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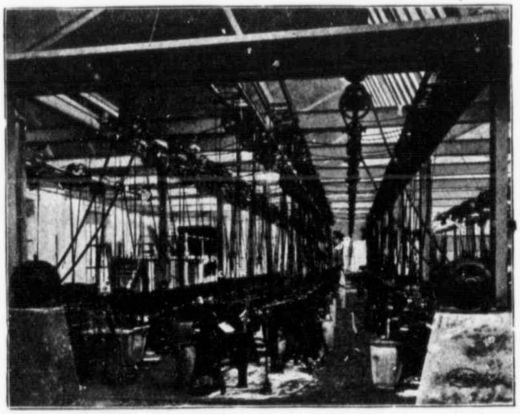

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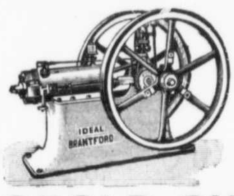

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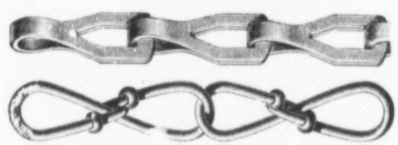

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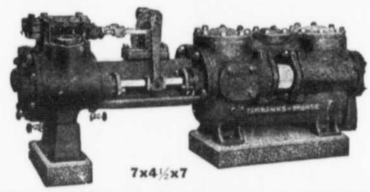

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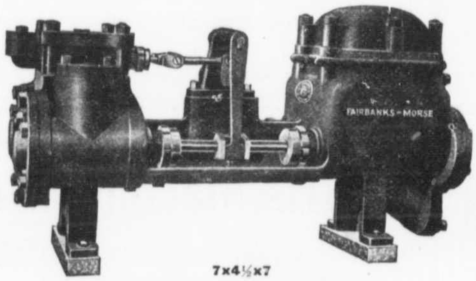

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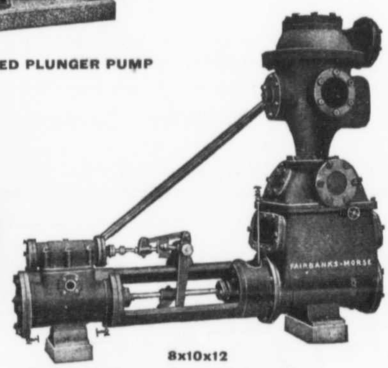

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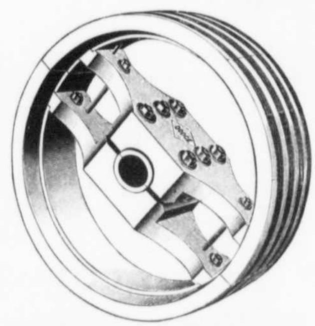

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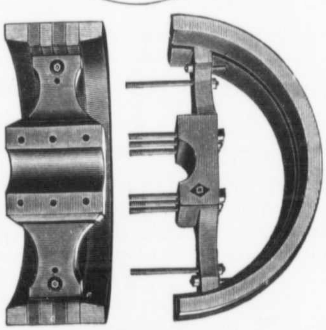

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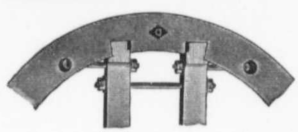

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Established in 1880. **Published on Fridays.**

The Canadian Manufacturer Publishing Co., Limited

Office of Publication: 408 McKinnon Building, Toronto

D. O. McKINNON—Managing Director

J. C. ARMER—Editor

Montreal Office—204 St. James Street.

ARTHUR B. FARMER—Representative

London, Eng., Office: 16 Devonshire Square, E.C.

WM. TUCKER & CO., Representatives

SUBSCRIPTIONS:

Canada $1.00. United States $1.50 per year. All other Countries in Postal Union six shillings sterling, including postage.

ADVERTISING RATES:

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IT IS TIME TO GO FORWARD.

The elections in the United States and Canada are over. Sir Wilfrid Laurier and Hon. Wm. H. Taft are pledged to carry out the administrative policies which have been dominant in their respective countries for the last eight or twelve years. With no danger of radical legislation upsetting business in the United States, and with the Canadian Government spending hundreds of millions yearly in great national undertakings, and with the population of the Canadian West growing by leaps and bounds, there is every reason to expect throughout the Dominion an era of expansion from 1909 to 1919 which shall eclipse even the remarkable records of growth and prosperity from 1897 to 1907.

We have had a year of depression, a period of business contraction. It has necessitated a serious, cautious study of the business situation to determine whether we were not over-sanguine and consequently reckless in our reaching after greater volumes of business for our individual enterprises.

This accounting has been made. What has been the result? It has been proven that speculation in real estate, particularly in the West, had been carried to extremes, but the commercial and industrial interests of Canada have made a showing which is creditable indeed. The small number of failures during the past year, despite the conservative attitude of banks in the matter of accommodation, has proven that business in Canada has been carried on along sound, safe and sane lines.

We have stood the test of the lean year and have been rewarded with a year of abundance. As has been pointed out in these columns before, the total revenue this year from crops of all kinds in Canada is tremendous compared with the figures of a few years ago.

Yet we are on the threshold of our national heritage. There are millions of acres in the Canadian West awaiting the coming of settlers from the Western States, from Great Britain and continental Europe.

As these settlers come, 250,000 or so each year, they add to the consuming needs of the country so that the factories and mills of Canada must increase from year to year their productive capacity or surrender a share of their trade in their line.

Indications point to a resumption of business along all lines at once. Already we have made the turn. Bank clearings throughout Canada are showing a liberal increase of business over a year ago, proving that the volume of business is greater. In this respect Canada has recovered much more completely than has our big neighbor to the south.

We reproduce from Bradstreet's (New York) a statement of the bank clearings in the leading cities of the United States and Canada for the week ending October 29, and a comparison showing the increase or decrease as compared with the same week last year.

	October 29, 1908	Inc.	Dec.
New York	$1,565,380,000	——	15.1
Chicago	232,060,000	——	4.7
Boston	136,375,000	——	23.2
Philadelphia	108,605,000	——	28.5
St. Louis	61,528,000	——	.01
Pittsburgh	38,975,000	——	26.0
San Francisco	37,885,000	——	6.5
Kansas City	38,169,000	——	3.2
*Montreal	29,992,000	2.1	——
*Toronto	25,285,000	21.6	——
Baltimore	23,293,000	——	26.5
Cincinnati	21,533,000	——	12.5
Minneapolis	21,080,000	——	17.5
*Winnipeg	17,355,000	37.6	——
New Orleans	14,762,000	——	24.6
Cleveland	14,397,000	——	17.1
Detroit	11,302,000	——	20.8
*Vancouver, B.C.	3,406,000	1.1	——
*Ottawa	2,848,000	26.8	——
*Quebec	2,104,000	14.1	——

* Canadian cities.

The total clearings in the United States centres aggregated $2,570,814,000, against $3,023,309,000 this week in last year. Canadian clearings aggregate $90,165,000, as compared with $77,978,000 in this week last year.

There are good reasons why Canada should not feel depression as acutely nor for such length of time as our neighbors to the south. We have not been quite as "aggressive" in times of prosperity, so have more foundation when business gave signs of crumbling away.

Furthermore, we are engaged in national undertakings of much greater magnitude in proportion to population and industrial strength than is the case with the United States. True, the Panama Canal is being built. Yet that enterprise is tying up American capital and engrossing American brains outside that country, whereas Canada's enterprise is bringing English and Scotch capital into this country and distributing it amongst our workmen, our factories and our stores.

To sum up, there are few reasons against and many favorable to the conviction that it is time for Canadian manufacturers and merchants to go forward, to show their faith and confidence not merely in the ultimate destiny, but also in the immediate advancement of Canada.

Caution is wise but the rewards of the next ten years in this country will go to the man who has faith in the land and who has the courage of his convictions.

Power Plant Canadian Locomotive Works

Producer Gas was Considered but the Heating Problems Resulted in the Choice of Steam. Details of Power Plant Equipment. Test of Power Plant. Paper Read Before the Canadian Society of Civil Engineers, October 29, 1908.

By Henry Goldmark, M. Can. Soc. C.E.

The works of the Canadian Locomotive Co., at Kingston, are the oldest establishment in Canada devoted to locomotive construction.

Dating back, as they do, almost sixty years, the history of these works exemplifies the fact that commercial success depends on ability in management more than on any other condition. Under different administrations the fortunes of the works have been various, though but little change was made in the plant itself, apart from some enlargement.

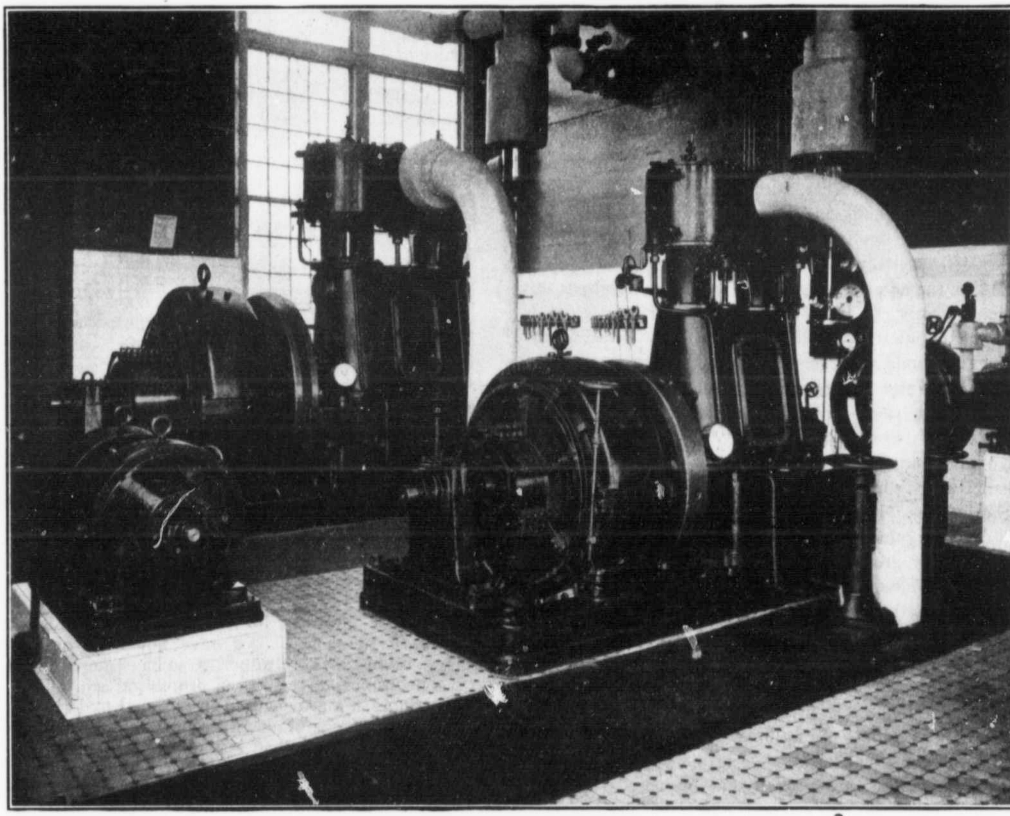

Photo Courtesy Laurie & Lamb.

Fig. 1—New Power Plant of Canadian Locomotive Works, Kingston; two Belliss & Morcom Engines, 365 B.H.P. and 165 B.H.P. Respectively; Canadian Westinghouse Generators, 250 K.W. and 100 K.W. Respectively.

The works, as shown in Fig. 1, front directly on the St. Lawrence River, close to the point where it leaves Lake Ontario, providing ample dockage facilities for the unloading and storage of coal and other bulky material.

The principal older buildings, viz., the machine shop and the blacksmith shop and foundry, have massive masonry walls in accordance with English traditions. In these old buildings the rather small windows interfere somewhat with good lighting, but the durability and the rigidity of their walls contrast favorably with much of our later work in which considerations of first cost have been paramount, resulting in unduly large maintenance charges.

While excellent engines have been built in these works, the plant has lacked modern facilities for handling heavy weights, and in many other respects has not been well adapted for the most economical and rapid prosecution of the work.

In the summer of 1906, general plans drawn up by the writer for the enlargement and modernizing of the works were adopted by the management. They were intended to provide for immediate needs, besides being arranged so that by successive additions the entire available property can ultimately be utilized.

The older buildings, as far as they are of a permanent character, have been modernized in construction and equipment, while existing temporary additions to the old shops are to be replaced by up-to-date structures.

Besides this, the capacity of the plant has been increased by the construction of new shops and the installation of a complete power plant, motor, lighting and heating equipment.

During the past two years the machine shop has been reconstructed by replacing the timber construction of the second floor by heavy steel columns and beams, permitting the installation of numerous jib cranes. The machine shop is ultimately to be extended eastward so as to occupy also the site of the present erecting shop. The blacksmith shop will be enlarged by absorbing the space now devoted to foundry work, a new foundry being built on another site. A large new erecting shop is under construction to serve ultimately for the erection of engines and tenders, besides providing for all boiler work.

It is believed to be advantageous in every way to concentrate as much of this work as possible under one roof. A building of this kind permits of more efficient and economical supervision, and reduces the cost of handling the material to a minimum. As compared with several separate shops a unified building is cheaper, more easily heated, and with a proper arrangement of skylights and lanterns, there is no difficulty in providing good over-head lighting. In a northern climate it is especially desirable to avoid the necessity of using outdoor transfer tables, and of passing from one building to another in bad weather.

