATORS.

In the struggle for supremacy between reciprocating and turbine steam engines on the one hand and gas, oil and gasoline on the other there is one branch of industry where the reciprocating type of steam engine still reigns supreme, namely, in rolling mills, where the rolling of heavy steel slabs and blooms into plates, bars, rails, etc., demands an

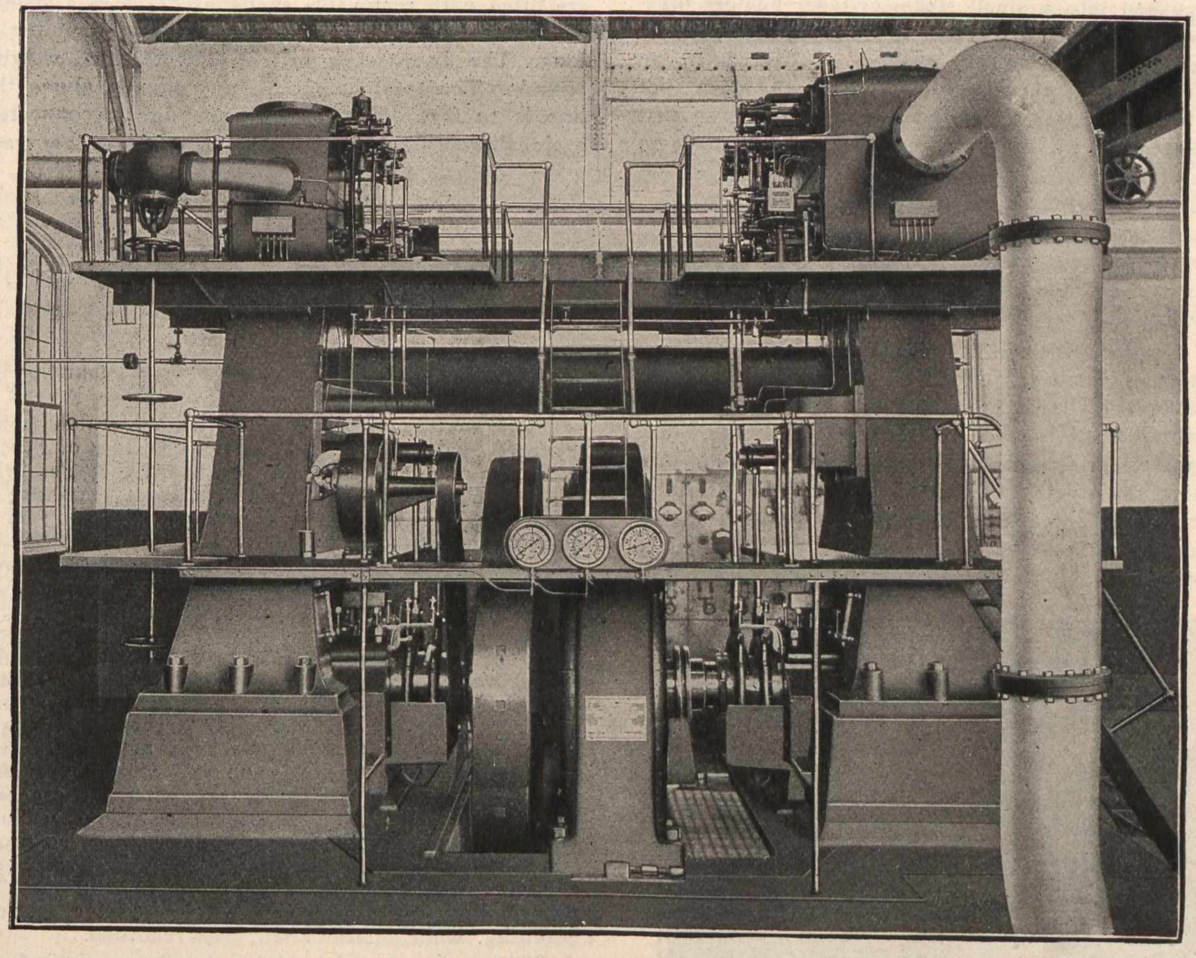


Fig. 1.—Pair of Vertical Engines Built by the Goldie & McCulloch Company.

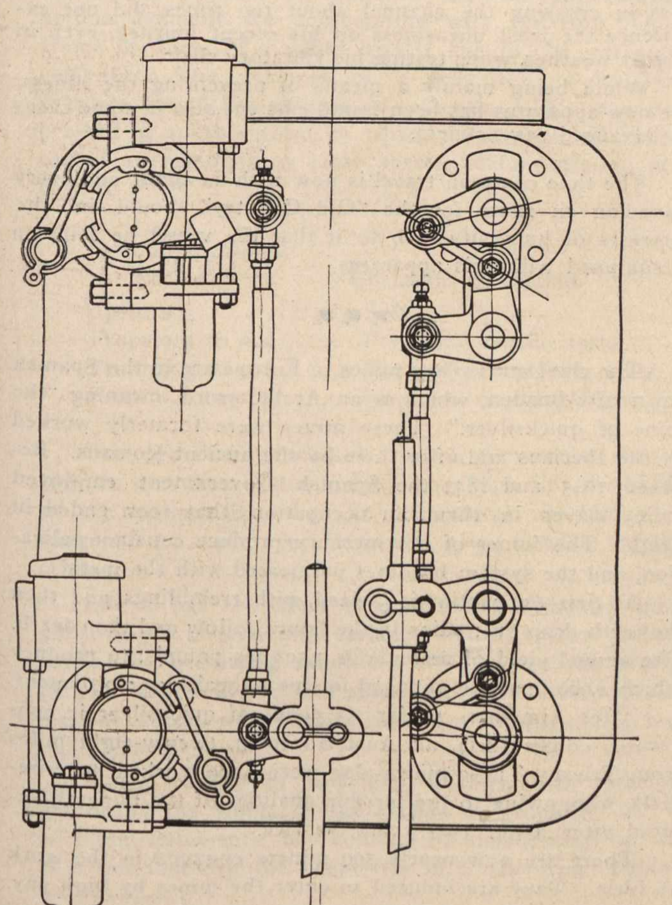


Fig. 2.—Valve Gear: H. P. Cylinder.

enormous sudden torque or turning effort and where the engine is subject to constantly varying loads and speeds.

It is encouraging to note, that Canada is keeping abreast of the times, in the designing and construction of engines to meet the demands of the rising iron and steel industries which are springing up in various parts of the Dominion.

The illustration above represents the latest Canadian practice in rolling mill engines, and shows one of the fine Corliss engines recently built for the Dominion Iron and Steel Co., Sydney, Cape Breton, by the Goldie & McCullough Co., Limited, Galt, Ont.

The engines are of the vertical, compound, Corliss type, high-pressure cylinder, 21" diameter; low-pressure cylinder, 42"; stroke, 30". Designed for a speed of 150 revolutions per minute, and are direct connected to 60 cycle, alternating current generators of 600 K.W. capacity. The main bearings, fitted with removeable shells, are 14" diameter x 28" long. Crank pins are 6¾" diameter x 8¼" long. Fly-wheel is 12 feet diameter, and weighs 32,000 pounds. Total height of engine above floor level is 19 feet. The valve motion of these engines is of the Corliss type, similar in construction to the standard for horizontal engines made by this company, with steam actuated dash pots. The governor is of the "Rites" inertia type, and is especially adapted for the parallel running of alternators, and for other places where extremely close regulation and quick action are necessary. The steam actuated dash pot enables the engines to be run at a higher rate of speed than is usual with this type of engine. Both high and low pressure cylinders are fitted with separate eccentrics for actuating the steam and exhaust valves, and the cut-off of both cylinders is under the control of the governor. This latter feature is essential to the proper regulation and economy of engines operating on a greatly varying load, and is especially desirable in a case where direct-driven alternating current generators are to be run in parallel. If the low-pressure cylinder is not so controlled, but has a fixed cut-off, the division of load between the two cylinders will vary with every change of load; the high-pressure cylinder carrying the greater proportion of the total at light loads, and vice versa. The closing of the admission valves is accomplished by steam pressure. When the valve is opened an extension of the dash pot spindle is pushed into a small steam cylinder against pressure, and when released the valve is closed rapidly, giving a sharp cut-off. The necessary cushion is effected by an air cylinder placed at the opposite end of the dash pot spindle. The top of this air cylinder is adjustable, so that the latch-plate arm on the valve spindle can be made to come to rest at its proper place. The steam and exhaust valves are double ported. The valve seats are lapped out and the valves ground to gauge. The edges of the cylinder ports are planed in a special planer. The oiling is effected from a central reservoir, with pipes leading to the various parts to be oiled.

The diameter of the high-pressure cylinder is 21"; the low-pressure cylinder, 42", and the stroke, 30". The speed is 150 revolutions per minute. The main bearings, which are fitted with removable shells, are 14 inches diameter and 28 inches long. The crank pins are 6¾" diameter by 8¼" long. The fly-wheel is 12 feet diameter, and weighs 32,000 pounds. The total height of this engine above the floor line is 19 feet. The engines are direct connected to 60 cycle alternating current generators of 600 k.w. capacity.

ELECTRICAL VIBRATING CHAIR

For the Prevention of Sea Sickness.

The steam turbine has effectively removed one of the discomforts of ocean travel, namely, the thud, thud, and constant vibration of the reciprocating engines; but, alas! that constant terror, sea sickness, still remains. It appears, however, that the electrical engineer has at last succeeded in eliminating this dreaded malady, thus enabling the passengers on a ship to derive all possible benefit from a sea voyage without the hitherto unavoidable inconveniences,

Electrical Vibrating Chair.

and the hygienists' dream of a floating sanatoria is now susceptible of realization. What the alopathic physician, with his medicinal fluids; homeopathic chemist with his minute pellets, or mechanical engineer, with his cardanic suspended berth or rotating deck, have been unable to accomplish has been achieved by the electrical engineer.

Here is what our reliable contemporary, the "Indian and Eastern Engineer," of Calcutta, India, says about it:

A novel process of a physical kind has been recently tested with the most excellent results on the steamship "Patricia," of the Hamburg-America line, and the channel steamer "Peregrine." This is based on a vibrating motion which actually prevents the outbreak of the sickness. The outfit is of the greatest simplicity and merely comprises a comfortable chair, the seat of which is set rapidly vibrating up and down by the force of an electromotor simply connected to the electrical lighting mains of the steamer. Those wishing to protect themselves against the dreaded sickness should sit down on the vibrating chair when they will feel about the same sensation as in riding on an automobile. The vibratory motion makes the rolling and pitching of the ship (which as is well-known is responsible for sea-sickness) less felt, the slow downward motion of the ship being paralyzed by the numerous short vibratory shocks occurring in an upward direction.

The success obtained with this apparatus (which was invented by Messrs. R. & W. Otto, directors of the "Sanitas" Electric Company, of Berlin), on board the "Peregrine," and on the "Patricia" on her last trip from Hamburg to New York and back, was quite surprising. As soon as the passengers felt the approach of the sickness, they sat down on the vibratory chair, when any uneasiness was removed either immediately or after a short stay in that position. Most of the patients remained free from the illness throughout the journey even after leaving the chair, while in some other cases the sickness returned a few hours after leaving, to disappear and finally to be entirely removed after another trial. In a third series of cases (which were the fewest in number and mainly comprised extremely susceptible persons), the characteristical phenomena of sea sickness after having been kept away during the stay on the vibrating chair, would immediately return on leaving the latter. These passengers accordingly remained for hours (in some cases up to ten hours) on the chair, but even in the case of so prolonged a treatment no noxious effect was observed. Everybody rather agreed on the pleasant effects of a stay on the chair, and many even took their meals there. Not a single case of vomiting, while on the chair, was recorded.

The writer is indebted for the above particulars to one of the inventors, who, after never being free from sea-sickness in crossing the channel about ten times, did not experience the least uneasiness on his recent journey, even in stormy weather, when testing his vibratory chair.

While being mainly a means of preventing the illness, the new apparatus has been found efficient also in some cases of advanced sea-sickness.

The time of ocean travel is now with us again, and every Canadian en route for the "Old Country" should—in the interests of humanity—see to it that the vessel he sails on is equipped with this apparatus.

✠ ✠ ✠

The chief quicksilver mines in Europe are in the Spanish town of Almaden, which is an Arabic word, meaning "the mine of quicksilver." These mines were formerly worked by the Iberians and after them by the ancient Romans. Between 1645 and 1843 the Spanish Government employed galley slaves in them, an occupation that soon ended in death. The fumes of the mercury produce constant salivation, and the system becomes permeated with the metal.

At first the victim is seized with tremblings and then the teeth drop out; pains in the bones follow and then death. The annual yield of mercury is 1,500,000 pounds, to produce which 4,000 men are engaged in this unhealthy employment.

After Almaden, so far as yield of quicksilver is concerned, comes Idria, an Austrian town, twenty-eight miles from Triest. These mines also were once worked by criminals, who, owing to the terrible qualities of the mineral, expired after about two years' service.

There are now nearly 500 miners engaged in the work at Idria. They are induced to enter the mines by high pay. A pension is allowed when they are disabled, and provision is made for their widows and children.

CAST IRON IN THE FOUNDRY*

By Percy Longmuir.

Carnegie Research Medallist, Author of "Elementary Practical Metallurgy: Iron and Steel."

As a rule, the average iron casting is judged by one or a combination of the following factors:

(a) General appearance and truth to pattern.

(b) Ease of machining.

(c) The properties of test bars attached to the casting.

(d) Resistance offered to the percolation of water or steam.

Not unnaturally, each stage followed in the production of a casting has a decisive effect on one or other of these factors. These stages may be described as "determining conditions," in that they determine the success or otherwise of any casting. Summarizing the more important of these stages, the following conditions are obtained:

1. Composition of the charge.
2. The mould and its cores.
3. The method of melting.
4. Casting temperature.
5. The presence of foreign matter, sand, slag, blow-holes.
6. Shrinkage or contraction faults

There are other determining conditions, but these will suffice for the present. Obviously, a fault due to moulding or core-making is at once apparent in blemishes on the casting, and is condemned by the factor given under (a), that of appearance. Shrinkage faults are also equally apparent, and may be due to defective feeding, but in many cases are to be traced to faulty design of pattern. Faults due to other causes are not usually evidenced until the casting reaches the machine shop, is placed under test, or is put into actual working life.

Carbon, without doubt, is the chief controlling factor, and of this element there is usually a total of from 3 to 4 per cent. present in all varities of cast-iron. In the presence of manganese total carbon runs higher, and in the presence of silicon lower, than usual; but this effect is not distinctly shown in foundry irons. It is not the amount of, but the condition of, carbon which is of importance. However, total carbon being approximately constant, it follows that the greater amount of graphite the less the amount of carbon available for combination with the iron. The extreme hardness of a white iron is due to the presence of cementite. The softness of a grey iron is due, not to graphite but to the absence of cementite. This may be expressed in another form, in which the content of combined carbon corresponds to some special feature desired in the casting.

Combined carbon. Per cent.	Character of casting.
Up to 0.3.............	Soft.
From 0.3 to 0.5......	For good tensile tests.
From 0.5 to 0.8......	For good transverse tests.
From 0.8 to 1.0......	For good crushing tests.

One per cent. combined carbon represents the usual limit in grey iron castings; for higher than this the hardness of the castings is a bar to economical machining. The range up to 1 per cent., however, gives a wide variety of product.

Silicon has the effect of dissociating cementite into its constituents of iron and carbon. Hence, silicon indirectly softens by producing conditions which favor the precipitation of carbon in the free state. Grey irons are, therefore, high in silicon, whilst white irons are comparatively low in this element.

Silicon added in sufficient quantity will precipitate practically the whole of the carbon as graphite. In view of these statements, the content of silicon may be taken as a fair index of the properties of a cast iron. Professor Turner, in 1885, clearly showed this to be the case, and his results have been very fully confirmed by Keep and other workers. Turner's results may be summarized as follows—in which a given content of silicon denotes a specific property of cast-iron:

Quality of Cast Iron.	Content of Silicon.
Cast iron yielding maximum hardness........	0.60
Cast iron yielding maximum crushing strength	0.80
Cast iron yielding maximum density in mass..	1.00
Cast iron yielding maximum crushing, tensile and transverse strength.................	1.40
Cast iron yielding maximum tensile strength.	1.80
Cast iron yielding maximum softness........	2.50

The silicon contents here shown relate not to the influence of silicon on iron, but indicate an amount of silicon necessary to produce the requisite balance between the two states of carbon.

The remaining constituents, sulphur, manganese, and phosphorous, are in effect of less moment than the influences already noted. In the absence of manganese, sulphur unites with iron, forming a brittle sulphide. Further than this, sulphur leads to unsoundness. Manganese also favors the retention of carbon in the combined form. Put in other words, manganese closes the grain of an iron, and increases its hardness. The latter effect is, however, not very pronounced in the presence of silicon. In the simultaneous presence of iron and manganese, sulphur appears to have a preferential affinity for the latter metal, forming a sulphide of manganese, which is not nearly so harmful as iron sulphide. Not only does manganese combine with sulphur, but under certain conditions it will effect a removal of some portion of the sulphur. Thus, manganese added to molten cast iron will lead to the formation of a manganese sulphide, which is slagged off. In this manner manganese acts as a softener, according to the extent of the sulphur removed.

Phosphorus in foundry irons is comparatively harmless, and its good points are found in the fact that it increases fluidity, giving a clean, thinly-running metal, and one retaining the sharpest details of a mould.

A control of the influence thus indicated would at first appear to be a matter of difficulty, but in reality this control is readily obtained. Naturally, the iron-founder must take his pig-irons as they come; but, nevertheless, a fair choice is offered in the many grades obtainable. Generally speaking, a given grade possesses certain special features. For example, certain Scotch irons are high in manganese; others are high in silicon, and will thereby carry a large amount of hard scrap. Apart from this, ascending numbers of any one type of iron are found to be fairly constant in the two elements, manganese and phosphorus.

Given the right silicon, a suitable ratio between combined and free carbon will follow, provided cooling is normal. Thus, thin stove-grate work, which cools in the mould with relative rapidity, has silicon from 2½ to 3 per cent.

Secondary influences are found in the contents of sulphur, phosphorus, and manganese. As far as the charge is concerned, the less sulphur entering the cupola the better the result. Average good quality castings may contain up to 0.1 per cent. sulphur. Manganese and phosphorus are, as a rule, taken as they come. An average content of manganese is 0.5 per cent. With silicon over 1.5 per cent., the charge may carry up to 1 per cent. manganese with advantage. An average phosphorus for good quality castings is 0.75 per cent., with 0.5 per cent. for specially strong work, and from 1.5 to 2 per cent. for a free-running iron in which strength is of no special moment.

* Abstract of paper read before the West of Scotland Iron and Steel Institute.

If a suitable variety of pig-irons is in stock, then a desired composition can be readily calculated. The variety of pig-irons obtainable permits of fairly wide adjustments of cupola charges. All that is desired in the way of mixing can be obtained by the use of dissimilar pig-irons. In certain cases ferro-manganese and ferro-silicon may be used; but the most effective and a cheaper plan is to use pig-irons high in the particular element desired.

Where extreme purity is required, no better base can be found than irons of hematite quality. For example, where castings have heat or corrosion to meet in working life, cast iron low in sulphur, phosphorus, and manganese is desirable. Hematite irons are, therefore, useful in special cases; but for the general run of work ordinary foundry grades are sufficient.

Another matter often raised in discussing melting practice is the absorption of oxides. Of late much has been written under this heading, and the addition of titanium advocated with a view to removing oxides. The author has no experimental results to offer in this respect; but his experience would lead to the conclusion that absorption of oxides does not occur in the cupola furnace. That an oxidizing atmosphere exists is shown by the manganese and silicon losses; but these do not necessarily prove an absorption of oxide by the charge. However, this question is one on which further work is desirable.

On pouring the metal into the mould, other of the influences noted came into play. For instance, it is common knowledge that the quicker the rate of cooling, the harder the casting.

In an ordinary sand or loam mould it is evident that the more massive the casting the slower will be the rate of cooling. Whilst silicon can be regulated to meet this condition, and to precipitate a required amount of graphite, its action ceases there. The perfection of the crystallization of graphite is largely a function of the rate of cooling; and the more perfect this crystallization, the weaker the casting, in that the graphite plates act to a certain extent as cleavage planes.

As a rule, the smaller the castings the finer the division of the graphite; and it would, therefore, appear desirable to hasten the cooling of large castings in order to retard the crystallization in graphite and to obtain it in a fine state of division. Various efforts have been made in order to achieve this end. For example, a stream of water may be led through the core barrel of a cylindrical casting; in other cases the heavy portions of a casting are, on solidification, uncovered, in order that atmospheric contact shall hasten cooling. These and similar methods are, however, chiefly successful when applied to obtain an approximately equal rate of cooling in castings of unequal thickness. When applied to retard the crystallization of graphite, they are not so successful; and there is always the danger that the method may lead to internal chilling; and a second difficulty is found in the development of internal strains. If a process applicable to any form of casting could be introduced to obtain the graphite in a fine and uniform state of division, then average tensile tests of 17 or 18 tons per square inch would become common.

These remarks do not apply to what is known as after-treatment. Taking an average sample of grey iron, a tensile piece, as cast, yielded 14.1 tons per square inch. A companion bar annealed for 48 hours at about 850 degrees Cent. gave 7.2 tons per square inch; whilst a further piece quenched from 940 degrees Cent. gave only three tons per square inch. The latter result is, of course, due to the development of minute water cracks. The low value from the annealed sample is due to the fact that graphite had segregated. When, however, a grey iron casting is too hard to machine, it may be softened by heating to a full red, followed by slow cooling. It has been shown that excessive hardness is due to the presence of free cementite; and the softening induced by this treatment is entirely due to the decomposition of cementite. In other words, hard and brittle cementite is split up into soft iron and free carbon.

Up to the present the only types of iron castings which admit of successful heat treatment are those containing free cementite. Naturally, this means a departure from the grey to the malleable iron foundry. The grey iron founder, in order to keep his castings within the machining limit, endeavors to keep combined carbon as low as is consistent with the properties desired in the castings. On the other hand, a mixture for malleable should be such that the first product is a full white iron. The following analyses show two types of malleable cast iron:

	1.	2.
Graphite	2.08	0.36
Combined carbon	0.12	0.73
Silicon	0.72	0.78
Manganese	0.30	0.09
Sulphur	0.06	0.30
Phosphorus	0.13	0.07

No. 1 is an American and No. 2 a British sample. Graphite reported in these analyses is, so far as we know, exactly the same as the graphite of a grey iron. It is, however, non-crystalline, and is distributed through the iron in a minute state of division. It will be noted from these analyses that the total carbon of No. 2 is lower than that of No. 1, and that the sulphur of No. 2 is five times as great as that of No. 1.

This difference in total carbon distinguishes between two methods of annealing—No. 1, in which the chief object is to split the hard cementite into ferrite and amorphous carbon; and No. 2, in which not only is the carbon condition changed, but a partial carbon removal is also effected.

The first process yields a "black-heart" casting, the fracture of which shows a dark, velvety centre with light edges; hence the term black-heart. Such castings represent conditions in which no carbon removal is attempted. The process consists in heating the castings to a temperature of about 850 degrees Cent., maintaining the heat for a period of from two to five days, and then slowly cooling to 600 degrees Cent.

Annealing, which has for its object a partial decarbonization, is effected in an oxidizing atmosphere, obtained by packing the castings in iron ore or mill scale. The carbon removal is slow; hence the annealing time varies from three to ten days, according to the thickness of the castings or the extent of decarbonization required. The rate of removal is greater the higher the temperature; but a limit is found at from 800 to 900 degrees Cent., owing to the danger of deformation.

Without entering into further details of malleable castings, there are two features to which the author would like to direct attention. First, the question of sulphur. The average sulphur of American castings analyzed by the author is about 0.05 per cent.; that of British malleable castings is about 0.3 per cent. Average tests show that on the whole British irons yield higher stress, greater elongation, and better bends than are to be obtained from American irons. The following figures illustrate this

Analysis		Yield point tons per sq. inch	Maximum stress tons per sq. inch	Elongation per cent. on 2 inches
Silicon	0.70	17.41	24.4	1.7
Manganese	0.14	16.16	27.0	5.7
Sulphur	0.39	12.24	24.0	3.5
Phosphorus	0.05	..	..	..

Notwithstanding the presence of practically 0.4 per cent. sulphur, these tests are extremely good. Yet this amount of sulphur in conjunction with a low manganese would be dangerous in a grey iron casting, and fatal in a steel casting. Apparently the long anneal familiar to British practice destroys the meshwork form of iron sulphide, and, by gathering together the sulphide in isolated globules destroys continuity.

The second feature lies in the rapid production of a semi-malleable product. Ledebur and Royston have worked in this direction; and the latter showed, in 1897, that by heating a white iron to the temperature at which on cooling it would solidify, a black-heart product resulted. The author has conducted various experiments on this form of treatment, of which the following may be given:

Annealed. Time = 100 Hours.

Combined carbon—Varied from 0 at the edge to 0.5 per cent. in the centre.

Graphite—From 0 at the edge to 3.2 per cent. at the centre.
Maximum stress—Tons per square inch, 25.4.
Elongation—Per cent. on 2 inches, 2.1.

Heated to Above 1,000 Degrees Cent. Time = 4 Hours.

Combined carbon	0.77 per cent.
Graphite	2.57 "
Maximum stress	21.4 tons.
Elongation	None.

Annealed represent normal works practice, and the results are the mean of three tests. The second set of results also represent an average of three tests. In this case the castings were laid on the floor of a coke-fired muffle when at a dull-red heat, and the temperature quickly raised to a white heat. On attaining this, the temperature was allowed to fall to a dull-red, and the castings withdrawn. After this treatment, the structure consisted of pearlite and amorphous carbon, the castings were soft to the file, whilst the tensile results given are comparatively good. Both sets of experiments are strictly comparative; and the tensile properties of the untreated metal are represented by a maximum stress of 12.9 tons per square inch.

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.

Knowing that 96,540 coulombs set free one chemical equivalent weight in grams of an element, or decompose one chemically equivalent weight in grams of a substance, or, in more general terms, reduce by one valency atomic weight of any chemically basic element, or increase by one valency atomic or molecular weight of any chemically acid element or radical—we can soon foot up the chemical energy of the change produced. The thermochemical heat absorbed in the separation of a chemical equivalent weight of an element is the energy required to isolate it; and since the passage of 96,540 coulombs produce that change the voltage drop must be such that the calculated heat equivalent of the electric energy expended—

$$96{,}540 \times \text{voltage drop} \times 0.2385$$

is equal to the thermochemical heat absorbed (Q for 1 equivalent). The voltage drop for the decomposition (V^d) must, therefore, be:—

$$\text{Voltage drop} = \frac{\text{Q for 1 equivalent}}{23{,}040}$$

These calculations have been made and verified by experiment on many chemical compounds. There are some few exceptions, but many such have subsequently been shown to be only apparent exceptions, the real reaction occurring during electrolysis not having been exactly understood, or else the thermochemical data not applying strictly to the conditions under which electrolysis took place.

Potential for Mixed Electrolysis.

The above data are easily applied when the current is doing only one thing, i. e., is separating out or dissolving only one element. But in many cases the current is causing a compound anode to dissolve, as when copper and silver both dissolve from a silver bullion anode; or two or more metals may be simultaneously deposited, as when copper and zinc are deposited together as brass. In all such cases the simplest procedure is to foot up the thermochemical energy of the total electrochemical change for any given time or number of coulombs passing. Then express this per 96,540 coulombs passing, and divide by 23,040; the quotient will be V^d

$$\text{Voltage drop } (V^d) = \frac{\text{Q for 96,540 coulombs passing}}{23{,}040}$$

Example: An electrolyte contains zinc sulphate with some copper sulphate, and is electrolyzed with a copper anode. There is deposited upon the cathode in one hour 15 grams of brass, containing one-third zinc and two-thirds copper. What voltage drop will occur in the cell in addition to that necessary to overcome its ohmic resistance?

Solution: The coulombs passing are those necessary to deposit 5 grams of zinc (chemical equivalent 65 ÷ 2) and 10 grams of copper (chemical equivalent 63.6 ÷ 2)

$$\text{Coulombs for zinc} = \frac{5.0000}{0.00001035 \times (65 \div 2)} = 14{,}864$$

$$\text{" " copper} = \frac{10.0000}{0.00001035 \times (63.6 \div 2)} = 30{,}383$$

$$\text{Sum} = 45{,}247$$

The weight of copper dissolved will be, on the same principles—

$$45{,}247 \times 0.00001035 \times (63.6 \div 2) = 14.892 \text{ grams.}$$

The solution of 14.892 grams of copper and deposition of 10 grams of the same element, shows that the only thermochemical energy required is that absorbed for the solution of 4.892 grams of copper and deposition therefor of 5.0 grams of zinc. The thermochemical equation is—

$$\begin{array}{llll} Zn\,SO^4aq & + \; Cu = Cu\,SO^4aq & + \; Zn & \\ -248{,}000 & + \; 197{,}500 & & = -50{,}500 \text{ calories,} \end{array}$$

Showing that 50,500 calories is absorbed for every 65 grams of zinc (its atomic weight) thus deposited. This equals an absorption of 3,885 calories per 5 grams of zinc, or for the whole period, during which 45,247 coulombs passed through the cell. For every 96,540 coulombs passing, the thermochemical heat absorption is

$$\frac{3{,}885}{45{,}247 \times 96{,}540} = 8{,}289 \text{ calories.}$$

and the voltage drop is

$$V^d = \frac{8{,}289}{23{,}040} = 0.36 \text{ volt.}$$

The above calculation is on the assumption that the copper and zinc deposit separately, as mixed crystals. If they really deposit as a chemical combination, the heat of formation of the alloy would need to be considered also in the above calculation.

The main point sought to be emphasized by the foregoing statements and illustration is that the current may, and very often does, do two kinds of chemical work simultaneously, requiring, if each alone took place separately, different drops of potential to accomplish the chemical work; in such cases, the only safe ground is to say that the coulombs passing must furnish the sum total of all the energy for all the chemical changes induced at the electrode surface, and, therefore, must drop sufficiently in potential to furnish the energy required (in addition, of course, to the ordinary drop of potential caused by the ohmic resistance of the bath).

Current for Mixed Electrolysis.

When the current is dissolving or depositing only one element, the calculation of the quantity of material concerned with a given transfer of electricity is a simple question: The Faraday, 96,540 coulombs, dissolves or deposits one chemical equivalent weight in grams.

If, however, two or more elements are simultaneously dissolved or deposited, as occurs frequently in metal refining or plating, the calculation is not so simple. The proper procedure in that case is to find how many coulombs are required for the separate weights of each element dissolved or deposited, and add these together to obtain the total current needed. Or, if the current used is given, and the question is the amounts of mixed metals dissolved or deposited, obtain the coulombs necessary to dissolve or deposit one kilogram of the alloy or mixed metals, and divide this into the total coulombs used.

Example: In the Wohlwill process of refining gold bullion, the anodes consist of 80 per cent. gold, 8 per cent. silver, 10 per cent. copper and 2 per cent. platinum. One hundred and fifty amperes pass through each cell, attacking or corroding the anodes uniformly, while the silver deposits at the bottom of the bath as Ag Cl, gold is deposited pure on the cathodes, and platinum and copper accumulate in the solution at $Pt Cl^4$ are—$Cu Cl^2$ respectively.

Required: (1) How much weight of anode is corroded per twenty-four hours?

(2) How much more gold is deposited than is dissolved?

(3) What voltage of decomposition, to represent chemical work, must be furnished?

Solution: (1) One kilogram of anode contains—

Gold	800	grams
Silver	80	"
Copper	100	"
Platinum	20	"

The coulombs necessary to dissolve these weights to convert these metals into $Au Cl^3$, Ag Cl, $Cu Cl^2$ and $Pt Cl^4$ are—

Gold	$800 \div (0.00001035 \times 197 \div 3) =$	1,177,076 coulombs.
Silver	$80 \div (0.00001035 \times 108 \div 1) =$	71,570 "
Copper	$100 \div (0.00001035 \times 63.6 \div 2) =$	308,831 "
Platinum	$20 \div (0.00001035 \times 195 \div 4) =$	39,638 "
		1,592,115

Coulombs available, per 24 hours

$$150 \times 60 \times 60 \times 24 = 12,970,000$$

Anode corroded away in 24 hours, per cell

$$12,970,000 \div 1,592,115 = 8.146 \text{ kilograms}$$
$$= 8,146 \text{ grams} \quad (1)$$

(2) The weight of gold deposited, by the total current, is $12,970,000 \times (0.00001035 \times 197 \div 3 =) = 8,815$ grams.

Amount dissolved,

$$8,146 \times 0.80 = 6,717 \text{ "}$$

Shortage in each cell, per 24 hours $= 2,098$ " (2)

This shortage, it will be recalled, has to be made up by dissolving some of the bullion in acid, and adding to the cells. There would be required $2,098 \div 0.80 = 2,747$ grams of bullion thus dissolved, making the total bullion treated per cell per day $8,146 + 2,747 = 10,893$ grams, of which 8,146 grams, or 74.8 per cent. would be treated electrolytically in the cell, and the rest, 25.2 per cent., would be dissolved chemically, and yet when added to the electrolyte, its gold deposited electrically.

(3) Basing calculations on the solution of a kilogram of anode, requiring the passage of 1,592,115 coulombs (16.49 Faradays), the 800 grams of gold dissolved has a corresponding 800 grams deposited, so that no chemical energy needs to be expended for it. For the other elements we have the following equations and heat absorptions or evolutions:

$$Au\ Cl_3 aq + 3Ag = Au + 3\ Ag\ Cl$$
$$-27,200 \qquad +3(29,000) = +59,800 \text{ calories.}$$
$$2\ Au\ Cl_3 aq + 3Cu = 2Au + 3\ Cu\ Cl\ 2aq.$$
$$2(27,000) \qquad +3(62,500) = +133,500 \text{ "}$$
$$4\ Au\ Cl_3 aq + 3\ Pt = 4Au + 3\ Pt\ Cl^4 aq.$$
$$-4(27,000) \qquad +3(79,800) = +131,400 \text{ "}$$

The above heat evolutions are for the solution of, respectively,

3 gram atomic weights of silver =324 grams.
3 " " " " copper =190.8 "
3 " " " " platinum =585.0 "

The heat evolution per kilogram of anode corroded will therefore be for:

$$80 \text{ grains silver} = \frac{80}{324} \times 59,800 = 14,765 \text{ calories.}$$
$$100 \text{ " copper} = \frac{100}{190.8} \times 133,500 = 69,980 \text{ "}$$
$$20 \text{ " platinum} = \frac{20}{585} \times 131,400 = 450 \text{ "}$$
$$\text{Sum} = 85,195 \text{ "}$$

This heat evolution takes place for the passage of 1,592,115 coulombs (16.46 Faradays). For one Faraday (96,540 coulombs) it will be,

$$85,195 \div 16.49 = 5,167 \text{ calories.}$$

and since one Faraday falling in potential one volt represents 23,040 calories, the heat **evolution** will **generate**

$$5,167 \div 23,040 = 0.224 \text{ volts}$$

which means that the fall of potential for chemical work is negative, i. e.,

$$V^d = -0.224 \text{ volts} \quad (3)$$

It is interesting to note that, the observed total drop of potential across the baths being 0.7 volt, the voltage drop to overcome ohmic resistance must be **greater** than this, i.e.,

$$V = V^d + V^c$$
$$0.7 = -0.224 + V^c$$
$$V^c = 0.7 + 0.224 = 0.924 \text{ volt.}$$

making the ohmic resistance of the cell

$$R = \frac{0.924}{150} = 0.00616 \text{ ohms}$$
$$= 6.16 \text{ milli-ohms}$$

Further, if no external source of current were used, the cell would have available 0.224 volt electromotive force, which should, if short circuited, send

$$\frac{0.224}{0.00616} = 36.3 \text{ amperes}$$

through the bath, that is, run it at 24 per cent. of the present rate, without any external generator of current.

Rise in Temperature of Baths.

A subject of much importance is that of the temperature of an electrolytic cell being maintained above the room temperature by the heating effect of the current. It is difficult to calculate ahead, before the apparatus is constructed, how high its temperature will rise above its surroundings, but it may be determined with considerable approach to accuracy how high it will be heated as soon as it has been constructed, and before electric current is applied, by a simple test.

The tank is filled with electrolyte, the electrodes put in place, and note made of the weight of electrodes and electrolyte. The tank is heated by a steam pipe until at desired temperature above the room, and then allowed to cool by radiation, with thermometer immersed in the electrolyte so as to determine the rate of fall of temperature per minute. An ordinary tank will cool approximately twice as fast if uncovered as if covered. Tests on a small tank showed, for example, the following results:

At 90° C. falling 3°.2 per minute.
" 80° " " 1°.7 " "
" 70° " " 1°.1 " "
" 60° " " 1°.0 " "

Knowing the weight and heat capacity of the electrodes and electrolyte (to which may be added half the heat value of the tank), it can be calculated how much heat is being lost per minute at any of the above temperatures. To maintain the bath at that temperature, would, therefore, require just that much heat to be generated within it electrically in overcoming the ohmic resistance, and if we know or have calculated the electric resistance of the bath we have

Heat generated in bath= (current used)^2 $\times$ resistance $\times$ 0.2385 calories per second.

and, therefore, the current required to supply any required quantity of gram-calories per minute will be,

$$\text{Current} = \sqrt{\frac{\text{Heat to be generated in bath per minute}}{\text{resistance of bath in ohms} \times 0.2385 \times 60}}$$

This same method of investigation can be applied to apparatus working with fused salts, or electric furnaces, providing that means of measuring the temperature satisfactorily are at hand.

Energy Required for Chemical Work.