This erecting shop is to consist ultimately of four or more longitudinal divisions, of about the same length, but of widths and heights varying with the work to be done in each part. The first of these divisions, now nearing completion, is devoted to boiler work, and occupies the site of the old boiler shop. It is 60 feet long and 400 feet wide, and has steel trusses and columns

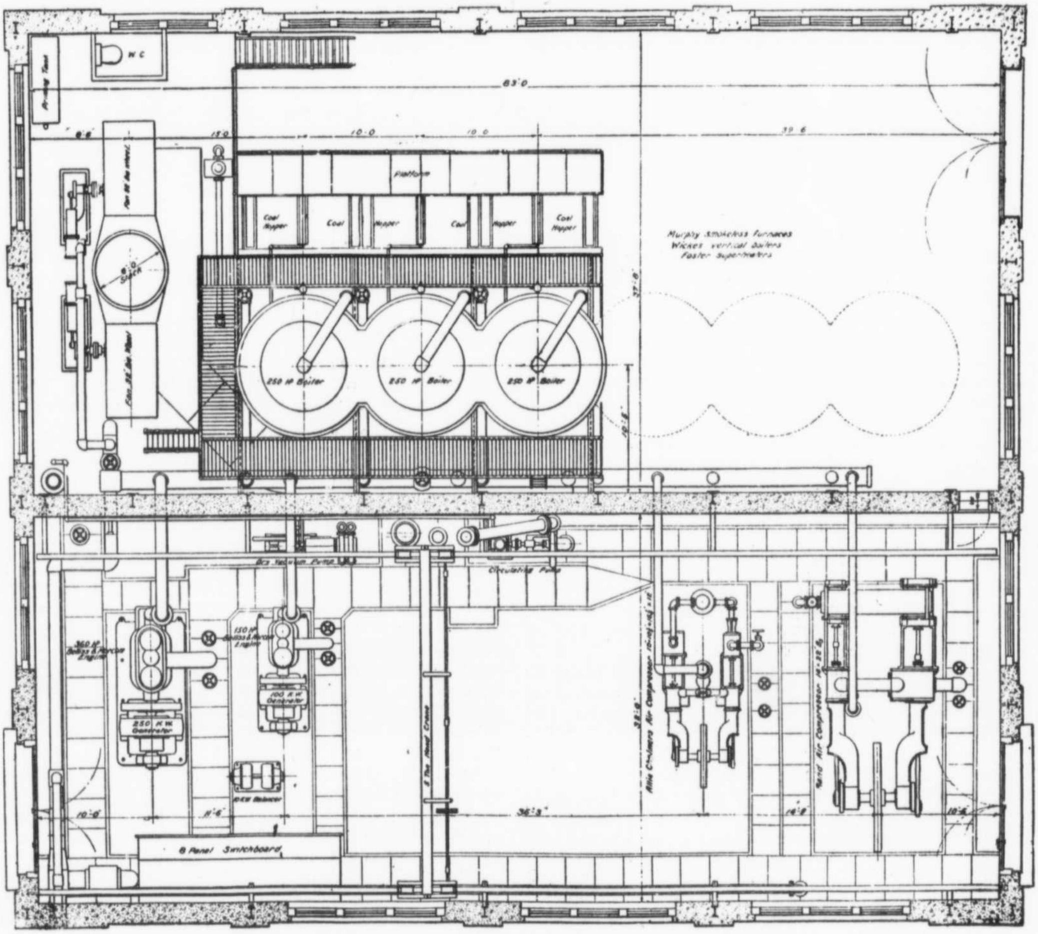

Fig. 2—Plan of Power Plant, Canadian Locomotive Works, Kingston.

and heavy concrete walls. The timber work of the roof is of the slow-burning type, consisting of 3 inch plank with 16 inch purlines 10 feet apart. A 20 ton Shaw electric travelling crane traverses the entire length of the shop, passing also under the riveting tower at the extreme south end. This tower is to be 55 feet 4 inches high to the runway rail of the hydraulic riveting crane, and is to contain two hydraulic riveters, with necessary accumulators and pumps.

The erection of boilers is done in the northern half of the building, and the rest of the building, up to the riveting tower, is to be used for punches, shears, planers, plate rolls, and other machinery.

Power Requirements.

The power, previous to the improvements, was supplied by three separate steam engines, and distributed to the tools by shafting and belting. The lighting system, mainly of incandescent lamps, was incomplete. The shops were heated in part by exhaust steam, but live steam was also used to a considerable extent, especially in very cold weather. It was decided to substitute a central power station large enough to supply the power, light, and heat now required, and arranged so as to permit of ready enlargement in the future.

The desirability of installing gas engines operated by producer gas was made the subject of some little study. Where the question of heating need not be considered it is believed that a plant of this kind will produce power more cheaply than steam engines and boilers. This will be the case even with much higher coal consumption than that claimed by interested parties, and taking into account also increased fixed charges on first cost of plant.

In case, however, the exhaust steam can be utilized for heating purposes, a steam plant will not only be simpler but generally more economical in operation as well as first cost.

In a climate like Canada, with long and severe winters, this will be the case except in rare instances. A steam plant with electrical generation and transmission of power was therefore adopted.

In view of the compactness of the plant and the nature of the work to be done, it was decided to use a continuous current throughout, generating it at 250 volts, and using this voltage in all motors with a two-wire distribution. All lamps are for 125 volts, with a three-wire distribution, a 10-kilowatt balancer set being used.

An analysis of the probable requirements was made on the basis of the actual indicated horse power of the engines in use, with proper allowance for the existing shortage of power which had not permitted all tools to run at their full capacity. The figures so obtained were checked by comparison with the requirements and load factors for similar machine shops elsewhere, especially at the Angus shops of the Canadian Pacific at Montreal, the figures for which were kindly placed at the writer's disposal.

Apart from the crane loads, which are intermittent, the present requirements for power and lighting were computed at 240 kilowatts at the switchboard. This estimate has been confirmed by the actual average 10 hour load for December last, which was 228 kilowatts, as taken from the switchboard readings.

The size of the power plant, and the several parts of its equipment, were based on the above power requirements, as well as on the steam required for operating the necessary air compressors and for heating.

A reasonable provision for spares was made, and the building is of ample size to allow for future increase in equipment. The building and equipment are briefly described in the following sections of this paper.

Power House.

The general arrangement of the power house is shown in Figs. 2 and 3.

The base of the entire building consists of a concrete slab about 3 feet thick, which rests on piles spaced 3 to 4 feet apart and driven to bed rock. The slab supports the walls, floors, and boiler and engine foundations. The space between the top of the slab and the finished floor level, where not occupied by foundations, is utilized for pipe trenches, all remaining voids being filled in with earth.

The building has a steel frame, of columns, and roof beams, 20 inch concrete walls, and a hollow tile and reinforced concrete roof on the Kahn system. Practically all the steel work is protected by concrete.

The engine room has a tiled floor, an enameled tiled dado, and painted concrete walls.

The entire building is fire proof except as to the doors and windows, and the interior is attractive and easily kept clean.

The engine and boiler rooms are 83 feet long and 32 feet and 38 feet wide, respectively, the latter being of somewhat greater height to accommodate the vertical boilers.

The north end of the boiler room is divided off by permanent fire proof partition to form a separate pump room free from the dust incident to stoking. The ceiling of this pump room is of reinforced concrete, resting on a steel frame, which supports the induced draft plant.

Equipment of Power House.

A view of the interior of the power house and the engine and generator equipment is shown in Fig. 1.

The equipment for any given power plant should be such as will produce the required power, light, and heat at a minimum cost. The type of apparatus by which this result can in each case be best secured will depend on local conditions. These should, therefore, be carefully taken into account. This is a point which is often overlooked, and the equipment is in many cases not suited to the special work which the plant is called upon to do. The most important elements involved, besides the amount of power required, are the length of the working day, the cost of coal and water, the amount of steam required for heating and other purposes, and the length of the winter season.

In the Kingston works there is little night work, a considerable amount of exhaust steam is required for heating, and the winters are long and severe. The cost of coal is not excessive, and there is plenty of river water available for boiler feed and condensing purposes.

Under these conditions, the lowest cost for fixed charges and operation will be obtained by apparatus, simpler and less expensive than that which would be proper in a large city central power plant.

The efficiency will, of course, be somewhat less than that obtained in the large plants with 24-hour service, which have no use for the exhaust steam.

It is believed that both the boilers and engines and auxiliaries, as well as the general layout, are in accordance with the above principles. The engines especially combine moderate first cost with a very low steam consumption, while the boiler efficiency is excellent without excessive first cost.

The equipment may be summarized as follows:

The boiler plant consists of three Wickes boilers, with Foster superheaters and Murphy stokers, and a Buffalo Forge Co. induced draft plant.

The pump room contains the Webster feed water heater, separate pumps (in duplicate) for boiler service and general shop supply, and a large fire pump.

In the engine room there are two Belliss and Morcom engines direct connected to Westinghouse generators, two air compressors, and a Worthington barometric condenser connected with both engines and compressors. The room also contains a balancer set and the switch board, and is served by a 5-ton hand power travelling crane. There is sufficient floor space to permit of the installation in the future of three more vertical boilers, an additional engine of somewhat greater capacity than the larger of those now in place, and another compressor.

The Boilers and Accessories.

The boilers are of the Wickes vertical water tube type, and designed for a pressure of 150 pounds per square inch. The rated capacity of each is 250 h.p., with a water heating surface of 2,510 square feet, and a grate surface of 42 square feet, so that the ratio of water heating surface to grate surface is 60. These boilers consist essentially of two drums, connected by vertical tubes. The drums are 78 inches in diameter, the lower, or mud drum, being 53 inches long, and the upper, or steam drum, 100 inches. There are 112 four-inch tubes. The upper drum has a well-stayed head with one large manhole and a smaller hole directly over each tube, the latter to enable tubes to be readily inserted or withdrawn. From the inside of this large drum the tubes can be readily inspected and expanded when renewals are made.

The construction of the boilers is very simple, and they appear satisfactory in operation. The fuel consumption is given in the record of tests below. The connection to the plate steel flue is at the bottom of the back of the boiler, the gases passing up the front and down the rear half of the boiler, a tile partition making a division between the two directions of flow.

These boilers were bricked in more heavily than customary for this type, there being 16 inches of common brick laid in cement and an inner layer of fire brick, with an air space of 2 inches between them. The flue is covered with heavy asbestos insulation.

The boilers are fitted with Foster superheaters of sufficient capacity to give 150° F. superheat. They are fastened to the front of the boilers just below the steam drum, the superheated steam pipe passing between two adjacent boilers to reach the main header.

The Wickes boiler having no combustion chamber immediately below the boiler, requires the addition of an exterior furnace or Dutch oven. This was utilized for the installation of Murphy stokers. The magazines are at present filled from above by an air hoist travelling on a runway over the stokers, but a light trestle extending to the out-door coal pile is to be substituted, permitting small dump cars to run directly over the stoker magazines.

The induced draft plant is in duplicate, each half being able to supply draft very easily for the three boilers now installed, while the two fans are of sufficient capacity to handle six boilers at moderate speed. The fans are 92 inches in diameter, connected with 7"x12"

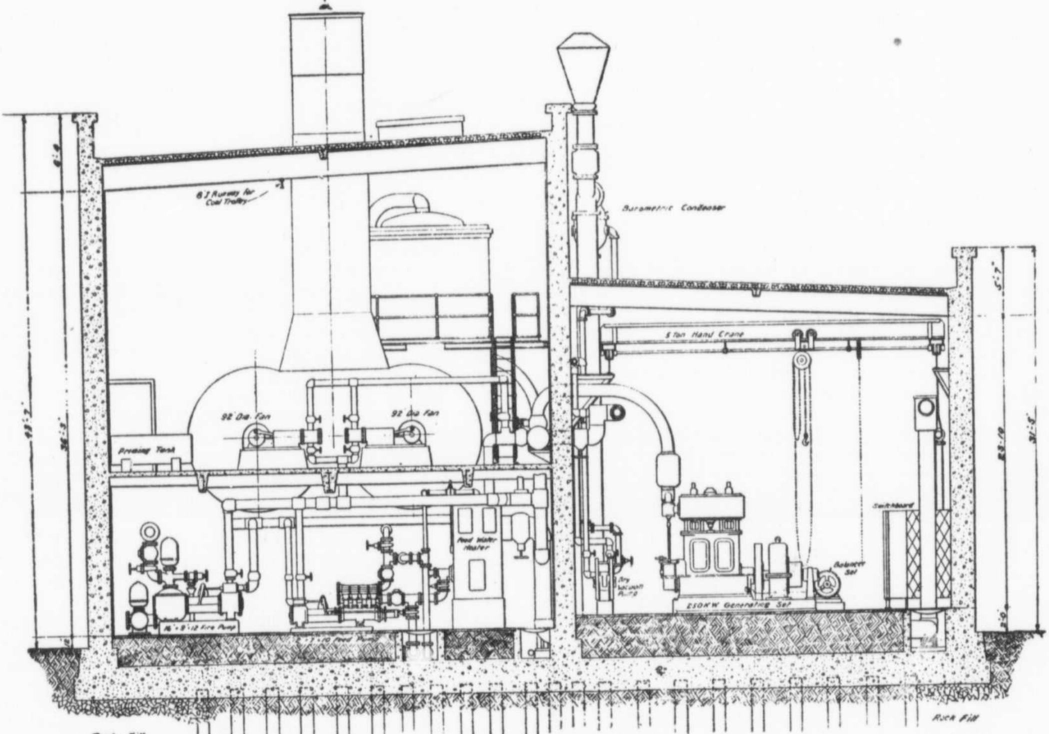

Fig. 3—Elevation of Power Plant, Canadian Locomotive Works, Kingston.

horizontal engines. A somewhat novel feature are the concrete foundations, about 18 inches high, supporting the fan engines and absorbing the vibrations very fully.

The pump room contains one 12″x7″x10″ Blake duplex outside-packed boiler feed pump, and one 7½″x5″x6″ Worthington boiler feed pump; also one 10″x7″x12″ Northey duplex water service pump, and one 16″x9″x12″ Northey fire pump, with priming tank. In the pump room is also located the 1,500 h.p. Class E. C. Webster Star vacuum feed water heater.

The condensing plant was built by the John MacDougall Caledonian Iron Works, of Montreal. It consists of a Worthington ejector condenser, with cast iron discharge pipe and entrainer, supplied by an 8-inch Worthington circulating involute pump driven by a Robb engine. The condensing plant is designed to be of sufficient capacity for the power plant, as enlarged in the future to the full capacity of the building. The exhaust riser is 20 inches in diameter, the condenser tail pipe 10½ inches in diameter. There is also a Knowles 6″x12″x10″ air pump. Both pumps are steam driven and located in the engine room, as shown in plan.