This energy must be equal in amount to the chemical work done, and the only measure of this that we have are the thermo-chemical heats of combination of the separated-out products to re-form the original material. A most striking generalization has been arrived at by the discussion of thermochemical data, viz., that taking the heats of formation of salts plus their heat of solution in excess of water (usually called "heat of formation to dilute solution"), these quantities are found to be **additive** in their nature, such being composed of the sum of two quantities, one characteristic once for all of the base, in all its combinations and the other being characteristic once for all of the acid radical, in all of its combinations. There is thus for each basic element a **thermochemical constant,** which represents the amount of heat it contributes to the formation-heat of a salt, the latter taken in dilute solution; and for each acid radical a similar **thermochemical constant,** representing in a similar manner the part which it contributes; the sum of these two thermochemical constants is the formation heat of the salt, from its elements, to dilute solution. The thermochemical constant is nothing more nor less, in the case of a base, than **energy drop** which represents the decrease of free energy in the element as it passes from the free, uncombined state into the combined state in dilute solution; in the case of an acid element, the statement is entirely similar; in the case of an acid (or basic) radical, it is the total energy drop from free elements to the state of combination as a radical.

The arbitrary basis selected to which to refer these thermochemical constants is best that of hydrogen constant equal to zero. This would make the thermochemical constant of every basic element the heat evolved when it displaces hydrogen from a dilute solution of acid; and that of an acid element or radical the heat of formation of the corresponding acid in dilute solution. Practically, the thermochemical constants have been evaluated by the comparison of the heats of formation of many acids and salts, and the selection of the most probable experimental values. The following tables have been thus derived by the writer from an extensive discussion of the subject matter. The constants are given in every case **per one chemical equivalent** for the base or acid, element or radical, and **not** for the normal number of equivalents which are designated by the symbol and dots (·) or accents (′).

I have also given the voltage drop corresponding to an energy drop of the designated number of calories per chemical equivalent, by the simple procedure of dividing the latter by 23,040.

Thermochemical Constants of Basic Elements.

	Per Chemical Equivalent.		Corresponding Voltage.
Li .	+62,900	calories	+2.73
Rb .	62,000	"	2.69
K .	61,900	"	2.69
Ba..	59,950	"	2.60
Sr..	58,700	"	2.55
Na .	57,200	"	2.48
Ca . .	54,400	"	2.36
Mg . .	54,300	"	2.36
Al . . .	40,100	"	1.74
$(N+H_4)$.	33,400	"	1.45
Mn . .	24,900	"	1.08
Zn . .	17,200	"	0.75
Fe . .	10,900	"	0.47
Cd . .	9,000	"	0.39
Co . .	8,200	"	0.36
Ni . .	7,700	"	0.33
Fe . . .	3,230	"	0.14
Sn . .	1,900	"	0.08
Pb . .	400	"	0.02
H .	0	"	0
Tl . .	— 900	"	—0.04
Cu . .	— 7,900	"	—0.34
Hg. .	—14,250	"	—0.62
Pt . .	—19,450	"	—0.84
Ag .	—25,200	"	—1.10
Au . .	—30,300	"	—1.32

Thermochemical Constants of Acid Elements.

	Per Chemical Equivalent.	Corresponding Voltage.	Salt.
F_2''(gas)	+52,900	+2.30	Fluoride
Cl_2 "	39,400	1.71	Chloride
Br_2'' "	32,300	1.40	Bromide
Br′ (liquid)	28,600	1.20	"
Br′(solid)	27,300	1.18	"
I_2''(gas)	20,000	0.87	Iodide
I′(liquid)	14,600	0.63	"
I′(solid)	13,200	0.57	"
S″ "	— 5,100	—0.22	Sulphide
Se″(met.)	—17,900	—0.78	Selenide

Thermochemical Constants of Acid Radicals.

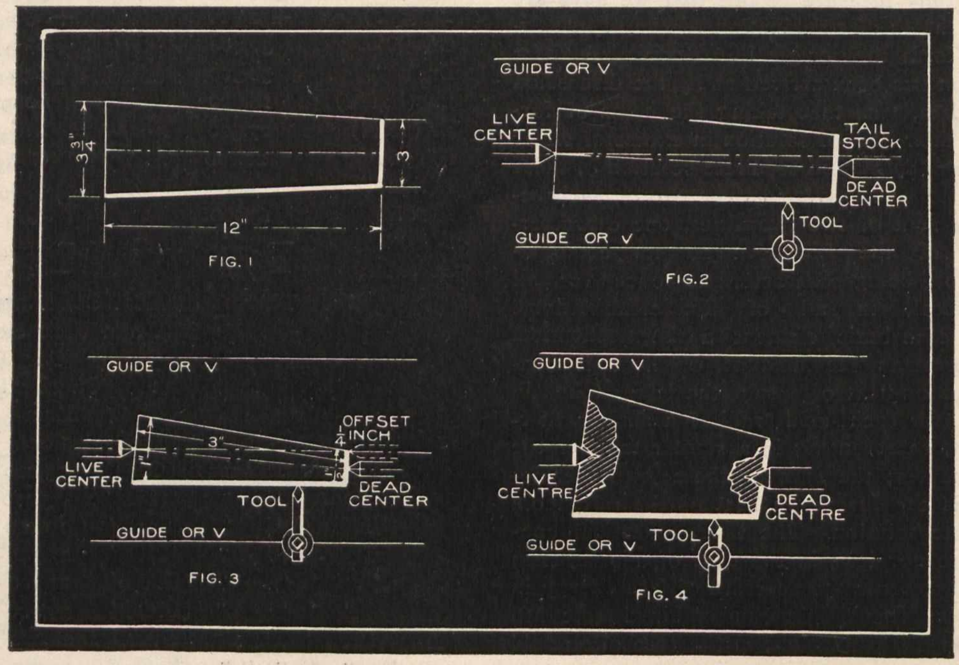
(From their elements.)

Constituents.	Radical.	Per Chemical Equivalent.	Corresponding Voltage.	Salts.
O_2(gas),H_2(gas)	(OH)′	+55,200	+2.40	Hydrate
S(solid),H_2 "	(SH)′	3,400	0.15	Sulphydrate
Se(met),H_2 "	(SeH)′	19,100	0.83	Selenhydrate
Cl_2(gas),O_2 "	(ClO)′	27,500	1.19	Hypochlorite
" " " "	$(ClO_3)'$	21,900	0.95	Chlorate
" " " "	$(ClO_4)'$	39,400	1.71	Per-chlorate
Br_2 " O_2 "	(BrO)′	28,600	1.24	Hypo-bromite
" " " "	$(BrO_3)'$	12,500	0.54	Bromate
I " O_2 "	$(IO_3)'$	65,000	2.82	Iodate
" " " "	$(IO_4)'$	52,600	2.28	Per-iodate
S(solid) O_2 "	$(S_2O_3)''$	71,750	3,11	Hypo-sulphite
" " " "	$(SO_3)''$	75,100	3.26	Sulphite
H_2(gas) " " " "	$(HSO_3)'$	149,400	6.48	Bi-sulphite
" " " "	$(S_2O_5)''$	115,200	5.00	Pyro-sulphite
" " " "	$(SO_4)''$	107,000	4.64	Sulphate
H_2(gas) " " " "	$(HSO_4)'$	211,100	9.16	Bi-sulphate
" " " "	$(S_2O_8)''$	158,100	6.86	Per-sulphate
" " " "	$(S_2O_6)''$	138,500	6.01	Di-thionate
" " " "	$(S_3O_6)''$	136,500	5.92	Tri-thionate
" " " "	$(S_4O_6)''$	130,600	5.67	Tetra-thionate
" " " "	$(S_5O_6)''$	133,100	5.78	Penta-thionate
Se(solid)O_2 "	$(SeO_3)''$	60,050	2.61	Selenite
" " " "	$(SeO_4)''$	72,800	3.16	Selenate
P(solid)O_2 "	$(PO_4)'''$	99,300	4.31	Phosphate
H_2(gas) " " " "	$(HPO_4)''$	152,750	6.63	Mono-H-Phosphate
" " " "	$(H_2PO_4)'$	307,700	13.35	Di-H-Phosphate
As(solid)O_2 "	$(AsO_2)''$	102,150	4.43	Arsenite
" " " "	$(AsO_4)'''$	70,200	3.05	Arsenate
H_2(gas) " " "	$(HAsO_4)''$	71,700	3.11	Mono-H-Arsenate
" " " " "	$(H_2AsO_4)'$	217,200	9.43	Di-H-Arsenate
N_2(gas)O_2 "	$(NO_3)'$	48,800	2.12	Nitrate
" " " "	$(NO_2)'$	27,000	1.17	Nitrite
" " " "	(NO)′	—3,800	—0.16	Hypo-nitrite
C(amor.)O_2 "	$(C_2O_4)''$	99,800	4.33	Oxalate
" " " "	$(CO_3)''$	82,450	3.58	Carbonate
H_2(gas) " " "	$(HCO_3)'$	169,100	7.34	Bi-Carbonate
" " " " "	$(CHO_2)''$	104,600	4.54	Formate
" " " " "	$(C_2H_3O_2)''$	120,500	5.23	Acetate
N_2(gas) " " " "	(CNO)′	37,100	1.61	Cyanate
" " N_2 "	(CN)′	—34,900	—1.51	Cyanide
S(solid) " " " "	(CNS)′	—18,100	—0.79	Sulpho-cyanide
Fe(solid) " " "	$(FeC_6N_6)''''$	—25,600	—1.11	Ferro-cyanide
" " " " "	$(FeC_6N_6)'''$	—52,800	—2.29	Ferie-cyanide

In using above tables, it must be borne in mind that the sum of the thermochemical constants for the basic and acid constituents of any salt, gives the heat of formation of the salt from the constituent chemical **elements,** in dilute solution. Conversely, the heat of formation thus obtained, is the energy necessary to separate the salt in dilute solution into its constituent chemical elements. The sum of the voltages, corresponding to this amount of chemical energy, is the voltage necessary to decompose the salt in solution into its constituent, free chemical elements. If these elements re-combine in the process of decomposition, to form other chemical compounds, then the whole chemical reaction must be taken into account,—best on the total energy basis; and when this is expressed in calories per chemical equivalent concerned, the necessary voltage for producing the change is obtained by dividing this by 23,040.

Lehigh University, December, 1905.

EXTRACTS FROM AN ENGINEER'S NOTE BOOK



Turning Tapers.

The turning of a given taper is a point in machine-shop work that has puzzled many a mechanic. The turning of tapers by setting over the tail-stock seems to present greater difficulty than the other methods; hence it will be more carefully considered here.

Tapers.

Tapers are usually designated by the amount per foot, that is, "¾-inch per foot," or "2 inches per foot." This means that if the piece is one foot long, one end has a diameter ¾ inch greater than the other end. If the taper is 3 inches per foot, the diameter of one end is 3 inches greater than that of the other, provided the length is one foot.

Sometimes the taper is stated as "1 in 8," or "1 in 12." In such cases, it is easy to reduce to "amount per foot." A taper of 1 in 8 is evidently 1½ inches per foot, for $12 \div 8 = 1.5$. A taper of 1 in 12 is 1 inch per foot, for $12 \div 12 = 1$. Although the taper is thus designated, the length of the tapered piece is not necessarily twelve inches. The statement means that the piece has a taper such that if it were one foot long, the difference in diameter would be the stated amount.

Fig. 1 (see blackboard), shows a piece of which one end has a diameter of 3 inches, and the other end a diameter of 3¾ inches. As the difference in diameter is ¾ inch, and as the piece is one foot long, the taper is ¾ inch per foot.

The Lathe.

We all know that if both the live centre and the dead centre are in line, a piece will be turned having the same diameter at each end. In other words, the piece will be "straight." We also know that the cutting tool is rigidly fastened to the carriage, which must move parallel to the centre line because of the guides or V's. It is easy to see that if either centre is moved from the centre line, the piece will be turned smaller at one end.

Fig. 2 (and also all the rest of the illustrations on the blackboard) represents a tapered piece in a lathe. The observer is supposed to be looking down on the lathe. From Fig. 2, we see that the end nearest the tool will be the smaller. As the head-stock is usually immovable, it is customary, when turning tapers, to move the tail-stock from its central position. Since most tapers are turned having the small end at the tail-stock, the dead centre is usually moved toward the tool or toward the front of the lathe.

In Fig. 2, it is assumed that the centres merely touch the ends of the piece; this is not true in practice; but this assumption makes the calculation easier. The effect of inserting the centres in the ends will be taken up later.

Amount of Offset.

The amount of taper given a piece depends upon the length of the piece, and the amount the dead centre is brought forward. Let us assume that we have a piece 3 inches long, and that we wish to turn a taper which shall be 2 inches per foot. Now the piece is 3 inches long which is one quarter of a foot. If the difference in diameter is to be 2 inches for 12 inches, it will be $2 \div 4$ ($= \frac{1}{2}$) inch for 3 inches. We know that the distance from the dead centre to the circumference is one-half the diameter; hence the dead centre should be offset one-half of ½ inch, or ¼ inch. This is shown in Fig. 3.

Leaving the dead centre offset ¼ inch, move tail-stock out so that a piece 6 inches long may be placed between the centres. The difference in radius will then be ¼ inch in 6 inches, and the difference in diameter will be ½ inch in 6 inches, or 1 inch per foot. Before, it was 2 inches per foot.

By following the same reasoning, it would be ½ inch per foot if the tail-stock were moved outward until a 12-inch piece could be inserted.

The above calculation was based on the assumption that the length was given, and also the **amount of taper.** Now let us consider a case in which the length is given, but the amount of taper is unknown. The piece is 8 inches long, and on one end a taper is to be turned. The tapered portion is to be 4 inches long, and the difference in diameters of this 4 inches is to be ½ inch. How much must the tail-stock be set over?

Let us first find that the taper would be 1½ inches per foot, because $3 \times \frac{1}{2} = 1\frac{1}{2}$. Then the tail-stock should be moved ½ of 1½ ($= \frac{3}{4}$) inch if the piece were a foot long; but, as it is only 8 inches (or 2-3 of a foot) long, it should be moved 2-3 × 3-4 ($= \frac{1}{2}$) inch. Had the piece been 18 inches long, the tail-stock should be moved 3-4 × 3-2 ($= 1\frac{1}{8}$) inches.

The Lathe Centres.

In these calculations, we assumed that the lathe centres merely touched the ends of the piece, thus making the length of the piece the same as the distance between centres. This assumption is not true in actual work; and if the calculation is to be accurate (and it should be as accurate as possible, to avoid continual changing of the tail-stock), the distance the centres enter the piece must be considered.

Fig. 4 shows (somewhat exaggerated) the effect of the lathe centres. If the piece is long, the error is slight; but if short, the actual taper will differ considerably from the calculated. Let us suppose each centre enters ¼ inch; both would enter ½ inch, and the length to be used in the calculation should be reduced that much. To make a taper for a fit, the calculation should be made as accurately as possible; and while turning the taper, the calipers should be used frequently, so that the tail-stock may be correctly placed. "Technical World."

The Canadian Engineer.

ESTABLISHED 1893.

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TORONTO, CANADA, JULY, 1906.

CONTENTS OF THIS ISSUE.

NOTICE TO SUBSCRIBERS.

The June number of "The Canadian Engineer" is out of print. Any reader who does not require his copy for filing is requested to return it to this office, and he will be credited with an extension of his subscription term for three months.

Owing to circumstances over which we have no control, we are constrained to hold over until August, exceedingly interesting notes and fine illustrations of the Foundrymen's Convention, held at Cleveland, Ohio, June 5th to 7th.

CHEAP POWER: FALLACIOUS FIGURES.

> "If there be any work that keeps many poor to make a few rich, that suits not a commonwealth."
>
> *Oliver Cromwell.*

One of the ablest thinkers of the last generation* has said—speaking of controversy—that "when we have stated our terms and cleared our ground, argument is generally, either superfluous or fruitless." Believing this dictum to be true wisdom; and as our space for polemics is limited, we purpose, as far as possible, confining ourselves to facts only in making out our case against what we hesitated not to describe in our last issue, as the "astoundingly fallacious" figures set forth in the "First Report, Niagara District," of the Hydro-Electric Power Commission, (published by the Government of Ontario, April 4th, 1906), as to the cost of electrical energy generated at Niagara Falls and transmitted to Toronto.

* Cardinal Newman.

On page 14 of the "Report," is this astonishing declaration:—

> All the calculations leading up to the cost of delivered power at municipal sub-stations, have been based on an **arbitrary** price of $12 per 24-hour H.P., per annum, at the high tension bus-bars of the generating station; the price being determined upon a knowledge of recent sales of large blocks of power at Niagara.

It will be observed, that not a word is said about the **special conditions and circumstances** under which the power in "large blocks" was sold. We thus see, that the fundamental constant quoted, viz., $12—the purchase price of high tension (12,000 volts), power at Niagara Falls, in both large and small blocks, is based upon a gratuitous, unproved, empirical assumption. It is clear, therefore, that approximately, three-fourths of the Commission's estimate = $16.53—the cost of low tension, or more correctly, high tension 12,000 volts step-down transformer station power at Toronto—is figured on a basis which no serious manufacturer would ever dream of adopting in the conduct of his own business.

The injustice of this assumption consists (1) in the fact, that it places the man on the other side of the table in the helpless position of having to prove a negative; and (2) that there is not a scrap of evidence before the public so far, to prove that colossal experimental installations like the three on the Canadian side at Niagara Falls, can sell high tension electrical energy at the **generating station** bus-bars at $12 per 24 hour-H.P., and pay reasonable dividends to their British and American stock-holders.

The most important factor in this whole matter is, however, not the purchase price of power at Niagara Falls; but the cost of transmitting this high tension electrical energy after it is stepped up—from 12,000 volts to 66,000 volts—with a theoretical loss of 2.5 per cent., or a practical loss of 5 per cent.; the transmission requiring twelve copper cables, each 88 miles in length—the number of cables necessary for the four Toronto circuits allowed for by the Commission—and its delivery at high-tension from the outskirts of Toronto, necessitating another transformation step-down to about 12,000 volts, with a similar 2.5 per cent. or 5 per cent. loss. Hence, folowing out the suggestions of the Commission, and splitting the difference between theoretical and practical losses, this would give 3.75 per cent. loss for each of the two necessary transformations; or a total of 7.5 per cent. loss over and above the line loss, and without allowing for load factor.

While the Commission has not allowed for any spare machinery, (plant), or for load factor, attention has already been called to the fact that they did allow for 8.25 per cent. loss between the purchase point at the Falls and the high-tension delivery point at the outskirts of Toronto.* Deducting 7.5 per cent. (for the two transformations) from this 8.25 per cent. would only leave 0.75 per cent. loss for the line, whereas an approximately correct allowance would be 10 per cent. The Commission's incorrect total allowance for losses, is, therefore, a very grave and serious error; since, according to the Westinghouse formula,* the cost for copper alone with only 0.75 per cent. line loss, would be $4,459,185, in order to deliver 50,000-H.P. But the "Report," (Table XXIII, p. 19) gives only

* J. Stanley Richmond, "The Monetary Times," May 25th, 1906.
* See Westinghouse Pocket Book, p. 26.