Engines, Generators, Switchboards and Air Compressors.

The engines are of the vertical quick-revolution type, built by Messrs. Belliss & Morcom, of Birmingham, England, and were erected by Messrs. Laurie & Lamb, of Montreal. They are cross compound, double crank, two-cylinder, vertical, enclosed double-acting self-lubricating engines.

The larger unit has a capacity of 365 b.h.p. at 350 r.p.m. The diameter of the high pressure cylinder is 15 inches, and that of the low pressure 24 inches, with an 11-inch stroke. The smaller unit is of 145 b.h.p. capacity at 475 r.p.m. The high and low pressure cylinders are of 10″ and 16″ diameter, respectively, with an 8-inch stroke.

The large number of revolutions permits the use of light and economical generators, and reduces the floor space occupied by the unit to a minimum. For the larger engine the floor space occupied by the set is 13′ 6″x6′, and the extreme height 10′ 3″. For the smaller unit the floor space required is only 10′ 9″x4′ 6″, with a maximum height of 8′ 1″.

It should be noted, too, that notwithstanding the large number of revolutions per minute, the piston speed is quite moderate, being 642″ for the 365 h.p., and 633″ for the 145 h.p. engine, a speed hardly in excess of that in so-called slow-speed engines.

There is a system of forced lubrication by which the oil is drawn from the reservoir by means of a force pump driven from an eccentric on the main shaft, and distributed under a pressure of 15 to 20 pounds per square inch. The engines are designed to operate successfully with steam superheated 150° F.

The governors are of the centrifugal type, controlling an equilibrium steam throttle valve, connected directly to the high pressure steam chest.

The frames of the engines are of an extremely massive character, reducing the vibrations to a very small amount, even with the high speed used. Their performance in actual service has so far been very satisfactory.

A series of tests were made at the builders' works to determine the steam consumption of the engines under various loads, and when operated both condensing and non-condensing. The following is a summary of these tests witnessed by the purchaser's engineer:

Engine Tests of Belliss & Morcom Engines.

(N.B.—Efficiency is ratio of brake h.p. to indicator.)

365 b.h.p. Engine.

365 B.H.P. Engine.

	Steam Pressure lbs. per sq. in. lbs.	Superheat	Vacuum inches	Efficiency %	Steam consumption, per B.H.P. lbs.	Steam consumption per I.H.P.
Full load, condensing . . .	153	141° F.	25.2″	92.3	15.1	13.94
Half load, condensing.....	147	71° F.	24.5″	90.6	19.3	17.48
Full load, non-condensing.	154	130° F.	0	91.9	18.4	16.90
Half load, non-condensing	155	64° F.	0	89.2	23.8	21.23
145 B.H.P. Engine.						
Full load, condensing.....	157	159° F.	24.5″	92.5	15.3	14.15
Half load, condensing.....	163	116° F.	26.2″	90.5	16.5	14.93
Full load, non-condensing	163	172° F.	0	91.8	17.4	15.97
Half load, non-condensing	159	194° F.	0	90.3	20.1	18.15

The generators were built by the Canadian Westinghouse Co., at Hamilton, Ont. They are direct connected to the engines, and mounted on a common base. The capacity of the units is 250 kilowatts and 100 kilowatts, respectively. They are compound wound for 240 volts, and are of the Westinghouse standard make in other respects.

The switchboard was built by the Westinghouse Co. It is Vermont marble, and contains three generator panels, one lighting panel and balancer set panel, and one total light-measuring panel; one power panel, with circuit breakers, and one total power-measuring panel. Recording watt meters of General Electric make, and Westinghouse registering ammeters, are used on the power and light totalling panels.

There are two air compressors. One of them is of the Ingersoll-Sergeant type, built by the Allis-Chalmers Co.; has duplex steam cylinders, 10″ diameter, and two stage air compression cylinders 10¼″ and 16¼″. The stroke is 12″. Its capacity is 444 cubic feet of free air per minute.

The second compressor was built by the Canadian Rand Co. It is compounded for both steam and air. It has a stroke of 22″, with high and low pressure steam cylinders 14″ and 24″, and air cylinders 14″ and 22″, respectively. The normal speed is 105 r.p.m. and its capacity at this speed is 1,209 cubic feet of free air per minute.

The steam piping is somewhat elaborate, as it was desired to utilize the exhaust steam as fully as possible at all times, while interfering as little as possible with the use of the condenser. An exhaust main was therefore laid along both the east and west walls of the engine room and connected by transverse pipes with each engine and compressor. One of these mains leads to the condenser, while the other connects with the heating system and the free exhaust.

By operating valves attached to indicator standards just above the floor, the exhaust from each engine and compressor can be turned into the condensing system or utilized for heating. Even in very cold weather the exhaust from the auxiliaries and the compressors has generally proved sufficient for heating purposes, while during the spring and autumn months, when only a small amount of heat is required, almost all the units remain connected with the condensor.

The live steam piping is of the highest grade, the main header in the boiler room being built in only three lengths, having welded nozzles and Van Stone joints.

The supply pipes are also of the welded type with rolled steel flanges, Van Stone joints, and Swedish iron gaskets.

All live steam pipes are covered with 85% magnesia covering 2 inches thick, and all other pipes with 1 inch of asbestos cellular covering. The covering is, in all cases, covered with canvas, sewed on and painted.

The piping in the power house was done by the M. W. Kellogg Co., of New York.

Tests of the Power Plant.

With the kind co-operation of Professors Gill and Willhofft, of Queen's University, Kingston, and their students, careful tests of the boilers and of the entire plant were made by Mr. C. J. Goldmark, E.E. The object of these

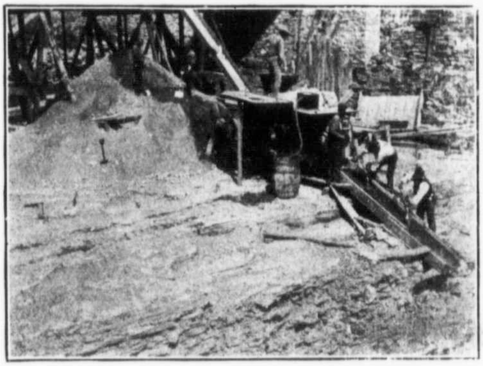

Fig. 1—Concrete Mixer at Work. 75 to 100 Tons per Day.

tests was to determine the efficiency and economy of the plant under the conditions of actual operation. These tests may be briefly summarized:

Boiler Test.

Duration, 10 hours............Object, economy.
Water heating surface..........2,500 square feet.
Grate surface.................. ..42 " "
Murphy stokers.

Fuel—
Kind of coal..................Yougheogheny stock
Thermal value of dry coal......13,133 B.T.U.
Percentage of moisture in coal..5%.
Percentage of ash and refuse referred to dry coal..........12.6%.
Dry coal burned per square foot of grate surface per hour...24.8 lbs.

Draft and temperature—
Draft in furnace...............0.264 inch.
Flue gas average temperature...530° F.

Water and steam—
Average temperature of feed water....................66.8° F.
Average steam pressure (gauge)..146.8 lbs per sq. in.

Superheating—
Average temperature of steam..523.5° F.
Average amount of superheat...159.5° F.

Economic evaporation—
Water actually evaporated per pound of dry coal.........8.07 lbs.
Evaporation from and at 212° per pound of dry coal corrected for quality of steam..10.42 lbs.
Evaporation from and at 212° per pound of combustible corrected for quality of steam...................11.93 lbs.

Horse Power—
Rated h.p. of boiler (10 sq. ft. heating surface—1 h.p.)....250 h.p.
H.P. developed by boiler.......292.6 h.p.
H.P. equivalent of boiler and superheater...............314.8 h.p.
H.P. in excess of rating...64.8=25.9%.
Efficiency of boiler and furnace..76.6%.

Economy Test of Station.

Duration, 11 hours.

Larger Belliss & Morcom engine (365 b.h.p.) and 250 kilowatt generator running; also Rand compressor. Both running condensing. Two boilers fired.

N.B.—The plant was not complete. There was no lagging on the steam pipes. There was no superheat at the air compressor, and only 40° F. at the large engine. The average load factor on the plant during the test was about 45 per cent. The average efficiency of the engine and generator was 86.5 per cent.

Steam used per I.H.P. per hour, including auxiliaries.......28 lbs.
Net (omitting auxiliaries).......23.2 lbs.
Percentage of total steam used by auxiliaries.............14.6%.
Dry coal per I.H.P. per hour, including auxiliaries.........3.24 lbs.
Dry coal per I.H.P. per hour, net corrected for drips.....2.67 lbs.
Evaporation from and at 212° F. per lb. of dry coal.........10.27 lbs.
Thermal value of fuel..........13,133 B.T.U.

Distribution of Heat, Light, and Power.

The live steam, exhaust, and compressed air pipes from the power house to the different shops are housed in by a wooden covering and supported on a structural steel trestle, which also carries the electric circuits.

Fig. 2—Excavating for Heavy West Retaining Wall.

All heating is done by direct radiation, except in the machine shop, where a fan blower, driven by an electric motor, has been installed.

All steam for heating is distributed at low pressure, exhaust steam being used whenever possible. The water of condensation flows by gravity to three receivers placed in pits below floor level, and is returned to the boiler plant by Bundy pumping traps. These traps are operated by live steam from the central plant, are simple and automatic in their action, and give good satisfaction. They enable the returns to be carried on the trestle, avoiding the difficulties of underground work.

The power distribution is at 240 volts on a two-wire system, while the lighting is taken care of by separate three-wire circuits—240—120 volts.

Cooper Hewitt mercury vapor lamps are used in the machine shop, foundry, and boiler shop; arcs and incandescents in the other shops. The mercury lamps have

Fig. 3—General View of Power House, Floor Level.

been very satisfactory as to illumination and economy. The light is very uniformly diffused, and there is an almost total lack of sharply defined shadows. All wiring is run in iron conduits, with iron panel boxes with enclosed fuses.

Each motor is controlled from a slate panel with circuit breaker, switch, and enclosed fuses.

The power plant was installed under the direction of Mr. Chas. J. Goldmark, who is also responsible for the electric layout and the details of the power house equipment.

Power Development at Cambellford

The power development at Campbellford, Ont., is now proceeding at a rapid rate under the supervision of A. W. Ellson Fawkes, A.M.I.C.E., engineer in charge. The head race of fore bay and west concrete retaining wall are now completed.

The excavation for the power house was carried along through difficulties owing to the large amount of water that had to be dealt with, and the depth of excavations for power house foundations is 40 feet below the water level.

The building throughout will be of reinforced concrete, amounting to over 3,000 cubic yards. To get this large amount of concrete in before the water rises, a Goold, Shapley & Muir concrete mixer was installed. This machine is operated by six men and is putting in concrete at the rate of 75 to 100 cubic yards per day.

The plant will have two 750 k.w. generators and all modern appliances that will make it one of the finest electric power stations for its cost.

Engineer Fawkes estimates that the plant will be ready for running at the end of the year.

The object of the town of Campbellford in putting in this power development is to offer better facilities to manufacturers to locate there. The power scheme was designed by J. S. Fielding, C.E., Toronto.

The contractor is James Bogue, Peterboro, Ont. Estimated cost, $100,000.

Figures 1, 2, 3 and 4 show different portions of the work.

The Wise One

"Precedent may be the whole cheese in law," said the gray-haired travelling man who had "covered" nearly every State in the Union, "but don't you bank on it in this business. Why? I'll tell you a story that's one on me, all right, but it taught me mine.

"Several years ago, when I was younger than I am now, I was travelling for a machine firm. One rainy night, the train I was on drew up at a jumping-off place in northern New York, and we were told we would be allowed time for grub. We had had nothing to eat for eight hours, and were as hungry as timber wolves in winter. We all piled out and made a general assault on the lunch counter.

"The rest of the bunch gulped down a cup of coffee, bolted a sandwich or two, and returned to the train. Did your Uncle Dudley hurry? Oh, no; not he. He was a modern Solomon. He had learned that the train would not go until the conductor did, so he watched him. This conductor was very deliberate in his eating, and made a hearty meal. I, congratulating myself on my foresight, did the same.

"After twenty minutes of it, I got rather anxious. When about ready to make inquiries, the said conductor

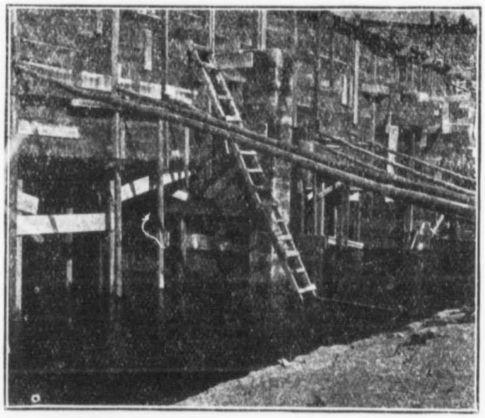

Fig. 4—Sheeting to the Arches of the Tail Race.

arose, sauntered to the platform, gazed reflectively at the glowering sky, and started off toward where the town might be. I watched him out of sight, and then looked for the train. Nothing in sight but the glistening rails.

"Dumbfounded, I returned to the station and asked the station agent where my train was. He informed me it had gone fifteen minutes ago, and that it was the last train till next day. It seems the conductor lived in that town, and was relieved there.

"There was no hotel in the town, but I finally convinced the station agent I was no post office thief, and was allowed to bunk on a bench in the station. Say, it was the hardest bed I ever had, and I've experienced some pretty bad ones in my time, too.

"I pulled out the next morning sore and stiff. My grip had gone on to Buffalo. What with telegraphing and loss of time the experience cost me, I have never been able to figure out. But I learned my lesson. Now, I bolt my grub with the rest of down-trodden travellers. No chances for mine."

Producer Gas and Gas Producer Plants

Second of a Series of Articles to Appear in the Power Edition, Taking up This Subject in an Educative Way. Information Has Been Gleaned from Various Noteworthy Authorities, Names of Authorities Being Given. Absolute Confidence Can be Placed in all Statements and Claims, as They Come from Some of the Highest Authorities on This Subject. This Series of Articles will be Followed by Another Series on Large Power Gas Engines. Each Article will be Complete in Itself. This Article: Early History; Detail Description of Pressure Type.