$2,117,978 as the "Total investment, including step-down stations and interswitching;" a difference of $2,-341,207. We do not forget, of course, that 0.75 per cent. line loss with a resulting outlay of $4,459,185 is a "Reductio ad absurdum" method of dealing with the erroneous figures of the Commission. Scientifically stated, our case is as follows:—

(1) That the initial cost of power at Niagara for Toronto —with such a scheme as that of the Commission—would, due to a 0.75 per cent. load factor; the Commission's allowed line loss of 6½ per cent.; and two practical transformation losses, be about $19, instead of the "Report" estimate of $16.53—provided the purchase price of $12 were correct.

(2) That the added cost due to a step-up transformation, allowing for the necessary spare plant; a practical transformation loss and correct fixed charges, and operating expenses, would be about $3, instead of the nothing allowed by the Commission.

(3) That the added cost due to line transmission—allowing the Commission's loss allowance of 6½ per cent.; their four circuits; the correct outlay for equipment and right of way, etc; and correct fixed charges and operating expenses, would be about $7, instead of the Commission's estimate of $1.86.

(4) That the added cost due to Toronto step-down transformation to about 12,000 volts, allowing for the necessary spare plant; a slightly less cost per H.P. for equipment; a practical transformation loss, and correct fixed charges and operating transformation loss, and correct fixed charges and operating expenses, would be about $3.50, instead of the Commission's estimate of $1.36.

Tabulated, the foregoing would be as follows:—

	Commission's Estimates.	Estimates Corrected.
Initial cost at the Falls......	$13.08	$19.00
Step-up transformation	0.00	3.00
Line transmission	1.86	7.00
Step-down transformation ...	1.36	3.50
Interswitching	0.07	
Administration	0.16	Included in 2nd, 3rd, and 4th items.
Cost of power at 12,000 volts delivered from Toronto step-down station	16.53	$32.50

If the foregoing approximate figures are true; and we challenge material contradiction, then our case against the Commission's Report, that certain of the estimated costs set forth therein are "astoundingly fallacious," is made out. Inasmuch as the total investment in equipment for generating and transmitting 50,000-H.P. of electrical energy at 12,000 volts, 88 miles to step-down station at Toronto, should be more than double the amount specified in the "Report," we respectfully submit for the gracious consideration of our esteemed newspaper contemporary, "The Toronto World," the question as to who has been "blundering." That the expectation of consumers getting power at $17 in Toronto is not confined to newspapers, politicians and manufacturers, is evidenced by the following extract, taken from "The Canadian Municipal Journal," June, 1906:—

> Hon. Adam Beck, chairman of the Hydro-Electric Power Commission, of Ontario, states, as a result of the enquiry, that power can be developed at Niagara for $8 per H.P., transmitted to Toronto for $5, and **sold to consumers there at $15 to $17.** This is calculated to result in a saving of $2,000,000 a year to the municipalities, besides making them independent of the coal operators. But it also means that cities in other less favored Provinces will be heavily handicapped. How will Montreal, for instance stand, where electric power costs $100 per H.P., thanks to the grasping power of a monopoly?

It cannot be denied, that the almost universal expressions of indignation among Toronto manufacturers against the power companies, and the great popular movement which swept over the Province like a flood, bringing 1,200 representatives of nearby municipalities in demonstration up to the Ontario Government, culminating in the passage of the drastic measure entitled "An Act to provide for the Transmission of Electrical Power to Municipalities," was instigated by the broadcast circulation of the erroneous statement made by the Chairman and other members of the Hydro-Electric Commission, to the effect that power in quantities could be delivered at a reasonable profit in Toronto at $17 per 24-hour H.P.; whereas, it was alleged, one of the Niagara Power companies has already contracted to deliver it in Toronto at $35—a comparative figure utterly misleading, since $35, is, we understand, for per kilowatt hour; while the estimated $17, is a flat rate, (i.e., so much per **maximum** horse-power per annum, to be paid for whether used or not). The $35 **measured** rate, converted into a flat rate, would be approximately $25.

Clause 6 of the "Act" aforesaid, provides that municipalities may apply to the Commission for a Power plant; who will furnish estimates, plans, specifications, forms of contract, etc.; but the following ingenious "Proviso" has been tacked on to the clause:—

> Providing that neither the Commission nor the Province of Ontario shall incur any liability to any municipal corporation or company **by reason of any error or omission in any such plans, specifications, or estimates.**

If it is a fact, that the Commission have made a serious mistake of over two million dollars in the total investment estimate contained in Table XXIII, report No. 1: due to the neglect of important transmission losses and cost of transmission apparatus, and, hence, given the price of power as $16.53 instead of, say, $32.50; then, the introduction of the almost ludicrous "Proviso" to clause 6, is an example of political wisdom worthy of Macchiavelli himself.

One word more. The political text at the head of this article exemplifies the attitude of "The Canadian Engineer" exactly. In so far as the aim of the Ontario Government in this cheap power movement is to safeguard the general interests of the people and manufacturers against the encroachments of Privilege and Monopoly then we are at one with them. But when, as in this instance, certain very estimable business gentlemen, set on foot a sensational campaign, which shakes the Province to its very foundation: evoking cries of robbery against a company which has risked millions of **British** capital—capital which could not be got in Canada—and all this, solely upon the questionable authority of two Montreal engineers, possessing only a theoretical knowledge of long distance power transmission, then we deem it a public duty to enter our protest. If this policy of denouncing private engineering enterprize **without just cause,** is persisted in, the industrial development of the country will assuredly be hindered.

Our captains of industry risking millions, can not equitably be expected to be satisfied with "a mere paltry bank interest on the par value of the bonds" for "capital can never be found to develop a country unless it can be given some commensurate return based on the risk it has run."

The following extract from "The Canadian Gazette," (published in England), shows that something is about to be done to allay the uneasiness of British investors:—

> Mr. Whitney, Premier of Ontario, is about to pay a visit to England, says the "Morning Post." He will confer with the bondholders in Niagara power companies, whom he will seek to relieve of anxiety as to the Government attitude towards the obtaining of power from the Falls.

It is probably unnecessary, but perhaps just as well to say, that in making the foregoing criticism from the Engineer's standpoint, we are not holding a brief for any corporation, or any individual; and have only taken upon ourselves this unpleasant task in the interests of sound engineering, and a stern sense of public duty.

EDITORIAL NOTES.

"The Times," (England), Replies on Electric Smelting at Sault Ste. Marie.

"The Times Engineering Supplement," of June 20th, 1906, is "at a loss to understand," on what grounds Dr. Haanel determined to "pass over the crude criticisms of 'The Times' with a smile." We can conceive the Dominion Superintendent of Mines, treating the latest critique of "The Times" even with contempt: for unsupported by a word of evidence, either theoretical or practical, the editorial referred to, simply reiterates its former conclusion, thus; "these experiments are well worth continuing, but hardly warrant any definite conclusion as to the results of a trial on a commercial basis." It is quite evident that nothing short of a 125 ton electric furnace plant, (5 = 25 tons each) requiring 10,000-H.P., and costing say $100,000, will satisfy our conservative English contemporary. That 55 tons of good merchantable pig-iron was successfully smelted from magnetite; nickel-ferro-pyrrhotite; and titaniferous ores which cannot be reduced commercially in the blast furnace at all, seems to be simply an interesting episode in the eyes of "The Times." That given a plant near one of Canada's waterfalls, and cheap hydro-electric power therefrom, ores can be reduced to pig-iron at a much less cost than by the blast furnace, seems to count for little in the judgment of the writer in "The Times," who persists in hiding himself behind the international reputation of the great Printing House Square newspaper. Dr. Haanel is certainly justified in describing his critic's latest effusion as "crude;" since evidence there is none, to show that the editorial writer of "The Times Engineering Supplement" knows anything about metallurgy; whatever else he may know.

Blissful Optimism.

Our attention has been called to a remarkable passage in the May number of our guileless contemporary, "Industrial Canada." It occurs in an article entitled; "Reports of Water-Power Commission," and runs thus:—

> Contracts could immediately be awarded and work commenced on the basis outlined. Every possible contingency seems to have been provided for—in fact, so liberal has been the allowance for contingencies that the cost of construction might reasonably be expected to fall well within the estimates. The same conservatism applies to the estimates of revenue, which under ordinary circumstances would be largely in excess of the figures shown. The report, therefore, is doubly valuable: first because the figures therein compiled are absolutely reliable as representing the situation in its most unfavorable aspect, and second, because the possibilities in the way of cheap power to which it unmistakably points are little short of phenomenal.

This effusive deliverance seems to have been written in accordance with the ancient formula of "shut your eyes and open your mouth and see what someone will send you."

The Coming of the Moulding Machine.

Every Engineering establishment in Canada possessing a foundry, that did not send the superintendent or foreman, or both, to the American Foundrymen's Convention, held at Cleveland, Ohio, U.S.A., June 6th and 7th, missed the greatest opportunity ironfounders ever had of gaining a profitable knowledge of economic founding, since the days of Tubal Cain. Two Canadian companies only were represented,—viz.—Canadian Westinghouse Company (D. Reid), and Toronto Foundry Company (S. S. Anthes). The comprehensive exhibit of moulding machines, foundry appliances, and supplies generally, in the Central Armoury, (see special August number), was a revelation of the wonderful progress made in the art of founding in metals since the year 1896: when the A.F.A. was founded in Philadelphia, with T. J. Best, of Montreal, and the present editor of "The Canadian Engineer" among the organizers. One ineffaceable impression made by the Cleveland exhibit was, that the moulding machine is destined to revolutionize the foundry business; for when—as was actually demonstrated at the Convention—a simple power machine, operated by one laborer, another shoveling sand, and one to carry away the flask, can turn out one mould per minute; or on a union rule of seven hours moulding, pouring 140 moulds per man; being twice as much as a union moulder can do by hand, then no enlightened owner of a foundry will submit to the primitive hand moulding methods of making duplicate castings, which we find in so many foundries in Canada to-day.

Fort William Grain Elevator Collapse: Mr. Jamieson's Comment Thereon.

Concerned from an Engineering point of view about the deplorable frequency of grain elevator break-downs in Canada recently, and desirous of bringing the searchlight of science to bear thereon, in order to prevent a recurrence of these disasters, which are such a hindrance to the trade and commerce of the North-West, we wrote to Mr. J. A. Jamieson, C.E., of Montreal, the authority on "Grain Pressure in Deep Bins," for his opinion of the cause of the recent collapse of the Ogilvie Elevator at Fort William, and have been favored with the following reply:—

> In reference to the collapse of the Ogilvie Elevator at Fort William, I have received a very complete set of photographs, and a close study of same leaves no doubt that the collapse was due to the failure of the foundations; but as to whether it was the piles of the concrete sub-structure that failed first, it is, at this date, impossible to say. As I have no definite data as to the actual foundations, I cannot make any calculations as to its strength. It has always been understood that the piles were driven down to the rock, but in view of this failure and from what I know of the soil in this district, I believe it probable, that what they assumed to be rock, was nothing more than a thin strata of cemented gravel with soft material underneath.
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> While I am entirely opposed to cylindrical bin structures in which the interstices are used as bins, I

have always considered the MacDonald system, which has very small interstices, the best of this type. Considering the excessive strains upon it due to the failures of the foundation, the bin structure has held remarkably well. As the bins in this elevator were 94 ft. deep, the minimum load, when filled, would be 6,000 pounds per square ft., over the whole area covered by the building, this would require a very strong foundation.

I believe that this failure, as well as a great many others, is simply the result of the vicious system of prospective elevator owners calling for competitive plans and tenders, and then awarding the contract to the lowest bidder. There are, of course, a number in the business like our Buffalo friends, who are simply guessing all the time; but those builders who can and do figure the strength of their structures, have to work on a much lower factor of safety than they would like if they hope to secure this class of competitive business of get any profit.

We propose in an early issue dealing with this whole question of grain elevator design.

A New Industry: Cobalt Ore Smelting And Silver Refining At Hamilton, Ont.

Just when going to press, comes to hand reliable news of the starting up of a Cobalt ore smelting and silver refining plant at Hamilton, Ont. The works are owned by Cobalt mine operators; the process being secret. Most of the machinery has been purchased from Germany and the United States. Twenty tons of ore has been shipped from Cobalt for treatment. Roasting and grinding to powder has already begun. It is said that some of the ore contains 75 per cent. of silver. If successful, it will mean much for the silver, nickel, and cobalt industry; for Cobalt ores have, hitherto, been sent out of Canada for treatment.

BOOK REVIEWS.

Minerals and How They Occur.—By Willett G. Miller, Provincial Geologist; formerly Professor of Geology in the School of Mining, Queen's University, Kingston, Canada. Toronto: The Copp-Clark Co., Limited. Size 7¼ x 5, pp. 252. (Price $1.00.)

In these eventful days, when the immense mineral resources and gem-stone treasures of Canada are being unearthed in the far northern regions of Ontario; Quebec, and British Columbia, the publication of Professor Miller's invaluable little primer on mineralogy, is as welcome as the flowers in May. It is true Dana and Geikie are always with us, but these classic text books on geology, perfectly scientific though they be, are to the average engineer and prospector—seeking not an expert but a working knowledge of applied geology—is as wearying as the legendary walk through the valley of dry bones.

Every mechanical engineer ought to know something of the ores from which the metals he uses are derived, also of refractory furnace lining materials, organic fuels, foundry sands, etc. Every civic engineer ought to be practically acquainted with the igneous rocks from whence he gets his paving stones and macadam roads, as well as the cement materials from which his concrete mixtures are made. Every architect should have a sound knowledge of the derivative rocks from which he gets his durable and easily sculptured materials for ornamenting and constructing the buildings he designs. To all such, this elementary work of 252 pages will be a veritable treasure. Although familiar with the standard works, we became so interested in Professor Miller's unpretentious little volume, that recently we carried it all through the Cobalt region for recreative reading. The author's mastery of his subject is evidenced by the fact, that in some chapters—particularly those dealing with the oxides of iron and other metals—he sometimes concentrates into a sentence or two, apt definitions and comprehensive expositions which, in more pretentious works, would be elaborated into whole chapters, and yet he says all that is necessary. The art of the teacher is evidenced on every page. One of the most luminous chapters is that on "Systems of Crystallization" of which there are 32 symetric types. This is a branch of science, the practical utility of which, is becoming more and more apparent every day. Crystals under the microscope are now playing an important part in the metallurgical and mechanical processes to which iron, steel and other metals are subject.

In summarizing the general character of the book, we may say, that in the introductory chapters are described, in a lucid manner, the materials of which rocks are made, and how the geological formations took place: illustrating these phenomena by means of admirable photographs—mostly taken in Canada. Then, the chemical composition and physical characteristics of the minerals are clearly explained. These, also, are illustrated by photographs of actual minerals and fossils. The valuable feature of the work is, the economic treatment of the subject; for simple chemical and blow-pipe tests are given, in order to familiarize the student or general reader with the common every-day metals. Not the least important section is that giving the commercial values of the common ores and minerals; while the chapter giving a list of kindred works will be welcomed by all who take a more than passive interest in the important subject of mineralogy.

We would not be surprised to hear, that in Canadian Technical Schools, this well-printed, graphically illustrated, and up-to-date scientific text book of mineralogy has displaced all others. The Provincial Geologist of Ontario is to be congratulated upon giving to the Dominion, at an opportune time, a gem of a text book, which ought to be prized by every science student, engineer, and prospector, in the Land of the Maple Leaf.

BOOKS RECEIVED.

Manual for Engineers.—Tables and other data for engineers and business men. Compiled by Chas. E. Ferris, B.S., Professor of Mechanical Engineering, University of Tennessee. Knoxville: University of Tennessee. Size 3 x 5¾, pp. 242. (Price 50 cents.)

The Manual of Lubrication, or How to Choose and How to Use Lubricants.—By Louis Simpson. Manchester: J. Andrew & Co., 1 Warren Street. Size 5¼ x 7½, pp. 92. (Price 3s. 6d. nett.)

The Naval Pocket Book.—The Navies of the World.—A complete list of every battleship, cruiser, gunboat, submarine boat, torpedo boat and destroyer, harbour, hospital, training and subsidiary vessel, giving details of displacement, armament, protection, engines, coal capacity, etc. Founded by Sir W. Laird Clowes; edited by Geoffrey S. Laird Clowes. London: W. Thacker & Co., 2 Creed Lane, E.C. Size 4 x 5¾, pp. 965. (Price 7s. 6d. nett.)

City Roads and Pavements.—By Wm. Pierson Johnson. New York: Engineering News Publishing Co. Size 6 x 9, pp. 197. (Price $2 nett.)

Steam Turbine Engineering.—By T. Stevens, C.E., and H. M. Hobart, B.S.c. Toronto: The Macmillan Co., of Canada, Limited, 27 Richmond St. West. Size 6½ x 9¼, pp. 814. (Price $6.50 nett.)

Industrial Furnaces and Methods of Control.—By Emilio Damour; translated by A. L. J. Queneau, B.S. (Paris), E.M., A.M. (Columbia), Consulting Engineer, The New Jersey Zinc Co. New York: The Engineering and Mining Journal. Size 6½ x 9½, pp. 317. (Price $4.00)

Machine Drawing.—For students preparing for the science examinations in technical institutes and evening schools. By Alfred P. Hill. London: P. S. King & Son, Orchard House, Wesminster. Size 11 x 8½, pp. 83. (Price 2s. 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.)

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.]

NEW PUBLICATIONS RECEIVED.

The Illuminating Engineer.—Published monthly by the Illuminating Engineer Publishing Co., Broad Exchange Building, New York. This journal is devoted exclusively to the technical side of artifical illumination, and the use of electricity, gas, and other illuminants will receive a due amount of consideration. It is a finely printed, well illustrated, and ably edited publication, worthy of patronage by everyone interested in artificial lighting. Size 6¾ x 10¼. (Annual subscription $1.)

American Society of Refrigerating Engineers.—The 1906 year book has just come to hand, and we are advised by the secretary, W. H. Ross, that anyone interested may secure a copy by addressing him at Suite 806, No. 258 Broadway, New York City. This book contains a list of the officers and members of the society, together with the constitution and by-laws. Size 3⅜ x 6½, pp. 32.

Concrete and Constructional Engineering.—A bi-monthly journal for engineers, architects and surveyors, contractors and builders, and all persons interested in cement, concrete, reinforced concrete, and constructional steel. This journal has been founded with the object of meeting the growing demand for reliable technical information, regarding the subjects mentioned, and will contain a reliable digest of the world's latest information. Publishing offices: 57 Moorgate Street, London, E.C. Size 7 x 9¾. (Annual subscription 7s. 6d.—post free.)

The Imperial Institute.—The first part of volume No. 6, of the Bulletin of the Institute has just come to hand. It contains able papers on the resources of the Empire. Copies may be obtained from the Institute, South Kensington, London, England. Size 6⅛ x 9¾, pp. 96. (Price 1s.)

Civil Engineering.—A Journal for Civil Engineers and Engineering Contractors.—This is the first journal ever published, devoted exclusively to the profession of the civil engineer. It is beautifully illustrated, is printed on the very finest paper, and as to the editorials, technical data, and information on "civils" generally it is high-water mark. Published by Horace Marshall & Son, 185 Fleet Street, London, E.C. Size 10 x 14½. (Price 6d. per copy.)

Reinforced Concrete (Advance Sheets).—**Practical Calculations and Application of Reinforced Concrete:** Part I. (calculation), compiled and published by Engineering Department, Trussed Concrete Steel Company, Detroit, Michigan. Size 5¼ x 8, pp. 31. (Price, 25 cents.)

Economices of Power Production.—The Canadian Section of the Society of Chemical Industry, has issued a pamphlet, entitled as above, giving a synopsis of the papers read at its 1904-1905 sessions. The subjects treated are flues and flue gases, smoke consumers and mechanical stokers, boiler waters, and producer gas and gas engines. The articles are all written in a non-technical style, which should be appreciated by every reader. Copies may be obtained from A. Burton, 44 York Street, Toronto, Ont. Size 6 x 9, pp. 48.

Recent Practice in the Erection or Lightning Conductors.—By Alfred J. Henry, Professor of Meteorology, prepared under the direction of Willis L. Moore, chief United States Weather Bureau. Published by the U. S. Department of Agriculture. Size 6 x 9, pp. 20.

City Engineer's Report, Hamilton.—The 1905 report of the City Engineer of Hamilton, Ont., has just come to hand. The report gives a detailed acocunt of all works done by the Engineer's Department, many of the reports being accompanied by full pag illustrations. Size 6¾ x 10, pp. 84.

British Fire Prevention Committee.—Fables for children, in respect oi the danger of playing with fire, bring four of the fables accorded awards in the Committee's Fable Competition of 1905. British Fire Prevention Committee, Waterloo Place, Pall Mall, London. Size 5½ x 8¼, pp. 16. (Price 3d.)

CATALOGUES AND CIRCULARS.

Electrical Supplies, Sockets, and Receptacles.—Canadian General Electric Co., Limited, Toronto. Supply catalogue No. 6 covers a complete line of standard sockets and receptacles, suitable for all conditions and requirements. The illustrations are excellent, and show many types. Size 8 x 10½, pp. 33.

Mine Telephones.—Stromberg-Carlson Manufacturing Co., Rochester, N.Y. "Mine-A-Phones" is the title of an admirable booklet, just received, which describes and illustrates the advantages to be derived from the use of telephones in mines. Size 3½ x 5¾, pp. 16.

Passenger Locomotives.—American Locomotive Company, New York, N.Y. A pamphlet just issued describes Pacific type passenger locomotives, built for various railroads. It includes photographic illustrations, and tabular information concerning each design. Size 6 x 9, pp. 48.

Pumps.—The Smart-Turner Machine Co., Limited, Hamilton. A neatly illustrated catalogue, giving detail as to sizes, cuts, of pumps, as follows: Piston, plunger, feed pumps, Jet condensing apparatus, power and centrifugal pumps, and oil separators. Size 3½ x 6¼, pp. 16.

Lightning Arresters.—Westinghouse Electric & Manufacturing Co., Pittsburg, Pa. "Westinghouse Protective Apparatus" is the title of circular No. 1132, describing and illustrating the various kinds of Lightning Arresters, as manufactured by this company. Size 7 x 10, pp. 23.

Asbestos Protected Metal.—The Asbestos Protected Metal Co., Canton, Mass. This is a new and perfected material for roofings, sidings, and ceilings. It is fully described in a catalogue 5 x 7½, pp. 23.

Drop-Forgings.—J. H. Williams & Co., 150 Hamilton Avenue and Richards Street, Brooklyn, N.Y. A handsomely illustrated catalogue showing drop-forgings of almost every description, manufactured from iron, steel, copper, bronze, and aluminum. Prices are given for all standard forgings, wrenches, etc. Size 5 x 7½, pp. 113.

Electric Fans.—Canadian General Electric Co., Toronto. Bulletin No. 838 sets forth ceiling and column fans of nearly every design. Full particulars are given, including price. Size 8 x 10½, pp. 12.

Electric Hoists.—The Yale & Towne Manufacturing Co., New York, N. Y. We have just received the latest catalogue from this company, dealing with electric lifting apparatus. The illustrations are excellent, and show very clearly the many uses to which this apparatus may be put. Special attention is called to the following points: Single point suspension; steel suspension; turntable collector rings; solenoid brake attachment. Size 5¾ x 9, pp. 24.

Refrigerating and Ice-Making Machinery.—J. and E. Hall, Limited, Dartford Iron Works, Kent, England. Messrs. Hall are makers of refrigerating machinery on their patent Carbonic Anhydride System, which is used by all the leading steamship and meat companies of the world. These machines are graphically described and illustrated in the catalogue they have sent to us. Size 5½, pp. 120.

A 48-page pamphlet describing various types of horizontal and vertical ammonia compression refrigerating machines and equipment for ice plants, breweries, packing houses, etc., has just been issued by the De La Vergne Machine Co., foot of East 138th Street, New York. The book is illustrated by many fine half-tones, a feature of these being the clever and artistic arrangement of composite views of plants installed in various parts of the world.

Electro-Static Voltmeter.—Canadian Westinghouse Co., Limited, Hamilton, Ont. This instrument, which is used for measuring high voltages, is compared with other methods, in circular No. 1130. The comparison is made in order that the advantages of the Westinghouse product may be appreciated. Size 7 x 10, pp. 8.

Car-wheel Lathes.—Niles-Bement-Pond Co., 111 Broadway, New York, N.Y. The "Progress Reporter" for June deals exclusively with car-wheel lathes, showing the capacity doubled in two years. Size 9 x 12, pp. 12.

Asbestos.—Canadian Asbestos Co., Montreal, Que. This company manufactures and carries in stock a full line of the following products: "Asbestic wall plaster; "Asbestine" cold water paint; asbestos roofing, building board, and shingles, packings and general mill supplies. The above products are admirably set forth in their recently published catalogue. Size 4¼ x 7, pp. 72.

Centrifugal Gas Blowers and Exhausters.—Bulletin No. 133, recently issued in the Sturtevant Engineering Series, published by the B. F. Sturtevant Co., Boston, Mass., is a pamphlet of sixteen pages. This bulletin is designed to illustrate from actual photograhs Sturtevant centrifugal gas blowers and exhausters installed in a few of the best and largest gas plants in the country. It contains a valuable table showing the various sizes and capacities of blowers and exhausters designed for gas plant work.

Electric Motor and Trailer Trucks.—A pamphlet describing electric motor and trailer trucks has just been issued by the American Locomotive Company, illustrating the types of this equipment, designed and built by them. The pamphlet gives a description of the principles of the designs, fifteen of which are illustrated, each illustration being accompanied by a list of dimensions. Size 9 x 6, pp. 55.

LEGISLATIVE TOUR IN NORTHERN ONTARIO

Inspection of Government Lines, Forest Lands, and Silver Mines in Cobalt Region.

By the Editor.

The 400 mile excursion, planned by the Hon. Dr. Reaume, Minister of Public Works, on behalf of the Legislative Assembly of the Province of Ontario, which started from Toronto, May 29th, up to North Bay, over the Government line (Temiskaming and Northern Ontario Railway), through the Cobalt region, and away into the forest lands of Northern Ontario, towards Hudson Bay—returning June 1st—was an event long to be remembered by the 108 legislators, judges, scientists, and representatives of the newspaper and technical press who were privileged to take part in this historic trip.

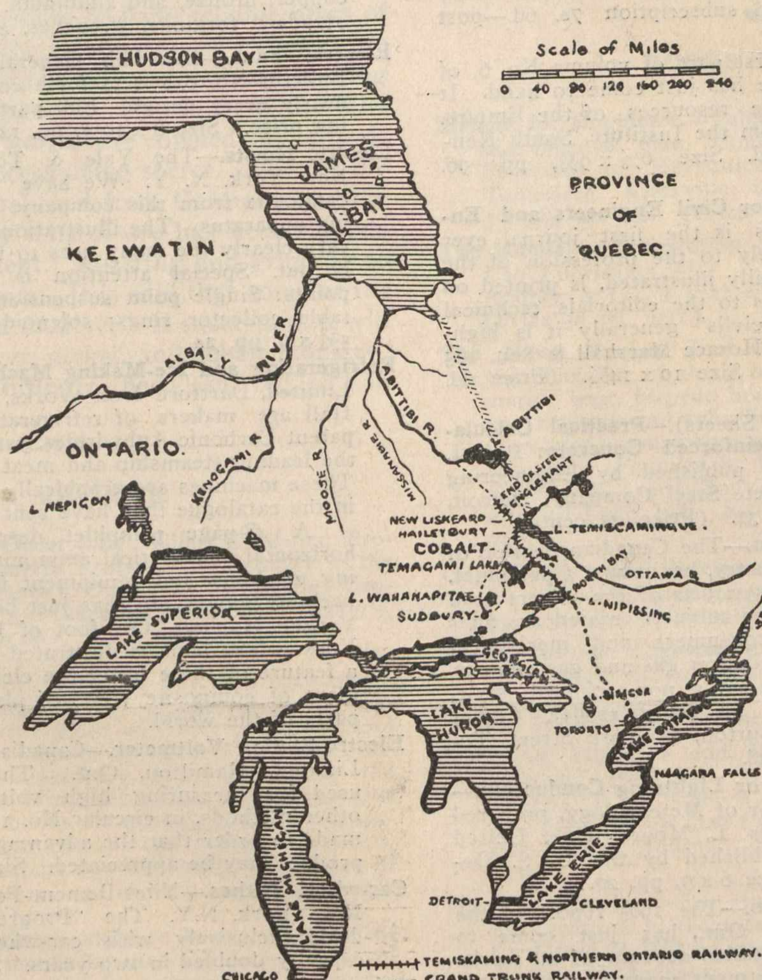
The aim of this observation tour was primarily, to enable the Ontario Legislators to see with their own eyes, what the taxpayers of the Province have got for the $7,376,000 already spent on the 113 miles of Government railway, laid down from North Bay to New Liskeard and beyond; and at the same time, to get a panoramic view and personal knowledge of the rich mineral, forest, and agricultural lands of the Cobalt region, in order to legislate in the interests of the Province, by opening out still further to civilization and commerce the resources of the fruitful "North Countree," up to the 200 miles of sea coast which separates Ontario from the great inland salt waters of Hudson Bay.

Staggering though $45,000 a mile seems to be for a settlers road, yet an experienced engineer has only to travel over the 165 miles of railway from North Bay to the "end of steel," and perceive the stupendous obstacles which had to be overcome: streams, rivers and ravines to be crossed, necessitating seventeen viaducts, bridges and trestles; wide stretches of muskeg to be solidly ballasted and cushioned; dense pine and spruce forest penetrated and levelled; and cuttings blasted through solid granite hills 100 feet high by 60 feet wide: difficulties which must have taxed even the experienced railroading skill and executive ability of Cecil B. Smith; then to see how substantially the trestling, blasting, track laying, and general equipping of the railroad has been done, to unhesitatingly affirm, that the money spent, has been well spent, and that the Ontario Government has an invaluable railroad and rolling stock asset, in the Temiskaming and Northern Ontario Railway.

The following is a necessarily brief diary of data gathered, scenes beheld, and incidents noted on this interesting tour.

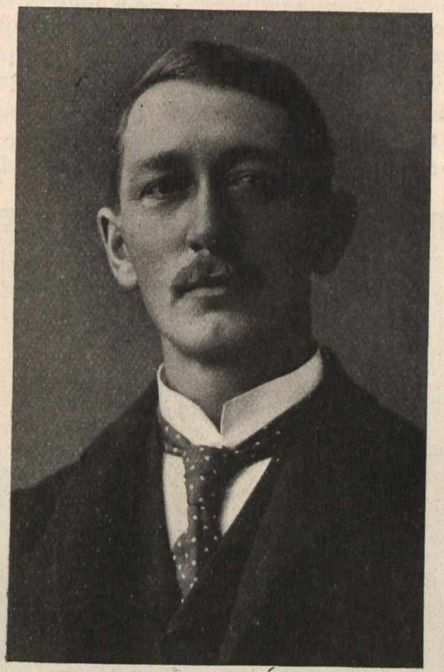
Diary.

May 28-29. About midnight Monday, the special train, consisting of five Pullman sleepers, two dining cars, and one baggage car, left the Union Station, Toronto, hauled by two Grand Trunk Engines, arriving at North Bay 9.15 Tuesday morning. The party were joined at the station by the following officials of the Temiskaming & Northern Ontario Railroads:—Messrs. J. H. Black, Superintendent; G. A. McCarthy, Chief Engineer; W. C. Cunneyworth, General Passenger and Freight Agent; and Geo Lee, Freight Agent.



Map Showing Route of Observation Tour.

The two Grand Trunk Railway engines were replaced by Temiskaming & Northern Ontario Railway, engine No. 107 and the train pulled out for the "North Countree" at 10.40 a. m., with engineer L. J. Shaw, at the throttle, assisted by fireman J. Fry, Conductor Jas. Nidd in charge of the coaches, assisted by brakeman A. Aubry, with baggageman Ed. Sheppard looking after the letters. At North Bay Junction the able master mechanic, Arthur Allan, joined the party, and a stop of a few minutes was made to inspect the yard and temporary repair shops, in which are employed about forty men. The motive power building 150 x 50 feet, is equipped with a 72" Bertram wheel turning lathe; planer 30" x 8'-0"; 16" shaper, 24" drill press; 2 = 36", and 1 = 14" lathes; complete grindstone and emery wheel equipment; "Acme" screw cutting machine, etc. These modern machines are all belt driven by 50-H.P. Ball engine, with steam generated by 60-H.P. tubular boiler. The plant is lighted by electricity from a 7½-K.W. generator, developing 100 C.P. engine No. 102 was on the blocks, undergoing repairs. In the carpenter's shop, 75 x 35 feet, which is equipped with modern woodworking machinery, i.e., band and rip saws; matching and moulding machines, shaper, knife grinder, etc., coaches were undergoing repairs, painting, decorating, etc. Every department was busy, and we were impressed with the orderly and systematic manner, in which the motive power and car department was being managed.



Cecil B. Smith, C.E.
Chairman of Railway Commission.
Author of "Railroad Engineering."

It is manifest that the shops described, will soon be inadequate for the equipment needed for the traffic on this increasingly popular road. But we gleaned that the contract has already been let for the foundations of a large modern Round-House, and commodious Machine Shop; to be built of reinforced concrete and located on the opposite side of the track from the existing building. The present motive power equipment of the line—North Bay to New Liskeard = 113 miles—consists of ten passenger engines: 8 = 19" x 24" cylinder, made by the Kingston Locomotive Works; and 2 = 17" x 24" cylinder, made by Pittsburgh Locomotive Works. Also, 4 freight locomotives, 19" x 24" cylinder, piston valve type, made by the Locomotive and Machine Company, of Montreal, Limited.

At 11.15 the train started merrily northwards again. Easy riding it was over the well ballasted and substantially laid single track of 80-lb. steel rails, and wooden sleepers. On the left of the road we noticed standard poles, connected by five copper wires, giving modern telegraph and telephone service along the whole line.

The first place of interest we passed, was Trout Lake; where the first sod of the Temiskaming & Northern Ontario Railway was turned on May 10th, 1902. Within the sweeping curve of the elevated railway, lies this charming little lake, situated in a fine open forest glade, and dominated at the back of the road by a steep hill, upon which it is proposed to construct a water reservoir. Trout Lake is one of the beauty spots on the route.

As we dashed along at 35 miles an hour, over long stretches of ballast filled trestlework, 30 feet high; through forest avenues of spruce and white poplar; and gaps cut through formidable granite hills, we began to realize, what constructive railroad engineering in the northland means. In the first 22½ miles from North Bay, the line rises 700 feet. After a brief stay at Widdifield, for water to replenish the thirst of the engines, we rushed by Moose Lake, and Redwater, coming into open country, with Lake Temagami on our left.

Speeding past Temagami Station and its picturesque surroundings, we travelled through part of the great Temagami Forest Reserve—which covers 6,000 square miles. About thirty-six miles of the railway runs through this Reserve, and in order to lessen the danger of fires from the locomotive sparks, the timber is being cleared for 200 feet on each side of the right of way. Much of this timber is good pine and spruce, which is selling at an excellent price by public tender. Among the interesting sights along the route, are the temporary saw-mills, where timber is being cut and prepared on the spot for shipment to the pulp mills, etc. In the Bureau of Forestry Report, 1904, it is estimated that on the Reserve, five billion feet (board measure) of good pine timber is ready to be cut—and this is exclusive of spruce, tamarack and hardwoods. Twenty-two miles from Temagami, we stopped for half an hour at the rising town of Latchford, with its two hotels, and twenty other buildings; seventeen of which are stores. The chief local industry is the Empire Lumber Co.'s factory. We heard whispers here, also, of important discoveries of Cobalt-Silver deposits. One man is said to have been offered $100,000 for a claim within three miles of the town. The writer then rode on the engine for nine miles, through one of the most awkward sections of the line—involving many earthwork and rock cuttings; necessitating numerous sharp curves, and nearly every foot of the way, over soft mineralized earth; mostly in the celebrated Gillies timber limit, on which Professor W. G. Miller, the Provincial Geologist, and staff, are engaged surveying, with the view of making an official topographical map. When, however, we emerged into open country again, the far famed Eldorado of the Northland—Cobalt! was in sight.

To those whose notions of a mining camp had been gathered from the romantic stories of Bret Harte, the first impressions of the City of Silver must have been disappointing. There is nothing picturesque about the town; which consists of erratic wooden houses and huts after the Noah's Ark pattern, perched among the tree stumps on the barren hillsides, or located down on the flat lands near the railway, which runs alongside the narrow lake. The streets are mud, and the sidewalks timber boards. Hideous placards advertising Regal Beer confront us everywhere. But although it is no "sweet Auburn village;" and though the civic marks of city refinement are missing, it is a veritable city of sunshine!

A Western Prospector.

The brutal rowdy of the western frontier is not here; thanks to direct railway communication, and the strong arm of Canadian Law. The rough miners, athletic college graduates, keen merchants, astute representatives of the wealthy syndicates, and grey-haired men making their last throw in life, are too much in earnest; have no time to fool after the gross and sensual. Every eye seemed to burn with excitement; on every face were the signs of hope and expectation. When we steamed in to the station, the platform was covered with groups of eager prospectors and claim owners. Brief fraternization, then away to the high ground above the station sped the party, and there explored the various fissure workings, and gathered specimens of ore with the pink cobalt bloom—the sure indication of silver. The most interesting strike was the Trethewey mines, where a costly power plant is being installed; tubular boilers, air compressors, pumps, pneumatic drills, etc. Over $265,000 worth of silver has already been taken out of this working, by hand labor; some carloads of twenty tons, containing silver valued at $70,000; and since millions are in sight, more expeditious methods are warranted. The mining of the ore in most of the workings inspected in the woods, was being done by primitive hand-drills; for the cobalt, nickel and silver ore bodies, or veins in the fissures are shallow, and near the surface.