BY J. C. ARMER

HISTORY OF THE DEVELOPMENT OF THE PRODUCER GAS PLANT

Everyone knows the old proverb, "Necessity is the mother of invention"; and it was true in the case of the producer gas plant. The four-cycle gas engine was invented by Mr. Otto, Deutz, Germany, in 1876. The fuel used was ordinary illuminating gas as made in large plants by the distillation of coal. The high thermal efficiency of the internal combustion motor appealed strongly to the engineers of the day; but it was realized that the gas engine would not be able to compete with steam engines in the large sizes if the type of fuel was to be illuminating gas. There was required a cheap form of gas, and fuel economy being of such importance in European countries at the time, it was natural that there should be considerable experimental work conducted, with the object in view of obtaining a process for the manufacture of a cheap form of gas, in order that the high thermal efficiencies of internal combustion motors might be fully taken advantage of.

Description of the Dowson Plant.

To Mr. Emerson Dowson, London, England, is due the credit of having placed on the market, the first successful producer gas plant. This plant was invented just two years after the gas engine was invented, so it is evident that no time was lost in preliminaries. This plant was the foundation of all producer gas plants; and the importance of Dowson's invention cannot be overestimated. The style of the earliest form of Dowson plant is shown in Fig. 1. In this diagram B is the gas producer, the gas being made by forcing, through the bed of incandescent fuel in B, a mixture of superheated steam and air, by which producer gas is formed as described in the article appearing in the last POWER EDITION of THE CANADIAN MANUFACTURER. The steam is supplied from a small vertical boiler A. The gas upon leaving the generator or producer passes through a water seal in the hydraulic box C. This not only helps to cool and clean the gas, but the seal prevents gas in the other parts of the apparatus being fired accidentally by the incandescent fuel in B. From C the gas goes to the cooler and scrubber D, and passes up through a column of coke, where the gas is cooled and washed by the spray of water shown. The gas next passes through the dry scrubber E, which is filled with sawdust, to the gas holder F. From here it is piped to the different points at which it may be needed.

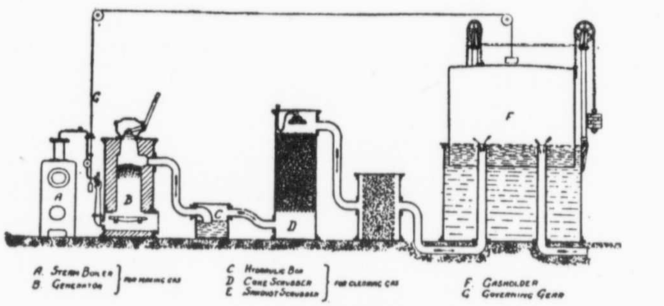

Fig. 1—The Early Dowson Gas Plant.

The use of the gas holder is to maintain a uniform pressure in the plant, and to act as a storage tank, in case of fluctuation in the use and production of the gas. The gas holder is assisted in this duty by the mechanism G, by which the rate of production of the gas is automatically governed to suit the rate of consumption from the holder.

A jet of steam from the boiler injects into the producer the air required for carrying on the partial combustion of the fuel.

The rate of gas production depends upon the quantity of steam and air sent into the producer, and through the governing arrangement the rise or fall of the gas holder raises or lowers a weighted lever which acts on the valve admitting the steam to the producer.

Objections to this Plant.

This plant was successful, but for all that it had many faults. In the first place it was too complicated and required too much space and attendance to be completely successful; and then too the style of fuel was restricted to anthracite or comparatively hard coal such as is mined in Wales and Pennsylvania. This last was a serious drawback to its universal adoption throughout England because of the predominance of the soft grades of coal.

The chief objectionable features were the separate steam boiler and the gas holder. The latter is, of course, required with any style of plant where it is necessary to store gas, or where it is used for anything else than gas engines. The separate steam boiler involves the consumption of about 25 per cent. more fuel than is actually used in the generator in the production of the gas. This is, of course, a very serious consideration from an economical standpoint.

The Bernier Gas Plant.

It was seventeen years after Dowson developed his plant, before there was any improvements to his plant suggested.

In 1895, M. Bernier, of Paris, invented a gas-making plant working upon the Dowson principle of a simultaneous blast of steam and air through incandescent fuel, but designed to utilize the waste heat of the generated gas in making steam. This plant is shown in Fig. 2. It was M. Bernier's ambition to make all the steam from the sensible heat of the gas, as in the proper operation of engines, gas has to be cooled in any case and until his experiments, all the sensible heat had been wasted. He was successful in raising some steam at atmospheric pressure, but it was then evident that some apparatus had to be devised to force or draw the steam and air through the fire. He decided to provide an auxiliary piston by the side of the working cylinder of a gas engine, and arrange this to suck the gas from the plant and deliver it to the engine.

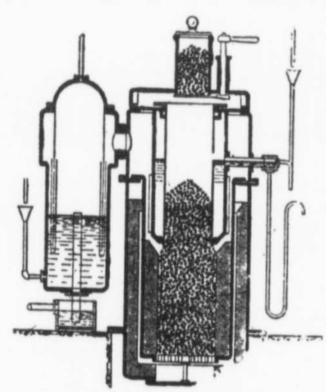

Fig. 2—The Bernier Gas Plant.

Other Early Gas Plants.

M. Bernier's plant, while encouraging, was not very successful, although considerable improvements were made later on. M. Taylor & Co., of Paris, still further developed the producer, and a view of their plant is given in Fig. 3. This plant became a commercial success both in France and in England, and a few of the plants are still to be seen at work in the latter country.

Messrs. Koerting Bros., Koertingdorf, Germany, were conducting experimental work along this line, and in 1895 they took out patent rights for a producer plant in which the air and steam were drawn through the plant under the influence of the negative pressure caused by the piston of the gas engine during charging or suction strokes. The results obtained from experiments with

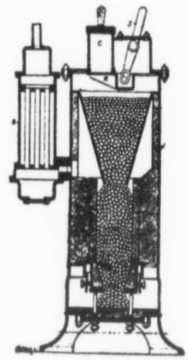

Fig. 3—The Taylor Producer.

this plant were discouraging, and the patents were abandoned. Irregular working of the engine under light load was experienced, due to the fluctuating low pressures through the plant; and it was concluded that the pressure type of producer was the most effective.

THE EARLY PINTSCH PRODUCER.

Thus the development of the suction producer plant with the regenerative steam boiler received quite a set-back. But in 1901 Julius Pintsch, Germany, designed and erected a suction producer plant to supply gas for an engine driving electrical machinery at Verviers, in Belgium. In spite of the many predictions to the contrary, the plant was a splendid success, and the installation has been in successful operation ever since. This plant is shown in Fig. 4 and, with the exception of a few details, is the same as the plant now made by the Julius Pintsch, in Germany, and by other firms having manufacturing rights.

In the diagram of the plant, (A) is the producer; (B) is the steam boiler, the steam being generated by the hot gases passing through it; (C) is a safety box which is left out on modern plants as unnecessary; (D) is a syphon; (E) are overflows; (F) is a wet scrubber filled with wooden grids; (G) is a sawdust purifier; and (H) is the governor.

Since that date there has been a marvelous development in the producer gas plant industry, and especially in the line of suction producers. Just eight years ago there was not a successful suction producer on the market, while now hundreds of firms in different parts of the world can supply producers of any size required.

TWO MAIN TYPES OF PRODUCERS, PRESSURE AND SUCTION

There are two distinct types of producer gas plants, the pressure and the suction. The pressure plant is one in which the air and steam blast is forced through the producer, either by steam pressure, as in the Dowson plant, or with a fan, as in the modern types of producer. A gas holder is essential in a pressure plant.

The suction plant is one in which the mixture of air and steam is drawn through the producer by the suction action of the gas engine, and no gas holder is required. There is another style of plant in which the air and steam blast is drawn through the producer by the action of a suction fan, which discharges into a holder. The fan is placed in between the scrubbing and drying apparatus and the gas holder, so that there is a negative pressure in the plant proper. This type of plant is strictly speaking neither a pressure nor a suction plant; but because of the gas being under pressure in the holder, it is commonly thought of as a pressure plant.

At first suction plants were made only in small sizes, i.e., 65 h.p. or less; pressure plants were installed when greater capacities were required. But now makers have full confidence in the suction plant for the larger horse powers, and suction plants are now commonly made in sizes up to 200 h.p. For larger horsepowers than this it is general practice to adopt the pressure plant.

It also has been common practice to use a pressure plant where more than one engine is to be operated from the same producer. But some firms now have devised regulating devices for the suction plant whereby more than one engine can be efficiently operated from the same plant.

When the gas is to be used for anything but power purposes a pressure plant installation is of course necessary.

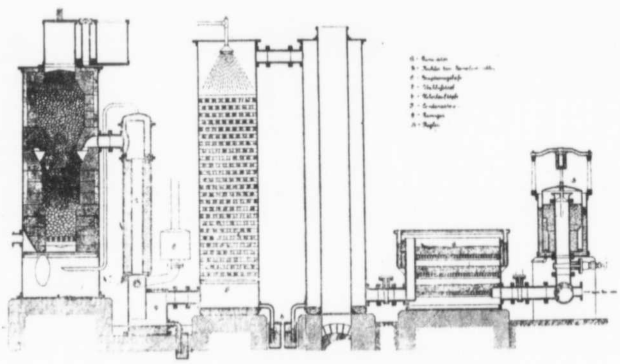

Fig. 4—The Earliest Pintsch Producer.

THE PRESSURE PLANT

The pressure gas plant is, as we have seen, the original plant; and the pressure plants now being made have been modelled after the original Dowson plant. Many improvements, however, have been made to minimize the complication, and to increase the efficiency of the pressure plant.

For instance, the separate boiler, which was responsible for such a large percent of the fuel consumption, is no longer used, except in special cases. Instead a vaporizer is provided in which the water is vaporized by the heat from the gas as it comes from the producer; then too the air and steam blast is supplied by a pressure fan in the modern plants, instead of by the steam pressure as in the Dowson plant. In some plants the steam is vaporized and is mixed with the air blast, while in others the air blast is passed over the surface of vaporizing water, and the blast thus becomes saturated with steam.

Only anthracite coal could be used with the original Dowson plant, and this was one of its objectionable features, especially in England where there is so much bituminous coal, and not much anthracite. This fact led to considerable experimenting in the use of bituminous coals, both in England and on the continent. The chief difficulty met with, of course, was in the purifying of the gas. It is claimed that Dr. Mond was the first to originate a successful bituminous coal plant, not many years since. This first plant was installed in England at the works of Brunner, Mond & Co., and it is still in operation.* In this style of plant the ammonia given off in the production of the gas is recovered, and the plants are spoken of as ammonia recovery plants of the Mond type. But these plants cannot be operated economically in units of less than 3,000 h.p., although there is an adoption on the market for moderate powers, but this is rather cumbersome and expensive.* In the adoption referred to, no attempt is made to recover the ammonia, and it was claimed that the heavy hydrocarbons in the gas were fixed by means of a common storage bell in the producer; but subsequent practice shows this to be inaccurate, and special provision is required to effectively get rid of the tar in the cleaning of the gas.

METHODS OF GETTING RID OF TAR.

"There have been a great many processes originated for treating the tars in bituminous coals during the last few years, and they invariably aim at fixing or destroying the tars given off by such coal. They have not so far been successful, at any rate, not to such a degree that cleanliness of the gas has been the result, and it has invariably been proved that the capital cost of the extra apparatus required to enable the tar to be so treated has far exceeded the cost of an ordinary plant,

* Thomas Rigby, in paper on "Power Gas Plants" presented to the Manchester Association of Engineers in 1905.

in which no attempt is made to treat the tars in the fire, and it has been out of proportion to any economy effected.

"It is very improbable that any plant will thoroughly fix the tar in a gas producer at any temperature, which can be practically and economically used in such apparatus.

"The down draught producer has been tried at various times during the last score of years, and although this sometimes destroys the tars, it also destroys other valuable properties of gas producers, which puts it out of court as a practical apparatus. In my opinion it is far better and easier to wash out the tar from the simple gas produced, and to

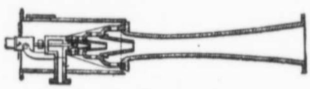

Fig. 5—The Koerting Blower.

utilize this tar in some other way, either as a fuel or as a by-product. It has been proved that it is possible to so clean the gas and that the valves of an engine are no more affected by the gas thus cleaned than by ordinary town's gas.

"It is possible by attention to certain details of design and structure to make producers of such small sizes for utilizing the commonest slack or dross fuel for the production of a uniform power gas."*

Such a producer as spoken of in the foregoing paragraph, has been designed and built by Crossley Bros., Openshaw, England, and this seems to be the only firm who have been successful in solving this problem in the way indicated.

Of the inverted combustion style of generator little need be said as this principle is only partially successful, and has many disadvantages.

Since the generator and its accessories and the gas holder are the features in which there is the chief dissimilarity between the pressure and the suction plants, these will be described in detail for each type of producer, while the features which are similar to the two types will be considered only in connection with the suction plant.

The Generator.†

The generator or producer consists of a retort made of refractory clay, vertically mounted, and cylindrical or conical in form. This retort is protected on its exterior by a metal jacket with an intermediate layer of sand which serves to reduce the heat lost by radiation.

The fuel is charged through the top of the retort, which is provided with a double closure in order to prevent the entrance of air during the charging operation. Different styles of charging hoppers, as they are called, are illustrated and described later.

The producer rests on a grid arranged at the base of the retort, upon which grid the ashes fall. The outlet of the injector pipe opens into the ash-pit, and this injector constantly supplies a mixture of steam and air. The mixture is generally superheated in passing through a coil arranged in the fire-box of the boiler, in the generator, or in the outlet for the burnt gases. Sometimes the air is subjected to preliminary heating by recouperating in some way the waste heat of the apparatus.