Cobalt City is the only spot in the world where silver has been found in the placer condition. Hitherto, Nature's wealth has been found in placer as gold, platinum, and precious stones; so that in this respect, Cobalt stands unique on the globe. Across the track, at Peterson Lake, the Earle people are taking advantage of this provision of Nature, and are installing a modern hydraulic plant, to raise water from the lake by a powerful pump to the hill, for washing purposes, and then with a 2" "Monitor" shoot down the hillside again. In this way, not only saving the silver, but at the same time laying bare the bed-rock; thus tracing the silver to its origin; i.e., determining whether it has been concentrated there by glacial action, or by local geological formation.

The most popular expedition of all was through the southern woods, to the famous Timmins Mine. Here "rich examples of ore were uncovered for the visitors. One of the miners kicked away with his foot a clump of moss, and disclosed a nugget, the end of a vein 4 or 5 inches wide, said to be almost pure silver. By rubbing it with his boot, it polished like a ten cent piece!" Over $600,000 worth of silver has been taken from this mine, and if the rest of the many "strikes" in the district were as rich as this one, the wealth of Cobalt region, would be beyond computation. And the potential wealth of this wonderland is not in its fabulous resources of silver alone; for science has recently discovered another important commercial use for Cobalt. Hitherto, in oxide form, it has been used as a coloring constituent for glass and earthenware ($3 per pound); but Edison has discovered that Cobalt can be largely used in electric storage batteries, in place of the heavy masses of lead and nickel now in vogue. By using Cobalt, he claims he can reduce the weight of storage batteries in automobiles by 50 per cent., and the cost of traffic in the cities 55 per cent. Mr. Edison is reported to have offered, through his representatives, to buy all the Cobalt on the Temiskaming market.

Rich beyond measure in earthbound treasures of valuable metals, minerals, and precious stones needed by our great civilizations, the possibilities of this region no pen can exaggerate.

Historical.

The discovery of this district as a mining section, was chiefly due to the location chosen for a new railway. Had the engineers chosen the route first contemplated, the mineral wealth would doubtless have remained undiscovered for years. The district had been "lumbered" a few years before the advent of the railroad, and during the operations a slide was so placed that the logs tore into the decomposed ore at the surface of a large vein. At that time no thought of its commercial value was entertained. In 1903, however, a railroad construction gang, attracted by the pink color of the Cobalt bloom, (an unfailing indication of silver), conceived the idea that the ore bed exposed might be of economic value, and drew the attention of the Bureau of Mines to the interesting find. Professor W. G. Miller, examined several samples, realizing the importance of the discovery, and upon his advice, a geological survey was made, and the mining possibilities at once made known to the public.*

"In the three months ending March, 1906, 360 tons of ore were shipped from Cobalt. This ore aggregated 580,825 ounces of silver: an average of 1,630 ounces to the ton. The value of the silver was $302,428. Since the opening of the camp at the end of 1904—when first shipments were made, the total output has been $2,250,000."

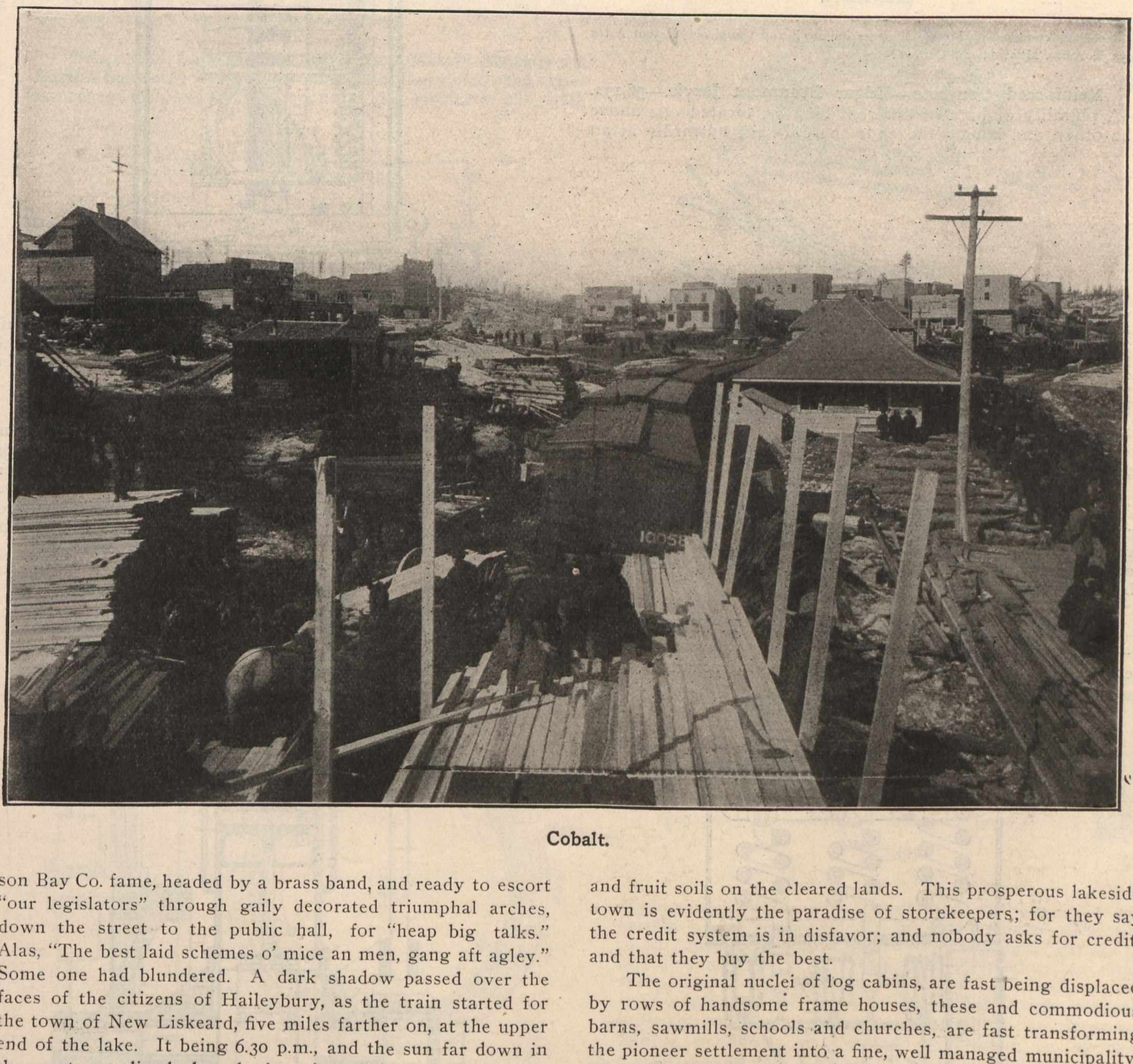
Lake Temagami.

*For geology of Cobalt Region, see "The Canadian Engineer," January, 1906.

After a partial inspection of three hours, it must—in view of the foregoing facts—have been a proud moment for the Legislators, Railroad Commissioners, and Provincial Geologist, as they returned to the Pullmans again, that they, by a wise forward policy, skillful engineering, and sound scientific advice, had been instrumental in opening out to commerce and civilization, the region of mineral wonders which they had just beheld; whose future possibilities no man could estimate, but whose material advantage to the Province of Ontario was as certain as the rising of tomorrow morning's sun.

Leaving Cobalt, to its visions of wealth, we soon came in sight of Lake Temiscamingue on the right, with charmingly located Haileybury nestling serenely down on the margin of the beautiful bay; out into which the Dominion Government have built a substantial stone pier in the form of a cross, for steam boat traffic to the mainland of Quebec, on the other side of the blue waters. A brief wait in the station, a quick glance at the assembled crowds of sturdy pioneers on the platform, led by Mayor C. C. Farr of Hudson Bay Co. fame, headed by a brass band, and ready to escort "our legislators" through gaily decorated triumphal arches, down the street to the public hall, for "heap big talks." Alas, "The best laid schemes o' mice an men, gang aft agley." Some one had blundered. A dark shadow passed over the faces of the citizens of Haileybury, as the train started for the town of New Liskeard, five miles farther on, at the upper end of the lake. It being 6.30 p.m., and the sun far down in the west, we dined aboard, then, in provided carriages, the party started in procession, through New Liskeard town, led by Mayor McKelvie, town dignitaries, and the brass band; culminating in a public meeting in a Presbyterian Church, where speeches were delivered by the Mayor; J. D. Taylor, President of the Board of Trade; Hon. Frank Cochrane, Minister of Lands and Mines; Hon. W. J. Hanna, Provincial Secretary; Hon. Col. Matheson, Provincial Treasurer; Hon. Dr. Willoughby; T. H. Preston, M.P.P.; Joseph Downey, M.P.P.; J. A. Macdonald, Editor "The Globe," and J. S. Willison, Editor "The News."

New Liskeard has been described as "the metropolis of the great clay belt," and with good reason; for the land forty miles north, is very rich clay loam; part of the sixteen million acres of clay belt, which crosses the Province from East to West. Here 65 per cent. of the freight north of North Bay is delivered for distribution. The town is admirably located, having connections by steamer with all points on Lake Temiscamingue; while the railroad station is an ideal distributing point to the fine farming country on the north and west. Within a measureable distance of this rising town, the finest hard wheat in the world is grown! The Wabe River, half a mile long, runs in from the lake into the town, and the steamers, and masted fishing boats, moored alongside the wharf, give the place a touch of the romance of the old Cornish town in the south of "Old England," after which it is named. The fertile area which environs New Liskeard, abounds with heavily timbered forests of pine, spruce, cedar, and tamarack, fir, etc., and immense quantities of pulp-wood and railway ties are being shipped over rail by the energetic farmers, who are tilling the rich virgin wheat and fruit soils on the cleared lands. This prosperous lakeside town is evidently the paradise of storekeepers; for they say the credit system is in disfavor; and nobody asks for credit, and that they buy the best.



Cobalt.

The original nuclei of log cabins, are fast being displaced by rows of handsome frame houses, these and commodious barns, sawmills, schools and churches, are fast transforming the pioneer settlement into a fine, well managed municipality. The chief contributing factor in this social evolution is the railway; which has enabled the settlers to find a ready market for their lumber, fish, and products of the fertile soil.

Professor Sharp, of Queen's, is farming near New Liskeard, and is said to be "looking prosperous and happy."

At the close of the public meeting, the party, pleasurably wearied with an eventful day in glorious weather, returned to the Pullmans; and had little trouble in wooing "balmy sleep, Nature's sweet restorer;" disturbed only by dreams of "God's Country," through which they had been passing.

(To be Continued.)

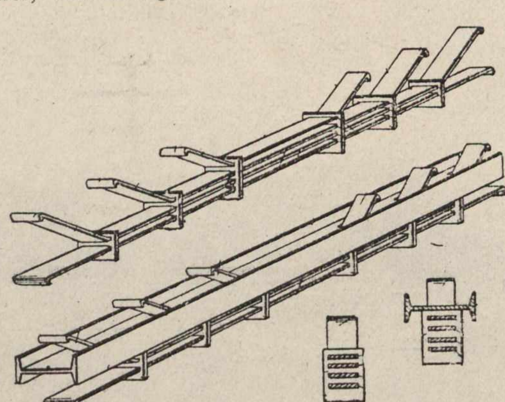
INTERNATIONAL PATENT RECORD

Dominion Houses of Parliament.

CANADA.

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

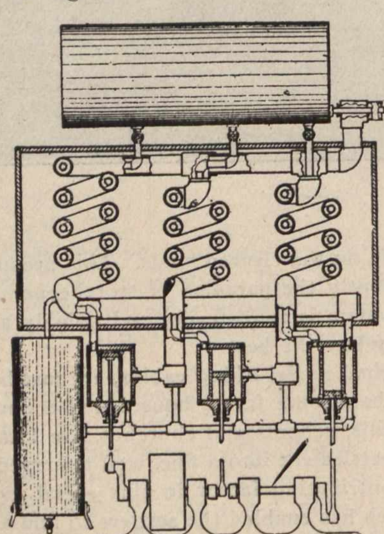
Reinforced Concrete.—Edgar Beaumont Jarvis.—96,172. —A plurality of bars of different lengths, located one above the other, and having the ends thereof bent upwardly at an



96,172.

angle, and suitable separator plates having orifices through which the said bars pass, the said plates forming a hanger or support from the upper bar for supporting the lower bars.

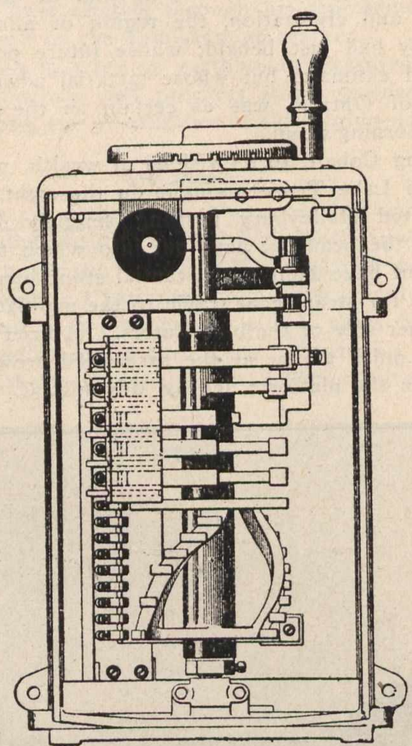
Apparatus for Liquifying Air.—James F. Place.—96,072. —This apparatus consists of two or more expansion engines, each engine having a counter current interchanger, com-



96,072.

prising an inlet compressed air pipe and two outlet vaporized liquid gas pipes, connected to a condensing pipe passing through a liquid air vaporizing vessel, which is in turn connected with a liquid air reservoir.

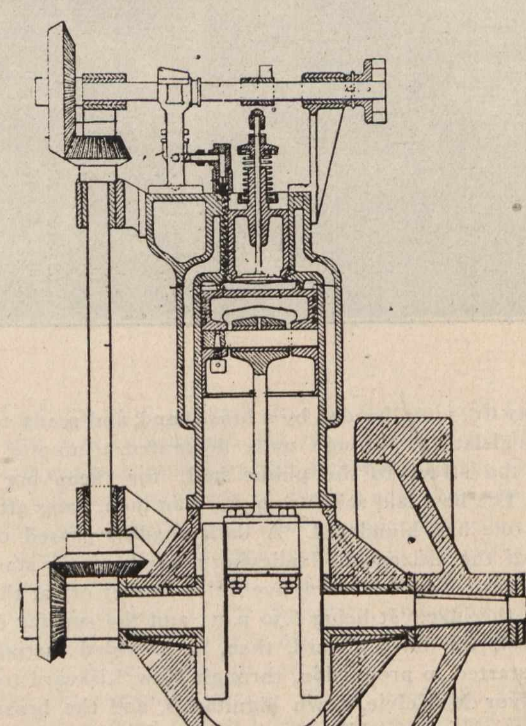
Electric Controller.—The Canadian Westinghouse Co. —96,343.—A resistance in the armature circuit of a motor; a controller switch, comprising a contact finger adapted to cut out the said resistance; a controller handle and a movable conducting segment connected thereto to engage the said finger; a magnet for automatically operating said



96,343.

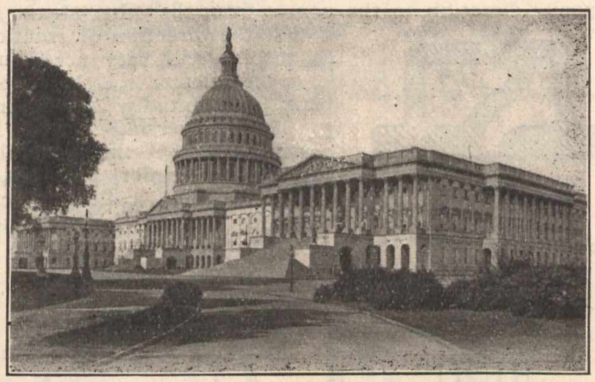
finger and cutting out the resistance in the armature circuit operated by the difference between the electro-motive force applied to the armature circuit and the electro-motive force of the motor.

Oil Engine.—James W. Cross.—96,319.—The main essentials are two compartments or chambers having a common opening into the compression end of the engine cylinder, both adapted to receive the air under compression; a piston working in said cylinder, and having an extension therefrom adapted to divide the said chambers near the end of



96,319.

the stroke; a pump for forcing oil into one of said chambers, and means for igniting said mixture. The method of working the engine is to divide the air being compressed into two compartments, force oil into one compartment and ignite the mixture, which, as the piston travels outwardly, mixes with the air from the other compartment and effects complete combustion of the oil.

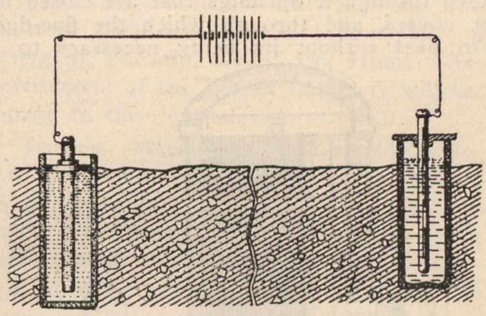


Capitol, Washington, U. S. A.

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.

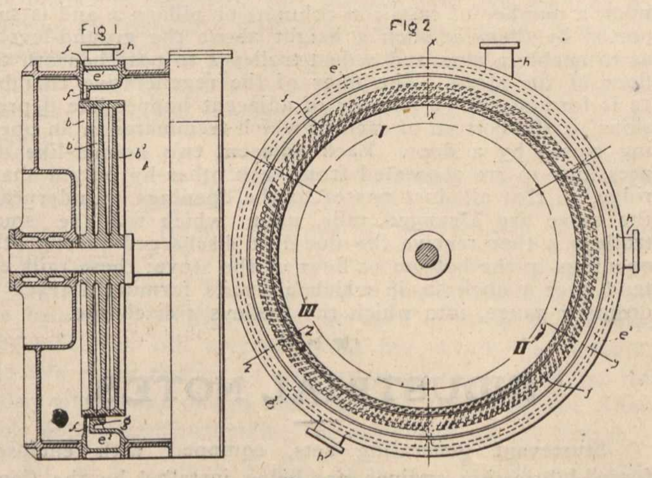
Process of Locating and Extracting Metals Beneath the Earth's Surface.—Edson R. Wolcott, Golden, Colo.—822,175.— A process of locating metals beneath the surface of the earth



822,175.

consists in placing electrodes having the relation of anode and cathode in the earth, and passing an electric current between them and causing the metals in solution in the vicinity of the electrodes to move through the earth and be deposited upon the cathode.