The chief features in the arrangement of generators which have received the attention of manufacturers, are the following: good distribution of the fuel in charging; easy descent of fuel; reduction of the destructive action of the clinkers on the walls; means for cleaning the grate without interfering with the generation of the gas; and prevention of leakage. Many devi es have been employed to fulfil these requisites.

A perfect distribution fuel during charging is attained chiefly by the form of the hopper, and of its gate, which is generally conical. In most apparatus, the gate opens towards the interior of the generator, and the inclination of its walls causes a uniform scattering of the fuel in the retort. It is all the more necessary to disperse the fuel in this manner when the cross-section of the retort is small compared with its height.

The facility of the fuel's descent is dependent largely upon the nature and size of the coal employed. Porous coal gives better results than dense and compact coal. It is, therefore, preferable to employ screened coal free from dust, in pieces each the size of a hazel nut. The various styles of cross-section given the interior of generators, including as they do cylindrical forms, truncated at the summit or the base, partially truncated at the base and the like, would lead to the conclusion that this question of fuel descent is not of the importance some writers would have us believe. Still, it must be considered that if the fuel drops slowly, its prolonged detention within the walls of the hopper, and its transformation into fusible slag may result in a disintegration of the refractory lining of the furnace.

The quantity of the steam, injected, greater or less, according to the nature of the fuel, renders it possible to obtain fusiable slags and consequently to prevent grave injury to the retort.

Cleanliness is most important so far as the operation of the generator is concerned. It should be possible to scrape the generator during operation without changing the composition of the gas. Mechanical cleaners with movable grates or revolving beds have the merit of causing the ashes to drop without interfering with the operation of the apparatus. The same meritorious feature is characteristic of ash-pits having water-sealed joints.

A generator should be provided in its upper part with openings through which a poker can easily be introduced in order to shake up the fuel and dislodge the clinkers which tend to form, and which cause the principal defects in operation, particularly with fuels that tend to swell, cake and adhere to the furnace walls when heated. Many producers, moreover, are provided with lateral openings, having mica panes, through which the progress of combustion can be observed.

Air and Steam Blast.

In the Dowson system of producing the air and steam blast a steam boiler of 75 pounds pressure is required. This method of blowing, which is rather complicated, has the disadvantage of varying on feed with the pressure of the steam in the boiler, which necessarily varies somewhat. This is one reason why some manufacturers have designed plants in which fans and blowers are employed to produce the draft; but the chief reason is the desire to utilize the otherwise waste heat from the gas to vaporize the water, in which case the steam cannot be produced under pressure.

The blowers employed when steam under pressure is used, are of different designs, but they are nearly all based on the Koerting blower, shown in Fig. 5. The blower consists essentially of a tube through which the steam is supplied under pressure and a cylindro-conical blast pipe. As it escapes under pressure the steam is caught in the blast pipe, and draws with it a certain quantity of air, which can be regulated.

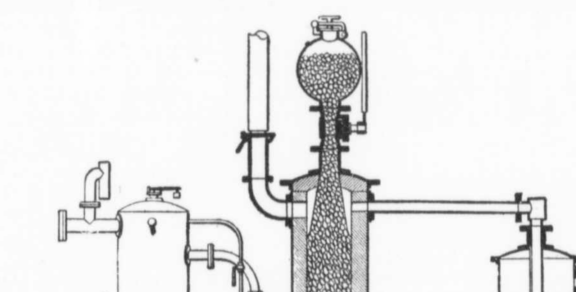

Fig. 6—The Gardie Producer.

Where the steam boiler is not used mechanical blowers are employed to produce the required blast. These are usually of the rotary type, but sometimes centrifugal fans are employed. In some producer installations the air blast is supplied under 70 to 90 pounds per square inch pressure. The Gardie producer shown in Fig. 6 is an example of this type of producer.

Washing and Purifying of Gas.

Ordinary methods of washing and purifying

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*Thomas Rigby (connected with Crossley Bros. Ltd.) in paper presented to Manchester Association of Engineers in 1905 on "Power Gas Plants."

†The authority for the detail description in this section is "Gas Engines and Producer Gas Plants" by R. E. Mathot.

will be described in connection with suction producer plants, but completer methods are adopted in the purifying of gas made in pressure producers. This is feasible since the gas in the pressure plants is under a greater pressure than in the suction plant, and for that reason the resistance of the washing and purifying apparatus to the passage of the gas is not of such great importance. The washing apparatus in different plants varies considerably but most frequently consists of a succession of contrivances in which the gas is washed either by causing it to bubble up through the water, by subjecting it to superficial friction against a sheet of water, or by systematically circulating it in a mass of continously besprinkled inert material, such as coke.

The object of washing is to remove the dust from the gas. The physical purification is completed by passing the gas through a

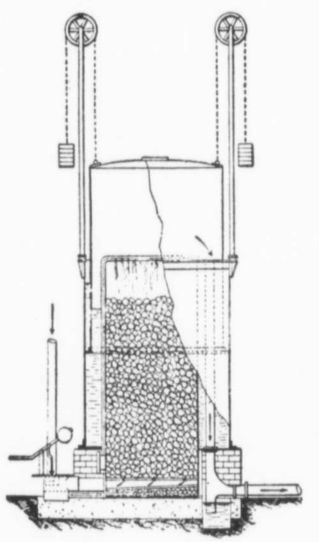

Fig. 7—Combined Gas Holder and Washer

filtering bed consisting of fibre, sawdust or moss, the latter being rather uncommon. If chemical purification is found necessary, it is usually affected by means of calcium hydrate, iron oxide, or, still better, by a mixture of lime and iron sulphate. The filtering material must necessarily be removed at intervals.

The Gas Holder.

The gas holder belongs essentially to the pressure plant. It is constructed upon the same principal as the gas holders used in city or town coal gas plants. The holder consists chiefly of a tank and a bell, the bell being balanced with weights so that it may rise or lower according to the capacity required, and the amount of gas generated. The tank contains water which forms a water seal against the escape of the gas. Sometimes the gas holder includes washing or scrubbing apparatus as shown in Fig. 7.

This figure also shows the arrangement of the bell with regard to the tank. Mechanism should be provided by which, when the bell is full, the generation of gas is automatically diminished or stopped. The bell of the tank is usually provided with a flap valve, opening towards the inside, so that should the generation of gas be stopped for some reason and the engine continue to operate until the gas in the bell is exhausted, there will be no danger of the engine sucking water, since atmospheric pressure will, when the gas is exhausted, open this valve.

In fairly small units it is possible to use the same water in this tank as is used to cool the engine cylinders thus doing away with the necessity for extra reservoir equipment; but care must be taken in an arrangement such as this that there is a sufficient quantity of water to warrant that it will not become so hot as to unduly heat and expand the gas in the bell. This same water is not used in plants where the engine is larger than 50 h.p.

The volume of the bell of the gasholder should preferably be not less than three cubic feet per brake horse power of the engine to be supplied; in this case the bell acts as a pressure regulator, assuring a sufficiently homogeneous gas, and rendering it possible to supply the engine during the short intervals in which it is necessary to stop the blast to poke the fire. But if it is desired to supply the engine from the holder for intervals longer than these, when the blast is closed down, its capacity must be made much greater per horse power of the engine.

Duplex Steam Pump Troubles

By Charles E. Bascom.

There is no accessory about the steam plant that receives the neglect that is bestowed upon the steam pump. You find it in some dark corner of the plant or in some pit half submerged in dirt and water. Sometimes it is oiled, and sometimes it is not—more often not. The only phenomenon about the pump is that it runs at all under the conditions in which it is placed. Even some of the builders seem to have a grudge against the pump, sending out any number of them with cast-iron rocker shafts and with stuffing boxes that will only hold 2-inch rings of packing. This is too often the case with the duplex pump.

If the cast-iron rocker shaft is not oiled properly, it will very soon wear so that the valves do not get their proper travel. When only two rings of packing can be put in a stuffiing box, it has to be screwed up so, to keep it steam and water-tight, that the rods are soon worn in the middle and a shoulder formed at each end. In this condition the pump will not make its full stroke. With the valves properly set on a duplex pump, if the rod packing or the piston packing in the water end is too tight on one side, the stroke of the piston on that side will be too short, while on the other side it will be too long.

If the pump has been in use for several years and there is any doubt as to whether your predecessor has neglected the valve and cylinder lubrication, disconnect the exhaust pipe and let the pump run against a pressure. If the exhaust is short and sharp, it will be known that everything is all right, but if a continuous blow is heard between the exhausts, it will be found that the valves and valve seats are worn so that steam is leaking past the side of the valves into the exhaust port. This is on the supposition that the pistons in the cylinder are tight.

Next take off the entire steam chest, put a scale on a steel straight edge on the valve, also on the valve seat. If they are found badly worn, as they doubtless will be, take a fine flat file and carefully file down both valves and valve seats until the straight edge will touch every part. Then scrape to a good fit, using a little red lead and oil on the valve face, and work the valve back and forth on the seat until both are fitted. Now loosen the packing, at the same time prying the rod toward the water end until the piston touches the cylinder head. Make a mark on the rod next to the packing gland, then pry it back toward the steam end until the piston touches the cylinder head. Make another mark on the rod next to the packing gland, as before, and then take a pair of dividers or a rule and locate a point half-way between the two marks, and make a third mark. Move the rod toward the water end until the mark last made comes up flush with the gland, and the piston will be exactly in the middle of the cylinder. Treat the opposite side in a similar manner, and both pistons will be at half stroke.

Now put on the steam chest and set the valves so that they will be in the middle of their travel. The valves should just cover the parts line and line. If the lost motion is not equal with the valves in this position, take out the pin connecting the valve rod with the valve stem and screw the valve stem in or out of the valve nut until the lost motion is equalized. Put on the steam-chest cover, tighten the glands and start the pump, which should have plenty of oil until the new faces on the valve and seat have attained their polish, when the amount of oil can be reduced. If the pistons have too much travel, reduce the lost motion in the valve gear and vice versa. If the rods are much worn, they should be taken out and turned up in a lathe. A larger packing will then be required.

With regard to the water end, do not try to pump hot water with soft-rubber valves, nor with a solid brass plunger pump unless it is outside packed. Use composition or hard-rubber valves for hot water, and examine them often if the plate between the valve and spring is too small, which is often the case. The valve should be turned over if it becomes convex on the under side. Old valves can be made nearly as good as new by bringing them to a face on a sheet of fine sand-paper. Lay the sand-paper, cutting side up, on a smooth board and draw the valve back and forth over it. See that there is no leak in the gasket between the cylinder head and the water end, and also see that there are no leaks in the gasket between the suction valves. Do not get the springs too tight on the suction valves, for in this event the pump will not take water. Watch for leaks in the suction pipe, and if the piston packing in the water end does not last as long as it ought, examine the sleeves, and if they are badly scored or rough, have new ones put in. Do not crowd the new piston packing in too tight, leave it a little chance to expand.—Power.

Consideration of Transformer Insulation

First of a Series of Articles on the Transformer to Appear in the Power Edition. This one Deals with Insulation. Others will Deal With Drying Out Transformers, Cooling of Transformers, Transformer Oil, Transformer Cases, Terminals and Bushings, Transformer Connections and Transformer Testing. This will be a Very Complete and Reliable Series of Articles.

By Norman P. Death,* Ass. M. A.I.E.E.

While the subject of insulation is a very broad one, more or less essential to all branches of electrical construction, I shall deal only with its particular application to transformers. The principal characteristics of insulation for transformers, however, apply in a large measure to almost all electrical apparatus, the difference being more in degree and application rather than in principle.

The electrical characteristics of a transformer are mostly dependent upon the quality, arrangement and proportion of the iron and copper that enter into its construction; that is to say, they are practically independent of the insulation. This statement may seem absurd on the face of it, since a transformer will not operate without insulation in its make-up, but the fact remains that the less space occupied by the insulation, the more efficient the transformer will be with a given amount of iron and copper. Insulation, however, of necessity performs a very important function; for in a transformer the conductors are usually in the form of wire, wound into one or more coils, each comprising several layers of one or more turns per layer. In operation, each turn, layer and coil is at a potential different from its adjacent turn, layer or coil, and the whole operates at some potential different from that of the earth. The separate parts of course must be insulated one from the other and the whole from the earth.

The Requirements of Insulation.

The primary function of insulation, then, is to insulate; to enable an electrical conductor to carry a current at some definite potential. The structure of the transformer and the conditions under which it usually operates are such that its insulation is subject to various forces, electrical, mechanical and chemical. The life of a transformer, then, depends upon the firmness of the insulation put into it to survive the various conditions under which it is forced to operate.

In the study of this subject one is naturally led to ask, Why does a thing insulate? R. A. Fessenden has well expressed it by saying: "A thing insulates because it is possessed of two distinct properties; first, the ability to stand the mechanical and electrical stresses" (and I wish to add another—chemical) "due to the voltage used; and second, a conductivity such that but a negligibly small current can flow through it and leak away. In other words, it will neither allow the current to break through it nor to steal through it. The first property is called by Maxwell the dielectric strength of the insulator. The other property is called the ohmic resistance. The two together form its insulating power."

Electrical work is divided into two branches wherein the requirements for insulation are widely different. In apparatus used for the transmission of intelligence (telephony and telegraphy) the voltages are low, so the dielectric strength is of relatively small importance; but the currents used are small, the circuits long, and an insulating material insulator is the two branches of electrical work naturally gives to the general term "insulation" a double significance—to one branch meaning something having high ohmic resistance, and to the other meaning something which has dielectric strength. This double meaning has often lead to confusion, for their meaning is quite different,

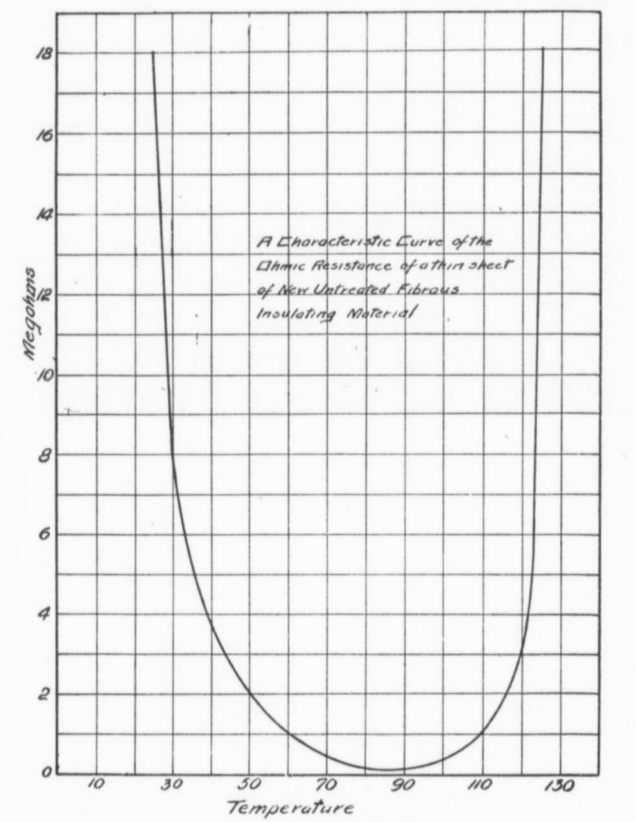

Fig. 1—Characteristic Curve of the Ohmic Resistance of a Thin Sheet of New Untreated Fibrous Insulating Material.

of high ohmic resistance is needed. On the other hand in apparatus designed for the generation and transmission of electrical energy, where the currents are large and where the voltages are high, dielectric strength is the property mainly desired, as the leakage of a small amount of current is not objectionable. This difference of requirement for an since an insulator may have a high ohmic resistance and at the same time not resist high voltage to breakdown.

Dielectric Strength Necessary in Electrical Apparatus.

In the insulation of electrical apparatus used for the generation and transmission of

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power, the dielectric strength is of the greater importance, the electrical resistance having relatively little value. Steinmetz has remarked—I do not recall the exact wording—that it is a very nice thing indeed—on paper—to read that the insulation resistance of a transformer, for instance, is 25 or 30 megohms, or even higher; but when the insulation resistance has been determined in the usual way, by the application of 500 volts direct current though a voltmeter and suitable resistance in series with the insulation to be measured; it is not so nice in switching in your transformer upon the line for the first time to have an inductive or static charge break through 25 or more megohms, reducing the insulation resistance to practically nothing and burning out the transformer.

But on the other hand, the insulation resistance of a transformer may be suspiciously low—only a few hundred thousand ohms—and still it may run continuously for years under average conditions of load without breaking down, even getting better as the insulating material dries out by the heat developed in it when running.

What is needed then, is to insulate the electrical circuits of the transformer so that it will operate without breaking down under all reasonable conditions of service. The insulation resistance gives no definite information as to the reliablity of the insulation in a transformer. Air, which is about the poorest insulator in disruptive strength, has a very high ohmic resistance, while on the other hand, the insulating materials having the best disruptive strength such as mica, have a comparatively low ohmic resistance.

To see this more plainly, let us examine the behavior of different insulating materials.

Behavior of Different Insulating Materials Under Test.

Take for instance two metallic plates and separate them by an air gap of say .004 inch. Now, measure the insulation resistance of the air at 100 volts difference of potential between the plates. It is higher than can be measured by means of the best instruments. Now raise the potential difference between the plates to 500 volts. A spark will pass across the gap and the insulation resistance which a moment before was infinite is now reduced to practically zero. Now insert in the air gap a piece of solid, dry insulating material, such as a piece of paper of the same thickness, and the insulation resistance will be measurable and very much smaller than the resistance of the air gap. Again, raise the potential to 500 or 1,000 volts and the piece of paper will withstand the pressure. If the paper is replaced by a sheet of mica of the same thickness its insulation resistance will be much smaller than that of the paper, to say nothing of the air. But the difference of potential at the terminals may now be raised to 10,000 volts or more and the mica sheet will not break down. "The electricity will rush out from the terminal plates upon the mica sheet in long, glowing streamers, beating against the mica with a hissing noise and forming a broad electrostatic aurora of violet light, and still the mica will not break down." This is the property desired. If this disruptive strength has anything in common with insulation resistance, its relation is not known. On the contrary, it seems that those insulating materials which have the highest resistance, like air, just happen to have the lowest disruptive strength, while those materials like mica which are relatively inferior in ohmic resistance, stand the electrical stress the best. Consequently the measured ohmic resistance of a transformer or other apparatus will not indicate its disruptive strength. As can readily be seen there may be two bare wires almost touching each other, but with a thin film of air between, giving a very high ohmic resistance which, upon applying normal voltage to the apparatus, will most likely break down instantly. On the other hand, the wires in a transformer may be insulated with material such as fibre or mica and if the insulation be a little damp—measuring perhaps only a few hundred thousand ohms resistance—and the transformer be put into service, its ohmic resistance will increase, likewise its dielectric strength will improve and the transformer will not break down.

A very high ohmic resistance is, therefore, not a measure of the reliability of the transformer against breakdowns.

The above considerations, then, in a measure indicate the proper method of determining the fitness of insulation to withstand the conditions under which it is forced to operate; that is, in testing samples we should actually subject them to an electrostatic stress until they break down and judge their quality by their dielectric strength, and not by their specific ohmic resistance. If the ohmic resistance is very low—comparatively speaking—the current which leakes through the insulation may be too small to do any harm. Ohmic resistance tests on transformers are of relative value only in so far as they give a clue as to whether there is somewhere a weak spot due to dirt and moisture, but this is not necessarily so.

They will not show how reliable it is. But if we apply a potential between the various parts of the circuit several times greater than that at which it normally operates without breaking it down, we have some assurance, then, other things being equal, that it will operate safely.

Deductions from Characteristic Curve of Ohmic Resistance.

Fig. 1 is a characteristic curve of the ohmic resistance of a thin sheet of untreated fibrous insulating material taken from the stock and subjected to a drying process.

From the proceeding the following general points may be noted:

(1) The ohmic resistance and dielectric strength of moist insulation are higher when cold than when hot.

(2) In expelling the moisture from a transformer it is bound to accumulate more or less in certain parts owing to the complex structure of the transformer, thereby causing the ohmic resistance to vary considerably until such an amount is expelled that the remaining moisture passes out at a diminishing rate, when the ohmic resistance will begin to rise.

(3) In the case of a thin sheet of insulating material, where the moisture is free to get out at all points without accumulating perceptibly at any one place, the ohmic resistance will gradually decrease to a minimum and then increase gradually, forming practically a smooth curve as indicated in Fig. 1.

(4) The decrease in ohmic resistance with the rise of temperature is evidently due to the presence of moisture (provided no chemical changes take place); for after the moisture is expelled the resistance increases with increased temperature, within certain limits.

(5) Low ohmic resistance is not necessarily an indication of poor insulation, but probably an indication of the condition of the apparatus in regard to moisture.

(6) A high e.m.f. should not be applied to apparatus when the ohmic resistance of the insulation is low.

(7) Material which is badly deteriorated mechanically by heat may still have a high ohmic resistance but very poor insulating qualities.

Then,—as stated before—the ohmic resistance tests of insulation is of relative value only. The same readings may be obtained twice from the same apparatus under entirely different conditions of real dielectric or volt resisting value. There is no direct relation between the breaking down e.m.f. and the ohmic resistance. However, a low ohmic resistance usually means a low breakdown test, but a low breakdown test does not necessarily mean a low ohmic resistance. These two tests have been aptly compared to the chemical analysis and the tensile strength of iron. A poor chemical analysis does not indicate whether or not there are flaws in the metal.

The principle use, then, of ohmic resistance measurements of insulation lies in the comparison they afford of the damp-proof qualities of various dielectrics and in the measure of the degree of dryness attained in drying out a piece of electrical apparatus.

Materials Used in Insulating.

Now we come to the comparatively short and simple description of what the materials actually used in construction consist of. We class all the materials usually used under the following head:

1. Friction tape.
2. Unbleached cotton tape.
3. Oiled cotton or silk.
4. Paper of various kinds.
5. Mica.
6. Micanite (of various forms).
7. Hard fibre and wood.

Of these most manufacturers at the present time use the cotton tape or oiled cotton to insulate the separate turns of the coil when winding the copper into the required formed coils.

Paper or micanite in the form of thin strips may be placed between each turn of these coils if made necessary by a high voltage between turns. When the coils are finished they are securely bound in place by three or four layers of friction tape.

Between the different layers of primary and secondary micanite or fibre barriers are placed to prevent arcing between high tension coils, and to prevent contact between high and low tension sides of the line. In small core type transformers this barrier usually takes the form of a micanite cylinder, which just fits the air gap between the primary and secondary coils. In the larger shell type construction, blocks and boards of fibre are used, these being placed between coils before clamping them in position.

Oil and Air Insulation.

When we speak of oil and air insulation, we mean that in the one case oil is used for the insulating material and that in the other case the space occupied by the air takes the place of insulation, which might otherwise be used. I may say here, however, that whenever air is used some means is always supplied by which the air is circulated through the windings, thereby cooling as well as insulating the transformer. In the case of oil insulation this does not necessarily apply, as in small units and up to say 500 k.w. there is no provision made for outside cooling.

The air insulation transformer is generally speaking more correctly called the "air blast" transformer, in as much that air under pressure of about ¾ ounces per square inches is used for cooling purposes. The insulation in this type consists mainly of cloth, paper, film, and wood, each and all of which are impregnated with oil or varnish.

Spaces or ventilating ducts are left between the coils for the free passage of air used for cooling purposes, and these passages act in the same manner as if they were filled with insulating material, such as oil, until a certain voltage is reached, when static discharges across the high tension coils take place. The usual range of operation of this type is up to 20,000 volts and the maximum is about 35,000.

When we use oil as an insulating material we have a wider range of voltages, the maximum running almost as high as we like to make it, and easily as high as the present day transmission line will permit.

The method of using oil as an insulating material in the transformer of the present day is simplicity itself. The windings, properly dried, are simply placed in the case and covered with oil. This oil insulates the winding from each other, from parts of the case; keeps them dry and also cools them by carrying heat generated in the coils and core to the case.

Fire Risks.

We might now consider briefly the fire risks of the two methods of insulation. To show the difference of opinion on this important branch of the subject we will quote the following:

"In both types the insulating material is of an inflammable nature, and under certain abnormal conditions may take fire with more or less serious consequences.

"The electrical engineer must, therefore, consider carefully not only the relative, but the actual fire-hazard which exists, and by proper and common-sense methods minimize such danger. Both types can be made entirely safe by correct methods of design and installation.

"I think it will be admitted that in general that type which contains the greater quantity of inflammable material will occasion the greater fire-hazard. The inflammable material in an air-blast transformer of say 1,000 k.w. capacity, will amount to about 800 pounds; in an oil-cooled transformer of the same capacity the amount will be about 7,300 pounds. While this comparison cannot be taken as a measure of the relative fire-risk, it is an indication to be considered, especially in view of the fluidity, the low temperature of ignition, and high calorific value of oil.

"While the quantity of inflammable material in an air-blast transformer is, as stated, relatively small, it has an extended surface exposed to a large volume of air, and therefore, if a fire starts from internal causes, such as short circuit or extreme over-load, is capable of rapid combustion. This combustion could be checked by shutting off the flow of air to a transformer by means of a diaphragm automatically closed by the melting of a fusible link, the fusible link so located as to be melted by the first contact with flame; a method similar to that employed for closing fire-doors in buildings.

"An oil transformer properly cooled is probably not particularly subject to ignition of the oil from internal burn-outs or arcs. It is well known that oil is an excellent medium for the smothering of alternating arcs, and this principle is utilized in connection with oil-switches. The vapor above the oil, may however, be ignited by electrical discharges. Even in this case, while the quantity of combustible material is enormous, the surface exposed is relatively small. The principle fire-hazard in an oil transformer is due to the large mass of inflammable liquid material which under certain conditions may become totally consumed. It becomes a special hazard in the case of fire from sources external to itself.

"Considerations of first cost, economy of space, simplicity, operating costs, etc., have resulted in placing transformers in the same room with switchboards and other apparatus, such as synchronous converters, motor-generators, etc. Under such conditions, it would seem that that the air-blast transformer constituted the lesser fire-risk than the oil transformer, and would therefore be generally employed if the fire-risk were the only consideration. The air-blast type, however, is limited in practice to pressures of about 30,000 to 35,000, as the static discharge which occurs at much higher pressures would in time break down the insulation. It is therefore necessary to employ oil insulation on the higher pressures now common.

"The fire-risk can be practically eliminated by placing such transformers in a room or rooms separated by suitable fire walls from the other part of the plant. This plan has already been proposed and introduced. An entirely separate building, sub-divided again into suitable rooms, may be employed where the maximum of safety is demanded. Much may be done to limit the risk, even when the transformers are placed in the same room with other apparatus, by proper systems of piping and draining the oil away from the building, by placing the transformers in a depressed area of concrete arranged for rapid drainage, etc. Of course any of the methods commonly employed for preventing, limiting, or extinguishing oil fires may properly be employed."*

This article by E. W. Rice, jr., gives the oil insulated type the greater fire risk principally on account of the greater amount of combustible material in the transformer case itself. Now referring to an article by J. S. Peck, in Vol. 2 of the same work we have the following:

"During the past year, a considerable amount of discussion has occurred regarding the relative fire-risks of oil-insulated and air-blast transformers. The general results brought out seem to indicate that so far as actual damage to the transformer itself is concerned, either by internal or external heat, the risk is much greater with the air-blast transformer than with the oil-insulated type. The greater risk of the air-blast transformer results, not only from the more inflammable nature of its insulation, but also on account of the presence of the air blast, which tends to increase the rate of combustion, as well as by the open construction necessitated by the method of cooling.

"In the oil-insulated transformer, the oil cannot be ignited unless it is first raised to a very high temperature. Oil also acts as an extinguisher of arcs which occur below its surface, and, if the transformer is inclosed in a tight case, the oil, even if ignited, cannot continue to burn, on account of lack of fresh air.