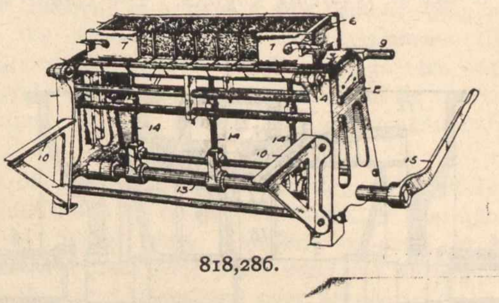
Steam Turbine.—Johann Stumpf, of Charlottenburg, Germany, Assignor to General Electric Co., A Corporation of New York.—821,599.—This invention relates to improvements in steam or gas turbines, and more especially to such



821,599.

turbines in which the pressure of the steam or compressed gas is transferred into streaming velocity, which is utilized in one or several bucket-rims. In such turbines the number of revolutions depends upon the number of bucket-rims to which the steam flows. It often occurs that the number of revolutions of a turbine has to be altered or changed, especially in case the turbine is used for driving screw-propellers, pumps, or the like. In the turbines hitherto constructed the consumption of steam was always increased if the number of revolutions had to be reduced. In order to do away with this disadvantage, the new invention consists in a turbine provided with several turbine-wheels or several rows of buckets in one turbine-wheel, means being provided for running the turbine with one or several rows of buckets, in which latter case shovels or buckets, so-called "return" buckets, are provided, which lead the steam leaving the buckets of one turbine-wheel into the buckets of the following one or in the case of using one turbine-wheel with several rows of buckets into the buckets of the following row. For this purpose the turbine is constructed with fractional supply—that is to say, a turbine in which the nozzle-rim is divided in several parts, each of which parts can be used for driving the turbine. In the first part of the nozzle-rim no return-buckets may be provided at all; in the second part one row of return-buckets may be provided, so that in case this part works two rows of turbine-wheel buckets are at work; in the third part two rows of return-buckets may be provided, so that in this case three rows of turbine-wheel buckets may be at work, and so on.

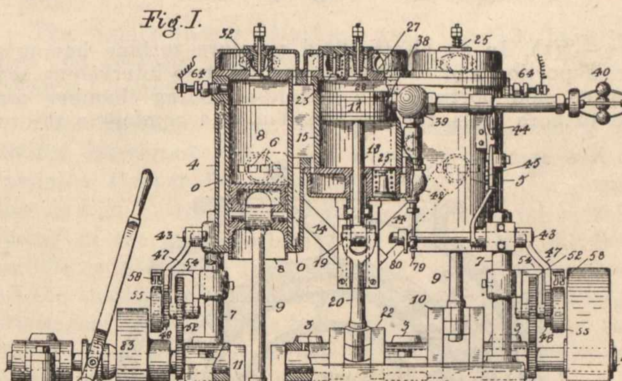
Process of Molding Concrete Bricks or Blocks.—William Porter, St. Paul, Minn.—818,286.—Claim.—1. A process of molding concrete bricks or blocks which consists in placing a thin layer of cement in a mold having a hard smooth floor



818,286.

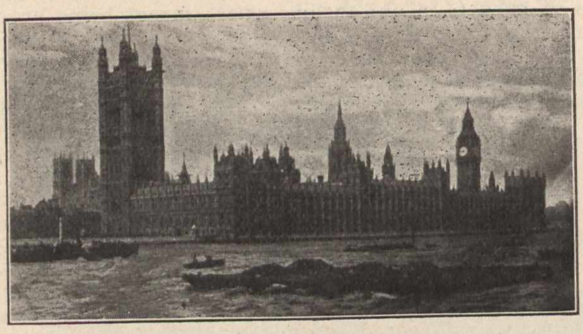
to form on the block a finished facing impervious to moisture, and then filling up and tamping the mold with a mixture of coarse sand and cement to form a comparatively porous backing, substantially as described.

Gas-Engine.—Frederick H. Hurlburt, of Alameda, and Thomas W. Munroe, of San Francisco, Cal.—820,497.—This invention relates to explosive or internal-combustion motive



820,497.

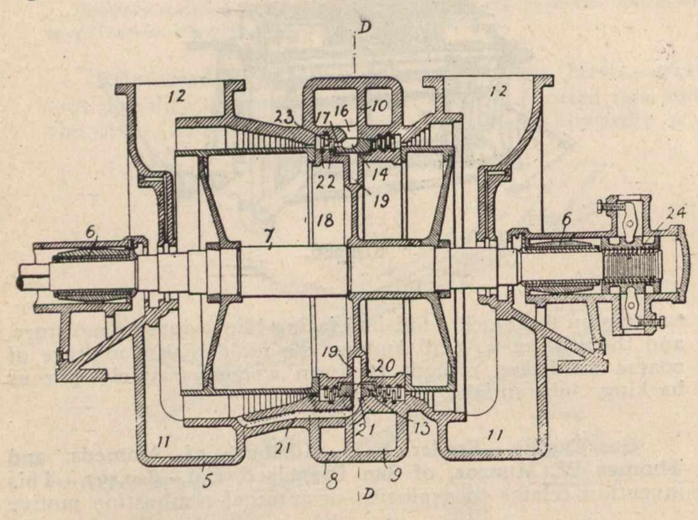
engines impelled by gas, or volatilized hydrocarbons, and to certain useful improvements in such engines. The object of this invention is to attain in an economical manner what is called a "two-cycle" action of such engines, to regulate the power of the same, and provide for quickly reversing their rotative motion, as is required in marine propulsion, hoisting, and like purposes. It consists of two single-acting motive cylinders, with pistons connected to oppositely-placed cranks on a common shaft, a double-acting compressing-cylinder between said motive cylinders, having a displacement volume greater than either of said motive cylinders, a piston in said compressing-cylinder connected to a crank on the common shaft at an angle to the motive-piston cranks, inlet-valves in said compressing-cylinder at both ends, pipes and passages from a fuel-supply to said inlet-valves, a valve at each end of said compressing-cylinder with passages leading to each motive cylinder respectively, a check-valve in each motive cylinder at the terminus of each of said passages, circulatory passages between the compressing-cylinder and the motive cylinders, a regulating-valve in said circulatory passages, igniting means, and a double-acting regulating-valve operating in connection with said igniting means.



British Houses of Parliament.

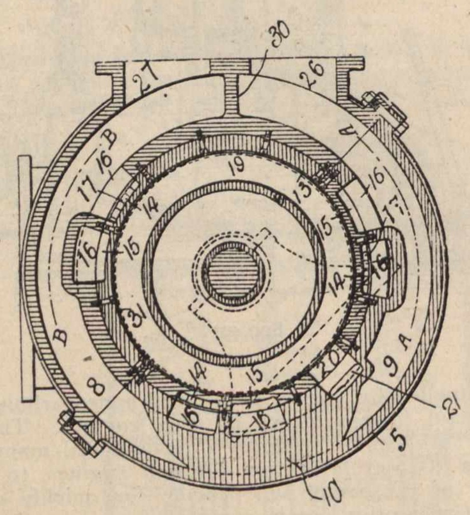
GREAT BRITAIN.

Reversing Elastic Fluid Turbine.—George Westinghouse, Pittsburgh, P.A.—16,542.—This invention relates to elastic fluid-pressure turbines, and more particularly to such turbines which are applicable to marine propulsion, and designed to act as reversing engines. The claims are as follows:—



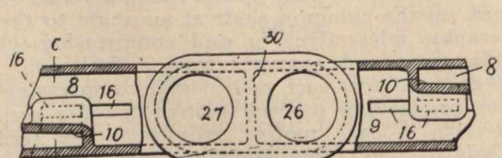
(Fig. 1.)

"(1). In an elastic fluid pressure turbine having an 'ahead' portion and an 'astern' portion, two intervening seals between said portions and a fluid-collecting chamber common to both seals, the arrangement of a conduit in the turbine casing communicating with said chamber for conducting the leakage fluid to an operative point of the turbine, substantially as described with reference to the accompanying drawing.



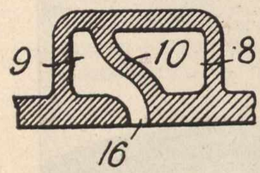
(Fig. 2.)

(2) For a reversing elastic fluid-pressure turbine a nozzle ring provided with two steam spaces and a plurality of admission nozzles discharging from each steam space, the nozzles from one steam space discharging in the opposite direction to the nozzle from the other steam space so that the direction of rotation of the turbine will vary according to the space selected for the supply of steam substantially as described.

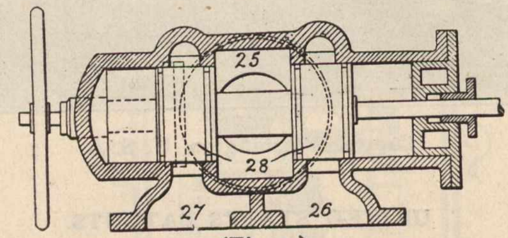


(Fig. 3.)

(3) In a reversing elastic fluid-pressure turbine the general arrangement of inlet passages, admission nozzles, collecting chamber and conduit for conducting the leakage fluid to an operative point of the turbine, as described with reference to the accompanying drawings."

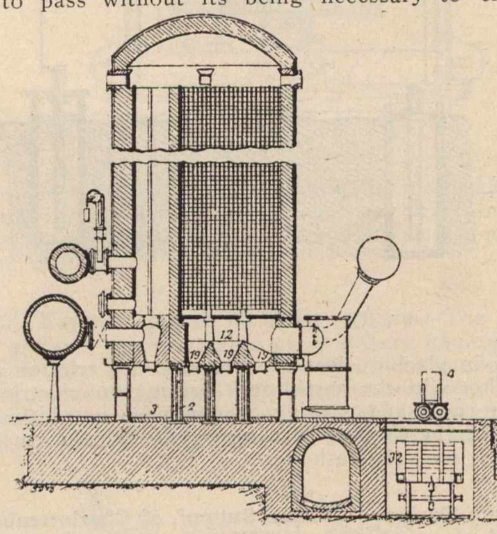


(Fig. 4)



(Fig. 5.)

Hot-Blast Stoves.—J. Evans and D. Lewis, Merthyr Tydfil.—5,975.—A hot-blast stove according to this invention is supported by pillars or columns, so that there is a space between its bottom or floor, and its bottom or floor has formed through it openings that are closed by suitable doors or covers, and through which the flue-dust can be caused to pass without its being necessary to enter the stove or to take the dust out from the bottom of the floor by hand in the usual manner. The floor of the stove rests upon a number of cast-iron columns or pillars 2, and is supported by them at such a height above the ground-level 3 as to enable a man and a dust-trolley 4 to pass beneath the floor of the stove. The floor of the regenerative chamber 12 is formed with a number of adjacent hopper-like depressions 19, the bottom of each of which terminates in an opening closed by a door. Each adjacent two hopper-like depressions 19 are separated from each other by only a sharp ridge, so that all dust passes to the openings. Underneath the stove are arranged rails, upon which run the small trolleys 4 that receive the flue-dust discharged through the openings in the bottom or floor of the stove; these rails extend over a dock 32, in which are rails forming a track of ordinary gauge, into which the trolleys 4 discharge.



5,975.

INDUSTRIAL NOTES.

Sturtevant generating sets, equipped with enclosed, forced-lubrication engines, are being installed by the Canadian Fairbanks Co., Limited, Toronto, Ont.

W. A. Milne & Co. have placed an order with the Smart-Turner Machine Co., Limited, Hamilton, for a side-suction centrifugal pump.

The Smart-Turner Machine Co., Limited, Hamilton, have received an order for a duplex ballast pump from the Collingwood Shipbuilding Co.

The Canadian Machine Telephone Co. are installing their system in Edmonton, Alberta. The complete system will comprise 2,000 telephones, 700 of which will be installed this year.

The Williams Gauge Company have opened a sales office in Montreal with Wm. M. Courtenay as sales manager.

The Polson Iron Works have recently ordered a standard duplex pump from the Smart-Turner Machine Co., Limited, Hamilton, Ont.

The Canadian Fairbanks Co., Montreal, have been awarded the contract for a Fairbanks-Morse 21 H.P. suction gas-producing plant for the W. H. Comstock Company, Brockville, Ont.

The Fairbanks Morse Co., Chicago, Ill., recently placed an order with the Jenckes Machine Co., Limited, Sherbrooke, Que., for a 115 H.P. vertical tubular boiler, 60" diameter by 14 ft. high. The boiler was shipped to Sault Ste. Marie.

The shipments of the Nova Scotia Steel and Coal Company for May were the largest on record with the exception of those for July of last year. The shipments for May show the fine increase of 23,000 odd tons over those for May of last year.

The Hyatt Roller Bearing Co., Harrison, N.J., U.S.A., has just broken ground for a three-storey addition, 75' x 100' to be erected adjoining their present machine shop. Samuel M. Green, of Holyoke, Mass., one of the best-known architects in the East, has prepared the plans.

The Weber Steel-Concrete Chimney Co., Chicago, Ill., inform us that they have opened a Canadian office, with headquarters in Toronto, Room 116, Home Life Building. The advertisement of the Weber Company will be found on another page in this journal.

The Jenckes Machine Co., Limited, have recently shipped to the Alberta Portland Cement Co., Calgary, a complete hoisting plant, consisting of 40 H.P. locomotive boiler and 7 x 10 hoisting engine, together with hoisting rope, steam piping, etc. The order was placed with the company's Rossland office.

A very interesting pamphlet has just been issued by the Sydney Cement Co., makers of the "Rampart" brand of cement, which is every day growing in favor among builders and contributors. The booklet gives a comprehensive description of the slag cement industry in general and of the Sydney manufactory in particular.

The Smart-Turner Machine Co., Limited, Hamilton, Ont., have supplied one of their standard duplex pumps to the North-Western Transportation Co., Athabasca Landing, Alta.

The committee from the city council of Woodstock and the Board of Trade appointed to make an examination of the plant and equipment of a Detroit iron working industry desiring to establish a Canadian branch were very favorably impressed with the prevailing conditions of the business, and as soon as a definite proposition is received from the company, they will prepare a report to be submitted to the council.

John F. Allen, 370-372 Gerard Avenue, New York City, has recently shipped to Manila, P.I., three large Allen riveters of 72" reach on order of the Atlantic, Gulf and Pacific Company for pipe work contract which this firm has secured there. The shipment is just one-half the order, the balance of which will go forward in about two weeks. The machines will average about five rivets per minute; and five other makers of riveting machines figured on the order, which was placed solely on the reputation the Allen tools enjoy, notwithstanding the price was not the lowest.

Mr. R. J. Younge, general sales manager of the Canadian Rubber Co., Limited, of Montreal, returned home on June 19th after a six weeks' trip in Western Canada and several American cities in the interests of the Canadian Rubber Co., Limited, of Montreal. Mr. Younge is most enthusiastic regarding the great future of the West, and found the business of the Rubber Company's Western branches expanding in a very marked manner. Whilst in the West Mr. Younge arranged for the opening of additional branches at Regina, Sask.; Calgary, Alta., and Victoria, B.C. Mr. Younge also visited Seattle and San Francisco and returned east via Chicago.

The Cobalt Refining Co. have placed an order with the Smart-Turner Machine Co., Limited, Hamilton, for a small side-suction centrifugal pump.

The report of the provincial inspectors of factories just issued at Toronto shows that during 1905 there were 635 accidents in Ontario factories, 37 of which were fatal.

The Trail electric plant, Rossland, B.C., owned by the Consolidated Mining and Development Co., was burned to the ground. The loss is $18,000, fully covered by insurance.

Allis-Chalmers Company has purchased exclusive rights to manufacture and sell the Christensen air brakes and air compressors, and has also secured the services of Mr. N. A. Christensen, the brilliant young Danish engineer, who invented them.

The corporation of Meaford have placed an order with the Smart-Turner Machine Co., Limited, Hamilton, for complete auxiliary pumping plant, consisting of duplex compound condensing pumping engine and independent jet condenser, pump, etc.

Port Colborne is to have a new cement company incorporated, the Great Lakes Portland Cement Company, capital $1,000,000. The company expect to turn out at first 1,500 barrels a day, and 2,500 barrels will be the maximum daily output. It will be the largest cement industry in Canada.

One of the most important steps yet taken in the negotiations going on for land in Sandwich East upon which the United States Steel Company proposes to erect a $1,000,000 steel plant took place recently, when a representative of the corporation paid over $17,000 in cash to Jules Robinet and Joseph Chappeau for their farms.

An important order has just been placed for the new power house of the Montreal Street Railway, which is now in course of erection at Hochelaga, with Babcock & Wilcox, Limited, of Montreal, for ten of their well-known water tube boilers, aggregating over 5,000 H.P., and equipped with their patent superheaters and chain grate stokers. This will be one of the most important power plants in Canada.

The Smart-Turner Machine Co., Limited, have supplied one of their standard duplex pumps to the Canadian Canners, Limited, Simcoe.

The Rossland office of the Jenckes Machine Co., Limited, Sherbrooke, Que., has closed a contract with the Dominion Copper Co., Boundary Falls, B.C., for one of their 42 x 30 Farrel-Bacon ore crushers; also for a 10 x 16 crusher of the same pattern. The capacity of the larger machine is 1,500 tons to 6 in. cube in a day of ten hours, and the shipping weight is 125,000 pounds. It is the largest pattern jaw crusher so far built anywhere. Several of these crushers have been put in use by the Granby smelter, of Phœnix, within the past three years.

The Electric Cable Company, of Bridgeport, Conn., has just installed an underground conduit system for the American Railways Company at Altoona, Pa. This conduit system was laid in wooden trenches in which the wires were embedded in voltax, the new insulating compound, which is being extensively adopted by the railway companies throughout the country. This system was described in a recent issue of the "Electrical Review." The American Railways Company have found this system so effective that they have recently placed large orders with the Electric Cable Company for further work.

Contracts have been closed and work is now under way on what will be the most notable series of reinforced concrete buildings in Montreal. The American Tobacco Co. for whom the factories are being erected, demanded speed in construction, and selected as the builders the Dominion Engineering and Construction Co., Limited, of Montreal. All the work is being done on the Gilbreth system and the cost-plus-a-fixed-sum contract. The architects, Messrs. Findlay & McGregor, declare that the plant when completed will be a model of its kind in Canada. The plans call for many novel effects, and also for the completion of the whole in five months.

The Amherst Foundry Co., Amherst, N.S., have ordered three travelling cranes from the Smart-Turner Machine Co., Limited, Hamilton, Ont.

Messrs. Connor, Clarke & Monds, consulting engineers, Toronto, are making a report on waterworks and sewerage systems for the town of Haileybury, Ont. They are also making a report on a hydro-electric power development at Hound Chute, on the Montreal River, about ten miles from Haileybury.

Arrangements have been made to hold a joint meeting of members of the American Institute of Mining Engineers and of the Iron and Steel Institute of Great Britain in London this month. The Lord Mayor has consented to act as chairman of the local Reception Committee, and a varied programme of receptions, visits and excursions is being arranged.

The Standard Oil Co. has ordered two "Hornsby-Akroyd" oil engines of 25 H.P. each, which will be shipped to Chinkiang, China, and used for pumping purposes.. The engines are supplied by the De La Vergne Machine Co., of New York, who state that the use of oil engines has increased enormously in the past few years, there being now over 14,000 oil engines of the "Hornsby-Akroyd" make alone in operation.