"There is, however, a danger incident to the operation of the oil-insulated transformer which is due to the fact that oil-vapor, when mixed with the proper proportion of air, forms an explosive mixture, which, becoming ignited, may burst the containing case and permit the oil to escape. With large transformers it is now customary to use a practically air-tight case, sufficiently strong to withstand an internal pressure of approximately 100 pounds per square inch, which is probably in excess of any pressure that can actually be obtained. In large transformer installations, each transformer, or each group of transformers, is often placed in a vault or pit, which is properly drained and, in the event of a case being damaged by external causes so that oil escapes, it will not spread about the station floor, but be carried away by the drain

"With every precaution taken, the presence of large quantities of oil must constitute a certain fire risk, and for this reason it has become the general practice to specify air-blast transformers for use in sub-stations which are located in thickly populated portions of large cities. Such transformers are usually wound for 6,000 to 15,000 volts, for which pressures the air blast transformer is well adapted. For very high voltages, it is of course necessary to use oil-insulated transformers, taking such precautions in their installation, as to reduce to a minimum the danger to surrounding buildings or apparatus.

"A method for reducing the fire hazard of the oil-insulated transformer which has been used to a limited extent, consists in placing the transformer in a tight case with a vent-pipe connected to the top of the dome-shaped cover. At the bottom of the case a connection is made with the water-mains, so that, in case of necessity, water can be admitted at the bottom of the case, driving out the oil through the top vent and leaving the case filled with water. The vent may be connected with a sewer, or with a suitable tank for receiving the oil."

This author gives the greater risk to the air-blast transformer for the simple reason that it is air-blast and so tends to quickly spread any fire which might occur in it or its vicinity. However, if the necessary precautions are taken in the installation and the necessary attention given during operation, I agree with Mr. Rice and think that the fire risk can be reduced in both cases to a negligible quantity.

The quality of the oil necessary to use will be discussed under the head of "Cooling."

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* "High Tension Power Transmission," by E. W. Rice, Jr., American Institute of Electrical Engineers

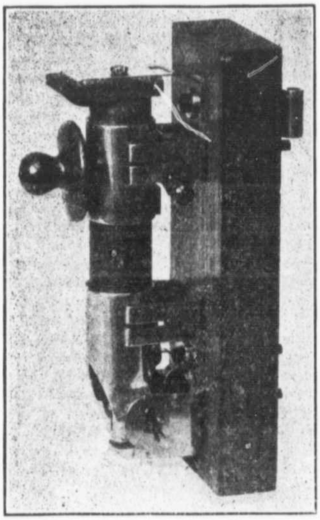
NEW EQUIPMENT FOR POWER PLANT

Only Descriptions of New and Interesting Equipment Can be Published. No Mere Manufacturers' Write-Ups Can be Used.

New Type Circuit Breaker

Both fuses and circuit breakers are recommended by the Fire Insurance Underwriters for use with motors because in the smaller installations the circuit breakers are too expensive. For this reason fuses are often used even though the work of replacing them when blown is excessive. Fuses are in many cases dangerous as well as expensive and troublesome to maintain. It is not an infrequent sight to find a blown out fuse replaced by so heavy a wire that it could burn out only with a current which would severely damage the apparatus it is supposed to protect.

The general use of circuit breakers has



New Type of Circuit Breaker.

been limited because of the first cost of the installation. In order to provide a breaker which shall be able to compare in price with enclosed fuses, the Canadian Westinghouse Co., Hamilton, has developed a small carbon break circuit breaker known as the type F.

The illustration shows the compact and neat construction of the circuit breaker, suggesting the appearance of a cartridge fuse. The tripping device is inside the movable arm, it may also be tripped by hand by the small insulating handle. In addition, an auxiliary magnet coil may be attached to provide for tripping the switch from a distance, such as is required in connection with automatic limit switches on machine tools.

These circuit breakers are made in four sizes for 12½, 25, 50 and 75 amperes. Each has an operating range of from 80 to 160 per cent., that is, the tripping device may be set for any current within these percents of the rated capacity. Adjustment is made by a knurled nut at the lower end of the arm and may just be seen in Fig. 1. These breakers are made in single pole types for direct current up to 250 volts and alternating current up to 440 volts.

The standard circuit breaker is mounted on a porcelain base, similar to the mounting of a fuse, with all the connections on the face of the porcelain to permit being placed directly on the wall. However, it is also supplied for switchboard and control tablet work where the connections are made on the back; two screws are provided for mounting under these conditions. The outfit as a whole takes up practically no more space than an enclosed fuse of the same capacity.

Catalogues Worth Having

These Catalogues will be sent by the firms upon request. Mention The Canadian Manufacturer.

Power Presses. General catalogue of the E. W. Bliss Co., Brooklyn, N.Y. This is a cloth-bound book containing 580 pages, illustrating a complete line of presses and similar tools made by E. W. Bliss Co. It is a regular encyclopedia of modern practice in this line of tools.

A. Baillot Cupolas. Catalogue of Jules de Clercy, 62 Ontario Street West, Montreal, illustrating and describing the Baillot cupola, which attracted so much attention at the convention of the American Foundrymen's Association held in Toronto last June, where it was shown in operation. This cupola has some features which should be investigated by all users of cupolas. Features claimed for it are: 15 to 30 per cent. saving in fuel; economy in attendance, time and power; better quality of cast iron; and continuous operation. Included with the catalogue is a copy of the paper: "Some Chemical Reactions in Foundry Cupola," read before A. F. A. by Jules de Clercy.

Gisholt Tools. A neat little booklet of the Gisholt Machine Co., Madison, Wis., illustrating turret lathes, vertical boring mills, universal tool grinders, horizontal drilling machines, double emery grinders, worm hobbing machines, gear testing machines, chucks, etc. It is made pocket size for ready reference.

General Tool Catalogue. Something exceptionally fine in the way of a general catalogue is that of the Warner & Swasey Co., Cleveland, O. The illustrating is a work of art. The printing leaves nothing to be desired. The information contained is concise and to the point. It is a most valuable catalogue for a mechanical reference library.

Bearings. Catalogue of the Hill Clutch Co., Cleveland, O., illustrating and giving detail information about their collar oiling bearings in their various mountings. This company announce the preparation of a new edition of their general catalogue.

Electric Travelling Cranes. A most interesting, particularly to railway men, bulletin of the Whiting Foundry Equipment Co., Harvey, Ill., Montreal, Canadian Agents Dominion Foundry Supply Co., containing a selection of crane installations in railroad shops of wide range. One of these is in the Canadian Pacific Railway shops in Montreal.

Reinforced Concrete Factories and Warehouses.—Bulletin No. 5 of the Turner Construction Co., 11 Broadway, New York City, containing a detail description with fine illustrations of the reinforced concrete building put up by this firm for Keuffel & Esser Co., Hoboken, N.J.

Electric Locomotives.—Special publication No. 7031 of the Canadian Westinghouse Co., Limited, Hamilton, illustrating and describing electric locomotives for industrial and mine use. These locomotives are built by the Canadian Westinghouse Co., and the Baldwin Locomotive Works, there thus being combined wide experience in electrical work and in locomotive work. This publication is a specially interesting one, and from it suggestions can be gleaned as to where money could be saved in industrial transporation.

Grinding vs. Cutting: Helps-Don'ts; Alundum.—Three little booklets published by the Norton Co., Worcester, Mass., containing a lot of useful data and information on grinding. "Helps-Don'ts" is a particularly useful booklet to have on hand for reference.

Nernst Multiple-Glower Lamps.—Neat little bulletin containing a treatise on the Westinghouse Nernst multiple-glower lamps, well illustrated, sent out by the Canadian Westinghouse Co., Hamilton.

Conveying Machinery. — Little bulletin of the Jeffrey Mfg. Co., Columbus, O., and Montreal, containing numerous illustrations of installations, of Jeffrey conveying machinery in saw mills, lumber mills and woodworking industries, which illustrations furnish ideas as to how logs, lumber, refuse, sawdust, shavings, pulp wood, chips, boxes, barrels, etc., can be handled.

"Builder's Bulletin."—The "Builder's Bulletin," the official organ of the Montreal Builders' Exchange, appeared last week in a handsome cover of heavy green paper. We note with pleasure the growth of the "Bulletin" both in size, and in the value of its news of the building trades.

Open Meeting of C.A.S.E.

On November 20 there will be an open meeting of Lodge No. 1, Toronto, of the Canadian Association of Stationary Engineers, at which meeting C. B. Turner, New York, will address the meeting on Formation and Prevention of Boiler Scale.

Test of Chatham Gas Plant

Report of K. L. Aitken, Engineer for the Municipality of Chatham, of the Gas Engines and Producer, made to Determine Whether the Contract had been Carried Out by Colonial Engineering Co.

In the last POWER EDITION of THE CANADIAN MANUFACTURER appeared illustrations, and descriptive matter of the municipal electric lighting plant of Chatham, installed by the Colonial Engineering Co., Montreal. This plant consisted of two 100 h.p. Hornsby-Stockport suction gas engines and producer.

Before taking over this plant the municipality employed K. L. Aitken, electrical engineer, Toronto, to make a test of the plant and report as to whether the contract had been fulfilled by the Colonial Engineering Co. This test has been made and the plant taken over by the city.

Because of the very great interest which is being taken in producer gas by the manufacturers of Canada just now, the important features of this report are reproduced here.

The first part of the report calls attention to the fact that the Colonial Engineering Co. installed two gas engines instead of one as called for in the contract. Concerning this Mr. Aitken says:

"I understand that the Colonial Engineering Co. made this change from one large unit to two smaller ones without additional cost to you, and if such be the case, you may consider yourselves fortunate. Had I been designing your equipment, I would have put in the two smaller engines in preference to the one large machine, and would have been willing to pay more for the two smaller engines.

"I understand that it was your idea to install one gas engine and put in a steam engine as a reserve, such steam engine being supplied with steam from the waterworks boilers some distance away. This arrangement would be good, and the steam engine might be a desirable acquisition with only one gas engine, but with the two gas engine plant I am very much inclined to think that the necessity for an auxiliary steam service is entirely eliminated and you are therefore saved the cost of this work, I will say further that I think you will be able to give better street lighting service with the plant as now installed, for the equipment, while it may on rare occasions require the cutting off of one machine for a few moments, will not suffer a complete shut-down. With the proposed plant of one gas engine and one steam engine, a dirty igniter would mean cutting off every light in town until the igniter could be cleaned or the steam engine could be put in operation. This latter move would take some little time due to the long length of piping required to connect the gas engine power house with the pumping station.

"The engines show every evidence of proper design, good material and good workmanship. The hit-and-miss system of governing which is used, is standard English and Continental practice, and will be found quite satisfactory for your work.

TESTS OF ENGINES.

"During almost all tests your city engineer, Mr. Jones, was present.

"The output of each engine was measured by means of a friction brake, which apparatus your city engineer will inform you is an entirely reliable device for making power measurements.

"In making a maximum capacity test on engine No. 25938 with natural gas, I obtained 125 h.p., and the engine then was running in such a manner as to be capable of delivering somewhere between 5 and 10 per cent. more than this amount.

"A similar maximum capacity test was made with producer gas, and 100 brake h.p. was obtained with three or four per cent. more capacity left in the engine.

"Engine No. 25939 showed a maximum capacity on producer gas of 98 brake h.p.

"On the combined test of the two engines I found that a horse power hour was developed with .92 (92-100) pound of coal, and therefore the two smaller engines have shown an efficiency eight per cent. better than that guaranteed for the large unit.

"The contract states that the one engine, when used on natural gas, must be capable of delivering a maximum of 210 brake h.p. Please note that engine No. 25938, as above stated, showed 125 h.p. on natural gas and had something to spare. The two engines are identical (note that on the maximum test on producer gas one showed 100 brake h.p. and the other 98 brake h.p.), and I would therefore say that the combined maximum power of the two engines on natural gas will be approximately 250 h.p., or 19 per cent. better than the guaranteed maximum.

"On producer gas, the contract calls for the one engine to have a capacity of 190 brake h.p. From figures given above, you will note that the combined maximum capacity of the two engines on producer gas was 198 brake h.p., or something over four per cent. better than the guarantee.

SUMMARY OF REPORT.

"As stated at the beginning of this report, the letter of the contract has not been fulfilled by the Colonial Engineering Co. in the two particulars mentioned, but the spirit has certainly been fulfilled, and I believe, and will most unhesitatingly say that a better and more suitable equipment has been furnished you than contemplated in the agreement. The guarantees have all been exceeded, and the furnishing of two units without additional cost to you will, as before stated, do away with any question of installing an auxiliary steam plant.

"In conclusion, I would state that the tests herein referred to were very carefully made, and the results as herein given are correct to the best of my knowledge and belief. Respectfully submitted,

(Signed) K. L. AITKEN."

Personal Mention

W E. Archer, mechanical superintendent of the Nasmith Co., Toronto, has just returned from a trip through the Eastern States, including New York and Philadelphia, investigating producer gas plants to be used in connection with the Nasmith gas heated oven.

Mr. W. Stark, secretary-treasurer of W. H. Storey & Son, Limited, of Acton, has resigned his position. Mr. Stark has been with Messrs. Storey for over twenty-three years.

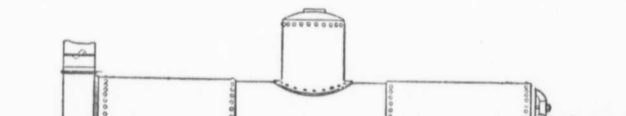


FIG. I. HOW BOILER WAS FIRST ERECTED

Wrong Boiler Setting

BY C. S. ROBINSON.

The two illustrations are of a boiler located in the plant at which I am employed. Fig. 1 shows the boiler as it was when first erected. The fuel used is natural gas and the boiler has been in use over a year, but was not worked very hard until about three months ago. The feed water is fed through the blowoff pipe, a thing I objected to when the boiler was set up, but I was not the chief engineer then, and the fellow who was in charge was able to talk the management into feeding this way.

Things went smoothly enough until we commenced to crowd the boiler, then scale began to collect at the end seam and around the blowoff pipe. A few weeks ago the feed pump gave out and I placed a larger one in its place. The result was that the mud collecting at the blow off was driven to the other end of the boiler, resulting in a few days in a nice bag about 6 inches in diameter.