The sixteenth annual meeting of the Ontario Association of Stationary Engineers was held at Hamilton on May 28th. The meeting was a very profitable one, and the largest held since the formation. About eighty members were present. Officers were elected as follows: A. M. Wickens, president (Toronto); W. A. Sweet, vice-president (Hamilton); treasurer, C. Moseley (Toronto); registrar, W. G. Blackgrove (Toronto). The meeting adjourned to meet in Brantford, May 27, 1907.

The United States Circuit Court of Appeals for the Third Circuit, sitting at Philadelphia, handed down a decision on May 24th last in the case of the Westinghouse Electric and Manufacturing Co. against the Cutter Electric and Manufacturing Co. The case involved the manufacture and sale of an automatic circuit breaker, which the complainant alleged had been infringed by the Cutter Company. In a previous decision of February 27th, 1906, the court decided against the defendant, but the latter asked for a re-hearing, and the present decision is that, after a reconsideration of the matter, it is of the unanimous opinion that the Westinghouse patent is valid, and the Cutter circuit breakers are an infringement thereof. An injunction and order for an accounting to the Westinghouse Company will be issued in due course. The patent involved was granted to Wright and Aalborg, September 26th, 1899, and is numbered 633,772.

Mr. R. Wison Smith, ex-Mayor of Montreal, who was recently appointed a director of the Lake Superior Consolidated Company, after returning from a visit to the Soo, in an interview says: "The rail mill can now turn out six hundred tons of rails per day. With the addition of a blast furnace it will soon be able to turn out a thousand tons. The steel rails will be the very best, and those who buy them will give the company repeat orders. There are rail orders twelve months ahead. These, of course, have not to be delivered immediately. There is no more promising enterprise in the Dominion to-day than the Soo industries. It is the biggest potentiality, not only in Canada, but of this entire continent. I have no hesitation in saying that for the completeness which marks several features, for the homogeneous principle running throughout the whole, for natural resources to maintain and replenish the industrial activities, this is the completest thing on the continent."

TELEGRAPH AND TELEPHONE

The Yukon district has asked the Federal Government to install space telegraphy over the 1,200 miles between Atlin and Quesnelle. This portion of the Yukon telegraph service is subject to frequent interruption during the winter months.

The New Brunswick Telephone Co., head offices Fredericton, will expend $100,000 this summer on improvements and extensions.

The Bell Telephone Company has received a five-year franchise from Berlin, Ont., on condition that the company removes poles and places wires underground along certain streets of the city.

The granting of permission to the Bell Telephone Company to increase its capital from $10,000,000 to $30,000,000 opens up to the present stockholders an enticing vista of valuable rights from time to time. There has been little of the company's stock sold lately, and it is doubtful if any quantity could be secured by vigorous bidding in view of the chances of handsome profits from future rights.

The decision arrived at by the Dominion Government in regard to telephone companies settles a dispute between the companies and municipalities. The latter have been demanding the restoration of their control over their own street rights, to which the companies have replied that such would not only imperil their capital invested on the faith of a Dominion charter, but would destroy the efficiency of their long-distance services. The Government has compromised by protecting the existing property of companies, but will refer to the Railway Commission disputes as to renewals and extensions. Telephone rates and questions affecting the interchange of messages will be settled by the Commission.

PERSONAL

The Technical University of Berlin has conferred on George Westinghouse, the American inventor, the degree of Doctor of Engineering.

The Waterous Engine Works Company, of Brantford, have donated $500 to the Bell Memorial Fund, as the telephone was invented in that city.

L. G. Coleman has been appointed assistant superintendent of the Ottawa Division of the Grand Trunk Railway. He will have charge of transportation, with jurisdiction over all employees in the station, train and yard service.

Prof. Geo. R. Mickle, lecturer on mining at the School of Practical Science, Toronto, who was one of the inspectors in the Cobalt district last year, has been appointed, under the Mines Act of last session, inspector of mining claims for the present season, and has entered upon his duties.

Dr. Haanel, Superintendent of Mines, has sent to the Governor-General a specimen of pig iron smelted by electric process during the recent experiments at Sault Ste. Marie. The pig iron has been beautifully ground and bevelled and enclosed on an ebonized frame. Its smooth and shining surface, which looks like steel, bears a suitable inscription in red letters. Samples of the pig iron in the form of paper weights, with suitable inscriptions, have been forwarded to the Prime Minister and Members of the Cabinet.

James Burnett, assistant engineer of the Montreal Light, Heat and Power Company, is about to sever his connection with that company, to become superintendent and electrical engineer of the Montreal and Southern Counties Railway, which is about to begin active operations on the south side of the river. Mr. Burnett has been connected with the company since the days of the Royal Electric Corporation. It is understood that his resignation will go into effect almost immediately, and that he will at once enter upon the discharge of his new duties.

MARINE NEWS.

It is announced on the authority of a high official of the company that, in view of the great success attained this year by the "Empress" boats, the Canadian Pacific Railway will shortly inaugurate a very fast line, to excel any possible service from the port of New York.

The enlargement of the Kiel Canal, which is necessitated by the increasing size of warships, is to be carried out at a cost of $50,000,000. The bed will be widened from 60 to 130 feet, and the width at the surface will be increased from 150 to 350 feet.

The steamer "Erin," whose green-painted hull has been familiar to mariners for many years on the great lakes, was ploughed down by the big Steel Trust carrier "Cowle" near Courtright, several miles below Sarnia, in the St. Clair River, on May 31st, in a dense fog. The "Erin" is one of the old type of wooden carriers with a grain capacity of about 40,000 bushels, and was easily crushed by the ponderous modern vessel that struck her fair amidships.

The complete fog alarm station, with keeper's portable dwelling attached, which is to be erected at Cape Arguille, Newfoundland, for the safety of steamers using the Canadian route, is now in course of construction at the works of the Marine Department, King's Wharf, Quebec. New works recently completed by contractors of the department and just accepted by the Government's local hydraulic engineer, Mr. Parent, on his recent tour of inspection, are the fog alarm and new lighthouse station at Martin River, fog alarm plant at Fame Point, new light at Gascon's, Baie des Chaleurs, and new dwelling for lighthouse keeper and completion of fog alarm plant at Cape Ray.

RAILWAY NOTES.

The Kingston, Gananoque & Perth Electric Railway has applied to the Legislature for permission to build an extension of its line from Lanark to Arnprior.

The building of the T. and N. O. Railway has preserved the bulk of the trade of this great northern district for Toronto, which otherwise would have been diverted to Ottawa and Montreal.

The Grand Trunk Railway Co. will erect a ten-story building on McGill Street, Montreal, opposite their present offices, at a cost of some $250,000, provided arrangements re taxes are satisfactory.

The Edmonton, Alta., City Engineer has prepared plans by order of the City Council for the building of an electric street railway to run from Kinestino to Twenty-first Street, on Jasper Avenue, and from Jasper to the Canadian Northern depôt, on First Street. The estimated cost of the railway is $66,000.

Besides the contract awarded the Dominion Steel Company by the Trans-continental Commissioners, the Grand Trunk Pacific has given the same company an order for 150,000 tons of steel rails at $33 per ton. The company has also received an order for 20,000 tons for the Montreal Street Railway.

Four new engines are to be added to the rolling stock of the Temiskaming Railway. Mr. Cecil B. Smith, of the Commission has also called for tenders for two switching engines, one to be at North Bay and the other at Engelhart, the divisional point. Eight new passenger coaches are also to be added.

It is rumoured that the C. P. R. is preparing to build another line through the Rocky Mountains at a point north of the present route, through Kicking Horse Pass, and that work will commence without delay. The story is that the new route will be about 300 miles north of Kicking Horse Pass, and that it is the best railway route through the Mountains.

Enormous quantities of rails, ties, and other railway supplies are being required for the Winnipeg-Quebec section of the National Trans-continental Railway. Tenders are now being asked for 65,000 gross tons of 80-pound steel rails (open hearth or Bessemer, at the option of the Commissioners) and the necesary fastenings; and for 1,545,000 railway ties; in strict accordance with the specifications of the Commissioners.

Manager Kilgour, of the Huron and Ontario Electric Railway, which proposes to build an electric line from a point on Lake Ontario via. Beeton, Newmarket, Flesherton, Meaford, Owen Sound, Southampton and Goderich to Sarnia, stated that the line would be pushed forward rapidly.

Canadian Pacific Railway officials have closed an agreement with the Town Council of Strathcona, by which the town is to have terminal facilities for the company's lines in Northern Alberta. The town gives them land for the purpose to the extent of seventy acres.

Fourteen thousand tons of steel rails for the Midway & Vernon Railway have been ordered, and the continuation of construction of this railway is to be started within a very short time, according to information secured in Montreal and New York, where the capital behind the road comes from. The rails have been ordered from the Dominion Iron & Steel Company, of Sydney, Cape Breton, and the order will be rushed out as soon as the works can commence on it.

MINING MATTERS.

A valuable find of bog iron ore is reported from the Township of Oakley, Muskoka. The ore is said to be almost entirely free from sulphur. It has been tested at a Bracebridge foundry and gives every satisfaction.

The Consolidated Mining & Smelting Co., of Canada, have ordered from The Jenckes Machine Co., Limited, Sherbrooke, for use at the Centre Star Mine, Rossland, a 36" x 24" Farrel-Bacon Ore Crusher, of which the capacity is 1,000 ton to 6-inch cube every ten hours. The shipping weight is 60,000 pounds.

It is announced with authority that the re-organization of the Port Hood Coal Company has been completed, and only awaits confirmation of the courts. It is said that suitable transportation will be sought to fill the orders for coal now on hand. The new company expects to rush things and attain in a short time an output of over 200,000 tons a year.

A report has been received by T. Gibson, Minister of Mines, of the discovery of a rich Cobalt silver vein on Concession 3, Township of Bucke. The party who discovered it was a novice and not an expert miner or prospector. This find is about a mile from the present active mining operations, and seemingly confirms the belief that the extent of the Cobalt mining field is much greater than was at first supposed.

Muskoka has developed an iron mine, which gives every indication of developing considerable industry in the district. The ore is easily obtainable, but at present transportation would be difficult. This obstacle will be overcome by the building of the Bracebridge & Trading Lake Railway, for the construction of which the lapsed bonuses have been re-voted by both the Dominion Parliament and the Ontario Legislature.

The Minister of the Interior has authorized Dr. Haanel, Superintendent of Mines, to make arrangements for an investigation into the precise location and extent of iron deposits of Canada. In the course of this investigation the approximate horse-power available will be ascertained. One of the parties will go to the Maritime Provinces, another will operate in Quebec and Eastern Ontario and the third in Western Ontario.

The Temiskaming and Northern Ontario Railway Commissioners have accepted the tender of the Town Site Mining Company for the mining of 37 acres of mineralized land south-west of the town of Cobalt, and have granted the company a lease for 999 years. In return the company pays a bonus of $40,000 and a percentage on all ore mined. On all ore valued at $1,000 per ton the company pays 25 per cent. and 50 per cent. on all ore valued at more than $1,000 a ton, no matter how rich the ore may be.

The mineral wealth of the Lake St. John region north of Roberval is at present attracting the attention of mining engineers and expert prospectors in all parts of the world, who are making a rush for the new Eldorado in Northern Quebec. The heretofore discoveries are dwarfed by the more recent findings, and now it is recognized that Chibugamoo district, which was first located by Mr. Peter McKenzie, is a deposit of wealth beyond estimate.

LIGHT, HEAT, POWER, ETC.

The power plant of the Winnipeg Electric Street Railway will eventually be capable of developing 30,000 horsepower.

The municipal operation of the electric-light system in Edmonton during 1905-6 resulted, it is said, in a profit of $20,873.71. This sum is to be spent on the extension of the power-house plant, and reduction in the price of light to consumers of three cents a kilowatt-hour will be made.

The question of the prohibition of export of electric energy from Canada will come before a conference to be held between the Federal and Provincial Governments at an early date. In the meantime the Dominion Government bill has been withdrawn in the House of Commons. This measure proposed to deal with the subject, but owing to the conflict of opinion as to whether the Federal or Provincial Governments had jurisdiction in the matter the bill was dropped for the present.

It is the intention of the city of Niagara Falls, Ont., to ask the Provincial Government for permission to develop 10,000 H.P. to run the city's waterworks pumping plant and electric-light plant, and have a necessary surplus on hand for an emergency. When 2,000 H.P. was previously requested it was not known what amount would be necessary, but the city now finds that 10,000 H.P. will be required.

NEW INCORPORATIONS.

Ontario.—The Erie Telephone Co., Rainham, $10,000. G. E. Dashner, A. Yager, S. Culver, E. Hoover, M. Kellam, B. Gee, and F. Held, Rainham.

The Lawson Cobalt Silver Mining Co., Eganville, $500,000. W. Lawson, D. F. McGregor, J. Brady, D. J. McEvan, and J. H. L. George, Eganville.

Ontario Iron and Steel Co., Toronto, $500,000. D. Muhlfelder, J. L. Steefel, and W. M. German, Toronto.

The Dunnville Gas Development Co., Dunnville, $400,000. S. Werner, R. Bradford, O. E. Wilson, J. A. Scholfield, T. Marshall, C. Herring, W. W. Kirck, H. Pyle, J. H. Rowe, J. Bradford, J. H. Smith, and W. J. Nicholson, Dunnville.

Dominion Henderson Bearings Co., Toronto, $300,000. W. Bowman, J. F. Adams, C. W. Thompson, J. H. Whitehead, H. C. Macdonald, W. E. Wood, E. P. Seon, J. G. Gibson, and C. H. Hunter, Toronto.

The Cobalt Central Silver Mining Co., Limited, New Liskeard, $500,000. T. McCamus, D. Stewart, A. W. Roebuck, F. L. Hutchinson, and D. H. Walkinshaw, New Liskeard, Ont.

The Jenkins Automatic Fender Co., Limited, Toronto, $150,000. J. Hallam, B. B. Jenkins, J. H. M. Jenkins, J. P. White, and Susan Hallam, Toronto, Ont.

The Soo-Cobalt Mining Co., Limited, Cobalt, $50,000. C. H. Moore, C. DeWolfe, J. D. O'Brien, C. M. Tilkie, W. C. Young, Cobalt, Ont.

The Cobalt Smelting & Refining Co., Toronto, $250,000. T. H. Miller, C. H. Gowman, J. H. Schlund, W. R. Cavell, and H. A. Wright, Toronto, Ont.

The Columbus Cobalt Silver Co., Limited, Toronto, $450,000. J. Columbus, D. Simpson, H. S. Pritchard, F. Watt, and F. C. Jarvis, Toronto, Ont.

Wolstrees Cobalt Silver Mining Co., Limited, Windsor, $250,000. J. W. Wolst, F. S. Kratzet, A. Brinkmann, A. Campbell, C. O. Campbell, F. H. Warren, and G. H. Hett, Windsor, Ont.

The Albert Mining Co., Limited, Toronto, $370,000. S. J. Pickering, W. J. Brown, J. Lewis, J. M. Clark, and G. C. Campbell, Toronto, Ont.

North Range Nickel & Iron Mining Co., Limited, Sudbury, $1,000,000. W. J. Bell, A. B. Gordon, J. Morin, J. Lauzon, R. McBride, and C. McCrea, Sudbury.

Wendigon Silver & Copper Mining Co., Limited, Windsor, $400,000. A. Green, J. A. Hunt, J. W. Hanna, J. Wigle, and A. Doumouchelle, Windsor, Ontario.

The Dominion District Steam Heating Company, Limited, Toronto, $100,000. W. N. Warburton, W. Seccombe, G. E. Bradshaw, H. L. Dunn, J. W. McDonald, M. A. McKessock, A. E. J. Blackman, E. A. Francis, S. Lackie, and R. S. D. Hartrick, Toronto, Ont.

Canadian Wire Screen Manufacturing Company, Limited, Toronto, $250,000. G. B. Meadows, F. A. Mansell, M. C. Mowry, A. T. Blackwell, H. G. Hopkirk, Toronto, Ont.

Sasagenaga Mining Co., Limited, Cobalt, $250,000. F. P. Gavin, H. H. Lang, A. J. Young, P. J. Montague, and F. Pottage, Cobalt, Nipissing.

Superior Portland Cement Railway Co., Limited, Orangeville, $50,000. G. McIntyre, D. B. Brown, G. E. Brown, W. H. Jackson, and W. DeLeigh Wilson, Orangeville, Dufferin.

Erie Cobalt Silver Mining Co., Limited, Toronto, $1,000,000. E. Montizambert, J. H. Jewell, S. A. Singlehurst, H. W. Maw, and G. S. Hodgson, Toronto, Ont.

Trethewey Silver-Cobalt Mine, Limited, Toronto, $1,000,000. W. G. Trethewey, W. E. H. Carter, F. W. Strathy, S. W. Black, and J. H. McGhie, Toronto, Ont.

The Amalgamated Oil Co., of Canada, Limited, $1,000,000. C. B. Keenleyside, B. V. Hole, A. Keenleyside, and W. D. Edy, London, Ont.

Dominion.—The Cobalt Exploration Co., Limited, Montreal, $30,000. A. Munroe, H. T. Pemberton, E. Languedoc, A. W. G. Macalister, and W. J. Henderson, Montreal, Que.

Consolidated Light Co., Limited, Toronto, $2,000,000. A. Oakley, J. W. Mitchell, W. H. Lyon, C. W. Fleming, H. G. Wallace, J. E. Pangman, J. A. Martin, and A. L'Estranged Malone, Toronto, Ont.

The Canada Dredge Manufacturing & Purchasing Co., Limited, Newcastle, $500,000. W. H. Russell, H. D. Aiton, G. J. Sproul, W. L. T. Weldon, and R. A. Murdock, Newcastle, New Brunswick.

The Rheaume Foundry Co., Montreal, $49,000. J. Rheaume, J. L. Rheaume, V. Rheaume, D. Rheaume, and A. L. Rinfret, Montreal, Que.

Electric Heaters Co., Ottawa, $100,000. A. F. Leggatt, W. L. P. Smith, C. H. Stapledon, C. L. Bishop, and A. A. Sears, Ottawa, Ont.

Morse Hardware & Lumber Co., Swan River, $100,000. H. V. Morse, J. T. Douglas, Elsie Morse, Martha E. Douglas, and S. G. Sanford, Swan River, Manitoba.

Manitoba.—Great West Power & Machinery Company, Winnipeg, $500,000. J. D. Flavelle, W. M. Flavelle, C. B. McAllister, J. Stuart, A. Kelly, P. C. Mitchell, Winnipeg, Manitoba.

The Brandon Construction Co., Limited, Brandon, $20,000. J. Hanbury, T. M. Harrington, W. Bell, A. J. Sheather, and J. H. Ingram, Brandon, Manitoba.

J. D. McArthur Company, Limited, Winnipeg, $1,000,000. J. D. McArthur, D. F. McArthur, B. J. McLeod, W. P. McDougall, and J. K. McLennan, Winnipeg, Manitoba.

The Cooper Gasoline Co., Limited, Winnipeg, $5,000. E. S. Cooper, Josephine M. Cooper, J. Shutt, C. W. Bradshaw, and D. G. McEwen, Winnipeg, Manitoba.