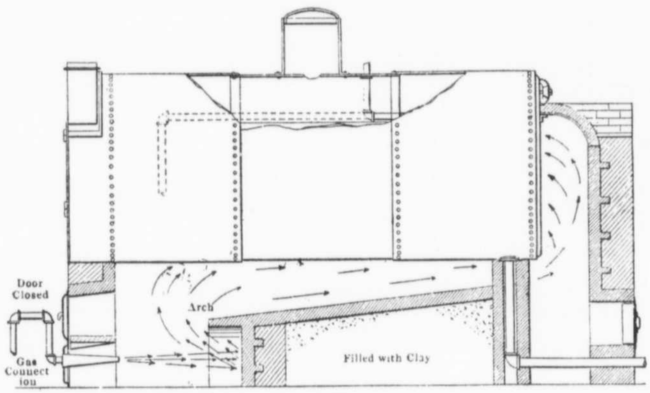


FIG. 2. SHOWING THE CHANGES MADE IN THE SETTING

The illustration also shows the way the furnace was constructed. Note the slant of the fire bridgewall and the location of the bag. In Fig. 2 is shown the way I have changed things, not only the feed-water connections, but the furnace as well. I might add that we have only cleaned the boiler once since making the change, but found that the mud was near the blowoff outlet, while before it was in the front end of the boiler.—Power.

Electric Walking Jib Crane

Special Walking Jib Crane Installation in Railroad Shop for Handling Wheels and Axles. Electrical and Mechanical Brakes on Hoisting Mechanism.

A very interesting jib crane installation is shown in the accompanying illustration. This crane is installed in the Burnside shops of the Illinois Central Railway, for handling locomotives and car wheels and axles. It is used chiefly to distribute them about the shop to wheel lathes.

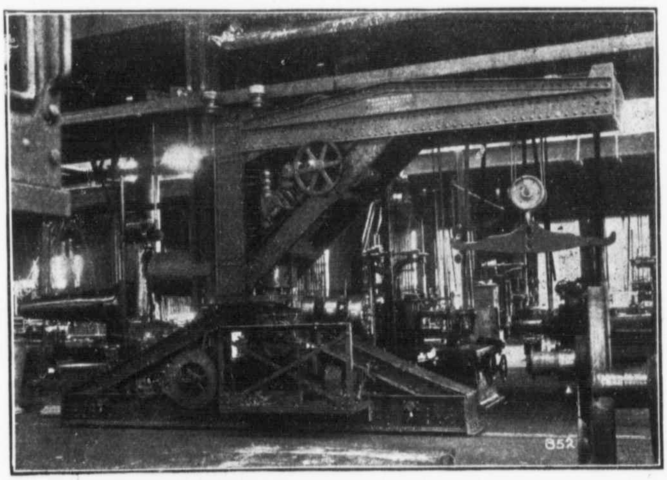
The crane travels on a permanent mono-rail track, running the entire length of the shop at right angles to the erecting pits. The top of the mast is supported by an I-beam track, as shown.

The track is laid as close to the columns separating the erecting floor from the machine shop floor as clearance will permit, so that the crane serves the erecting pit on one side of the track, and the wheel lathes on the other.

The capacity of the crane is 7 tons. It is operated by four motors: the 15 h.p. hoist motor, hoisting 16 feet per minute; the 10 h.p. crane travel motor, travel being at the rate of 180 feet per minute; the 2 h.p. rack motor, which racks the trolley on the jib at the rate of 90 feet per minute; and the 2 h.p. jib rotating motor, which swings the jib at the rate of two r.p.m.

The crane has a working radius of 12 feet. The jib is fixed in a horizontal position. The maximum lift of hook from rail is 10 feet. It will be noticed that the crane has very low head room.

The hoisting gearing of the crane is provided with a double automatic safety brake, so arranged that the load may be raised and lowered by power, and is automatically sustained at all times. This brake attachment consists of two independent brakes, one mechanical and one electrical. The electric brake is operated by an electric solenoid in circuit with the hoisting motor, and so arranged as to come automatically into action when the electrical current is off the hoisting motor circuit.



Walking Electric Jib Crane.

This crane was specially designed by The Whiting Foundry Equipment Co., Harvey, Ill., for the Illinois Central Railway Co. to do this work.

POWER DIRECT FROM COAL.

In his spare hours, away from the laboratory, Thomas A. Edison is having to go through the mental crucible preparatory to physical experiments to be undertaken later, two inventions, the last of a commercial nature which he will undertake. One is the development of power direct from coal; the other, the artificial manufacture of black diamonds to be used for drilling purposes.

"If I do not reach it myself I will live to see the day when power will be utilized from coal without the aid of steam," said Mr. Edison. "We are working in that direction, and some morning the world will be informed that the discovery is a fact. Electricity is many times more effectual than steam. In a few years a steam railroad will be a novelty.

"I have been experimenting to get a black diamond which is better for drilling purposes than the white diamond. So far I have not succeeded, but have not given up. Imagine the impetus that would be given to the mining industry through the discovery of a cheap diamond for boring purposes. Not the hundredth part of one per cent. of the metals in the western mountains has been reached yet."

A SOAP BUBBLE HANGING FROM A REED.

HENRY FREDERIC AMIEL—1821-1881.

Our life is but a soap bubble hanging from a reed; it is formed, expands to its full size, clothes itself with loveliest colors of the prism, and even escapes at moments from the law of gravitation; but soon the black speck appears in it, and the globe of emerald and gold vanishes into space, leaving behind it nothing but a simple drop of turbid water. All the poets have made this comparison, it is so striking and so true. To appear, to shine, to disappear; to be born, to suffer, and to die; is it not the whole sum of life, for a butterfly, for a nation, for a star?

CAPTAINS OF INDUSTRY

Opportunities for Business. News of Building or Enlargement of Factories, Mills, Power Plants, Etc.—News of Railway and Bridge Construction—News of Municipal Undertakings—Mining News.

BUILDING NEWS.

Ontario.

NORTH BAY.—The new town of Matheson, on the Temiskaming & Northern Ontario Railway, has been destroyed by fire. The loss is estimated at $75,000 with no insurance.

TORONTO.—The McLaughlin Carriage Co., of Oshawa, Ont., intend to erect a four-story and basement factory and warehouse at the corner of Richmond and Church Streets.

HESPELER.—Joshua Wayper is preparing to have extensive improvements made to the Queen's Hotel, here.

GUELPH.—The boiler used for heating the Palmerston school has given out and a new one will be installed.

TORONTO.—The premises owned by Burgess Powell, Yonge Street, has been damaged to the extent of $1,000.

WINGER.—The evaporators of the Erie Evaporated Co., here, have been totally destroyed by fire.

CARLSBAD.—The general store and hotel owned by T. L. Boyd has been destroyed by fire.

AYLMER.—The hotel owned by Henry McLean has been destroyed by fire.

STRATFORD.—The Stratford Mfg. Co. intend enlarging their factory immediately.

ASHBURNHAM. — The Peterborough Furniture Co. are considering the erection of a new building here.

RODNEY.—The butter dish and berry box factory here will be enlarged this fall.

LISTOWEL.—The Mevers Milling Co. are building a three story brick addition to their present building.

BRANTFORD.—A large brush factory will be erected here by Mr. Smith.

Quebec.

MONTREAL.—The Redpath Estate have taken out a permit for the erection of a five story warehouse to cost $22,000.

MONTREAL.—The morgue and undertaking establishment of C. A. Dumaine & Co., Notre Dame East and St. Andre Streets, was damaged by fire recently. Loss about $15,000 covered by insurance.

MONTREAL.—An observation ward will be added to the Victoria Hospital. Messrs. E. & W. S. Marwell, 6 Beaver Hall Square, are the architects.

MONTREAL.—Fire escapes will be installed on the city hall facing the Champs de Mais at a cost of about $6,000.

THREE RIVERS.—Plans for a store for Messrs. Bellefaville & Giroux, a store for Mr. Badeau, and a complete block of stores and offices for Mr. Balcer, in Three Rivers, have been prepared by Messrs. Daoust & Laforatt, architects, Three Rivers, P.Q.

Manitoba.

WINNIPEG.—The Scottish Co-operative Society have decided to erect six elevators at once along the Grand Trunk Pacific within Manitoba.

WINNIPEG.—The Manitoba Gypsum Co. here have been granted a permit for the building of a $3,000 addition to their mill.

British Columbia.

REVELSTOKE.—A branch of the Molson's Bank will be erected at Revelstoke, B.C. Mr. A. F. Dunlop, Lindsay Building, Montreal, is the architect.

Alberta.

PRINCE ALBERT.—The roundhouse here will be enlarged by an addition of a machine shop.

Prince Edward Island.

CHARLOTTETOWN.—The village of O'Leary near here was almost wiped out by fire, damage amounting to $15,000.

Newfoundland.

ST. JOHN'S.—The block of Baird, Gorden & Co., has been destroyed by fire, the damage amounting to about $500,000. The Royal and Queen Insurance Co.'s are interested in the insurance.

MILL AND FACTORY EQUIPMENT.

Ontario.

COBOURG.—Work will soon be started on the construction of the steel rolling mills plant here. Martin, Jex & Co. have the contract for the three buildings.

CORNWALL.—The Royal cheese factory Summertown, has been totally destroyed by fire with its contents and all the machinery.

GUELPH.—The London Machinery Co. will build a new plant here for the manufacture of hay carriers and other stable machinery. The plant will include a moulding shop.

NORTH BAY.—The T. & N. O. Railway Commission will build a car repair shop and a pipe and casting shed here.

FORT FRANCIS.—C. O. Opdahl will erect a new planing mill and wood-working factory here.

YOUNG'S POINT.—The entire sawmill including all the machinery belonging to Dunn & Young has been completely destroyed by fire.

GALT.—G. P. Clapp and J. Eatough, of Montreal, will establish a tack and nail factory here.

Saskatchewan.

SASKATOON.—Douglas, Piper & Johnson, flax millers, will establish a flax mill here.

British Columbia.

SKEENA CITY.—A large sawmill of 50,000 feet capacity, per day, is to be built here by Seattle and Vancouver capitalists

POWER PLANT OPPORTUNITIES.

Ontario.

TRENTON.—The Electric & Water Co. here are planning a large water power development. J. J. Wright, of Toronto, is the manager.

GALETTA.—The Galetta Electric Power & Milling Co. have almost completed their power station here, and are erecting a pole to supply Arnprior with light.

STREETSVILLE.—A municipal electric lighting plant has recently been installed at a cost of $26,000 and is now supplying current at six cents per kilowatt.

ST. CATHARINES.—An agreement with the Lincoln Electric Light & Power Co. for street lighting at $50 per light, has been signed by the city council for a period of five years, with the option to renew for a further period of fifteen years.

BRANTFORD.—The committee of Aldermen and representative citizens on November 2 passed a resolution recommending that the sub-committee prepare a report showing the cost of municipal ownership of an electric plant for lighting and power purposes, power to be supplied by the Hydro-Electric Power Commission.

Quebec.

MONTREAL.—The Montreal harbor engineer is now preparing plans for an electric power plant on the harbor front to supply all the power required along the harbor. Plans for a drydock are also being prepared, and for a concrete wall around the piers to prevent wearing.

COMPANIES INCORPORATED.

Ontario.

GALT.—Canadian Brass Co., here, have been incorporated with a capital of $100,000 to manufacture brass goods. The provisional directors include E. J. Getty, F. S. Scott, and H. Leddon, all of Galt.

PETERBORO.—The F. R. J. MacPherson Co. have been incorporated with a capital of $40,000 to carry on the business as hardware merchants, tinsmiths, plumbers, etc.

TORONTO.—The Badger Mines Co., Limited, have been incorporated with a capital of $2,500,000 to maintain and manage mines and mineral lands. The provisional directors include Frank Denton, H. L. Dunn and Irwin Stuart Fairty, all of Toronto.

WATERWORKS, SEWERS AND SIDEWALKS.

Ontario.

ORILLIA.—The town council here have decided to submit $10,000 by-law to the people for waterworks purposes.

ELMIRA.—Extensions will be made to the waterworks system at a cost of $25,000.

LINDSAY.—The water commissioners here are contemplating the installation of electric energy in the pump house instead of steam.

Nova Scotia.

DARTMOUTH.—About $59,500 will be spent on extensions to the water and sewerage systems here.

BRIDGES AND STRUCTURAL STEEL.

Quebec.

QUEBEC.—On December 1, 1908, the Dominion Government will assume full charge of the construction of the Quebec bridge, and the Quebec Bridge Co. will cease to exist. The directorate of the Quebec Bridge Co. have received official notice from the Department of Railways and Canals in keeping with the foregoing, and according to the terms of the transfer, the Government will take over the company's assets and liabilities at the same time refunding the shareholders and directors of the Quebec Bridge Co. the amount of their investment, etc. The approaches to the bridge are now complete, and the superstructure will be started as soon as plans are prepared.

TRADE NOTES.

Ontario.

TORONTO.—The Belleville Portland Cement Co. have opened an office at 24 Yonge Street Arcade.

PETERBORO.—The William Hamilton foundry will begin operations in a short time.

WALKERVILLE.—The Kerr Engine Co., Limited, have just received an order for 100 of their gate hydrants for the city of Vancouver, B.C.

GREEN CREEK.—Work has begun on the construction of the Canadian Northern Railway here.

FORT FRANCIS.—Work on the large dam here has been resumed.

Manitoba.

WINNIPEG.—The capital stock of the Wilson Stationery Co., Limited, has been increased from $30,000 to $100,000.

Quebec.

MONTREAL.—The new Grand Trunk Railway offices, corner of St. James and St. Francois Xavier Streets, were damaged by water recently in putting out a fire in the floor above.

THREE RIVERS.—Tenders for a dock and icebreaker for Three Rivers will be received by the department of Public Works, Ottawa, until November 27, 1908.

ST. ANDRE.—Tenders for construction of an extension to the wharf at St. Andre, Kamomaska county, P.Q., will be received until November 23, 1908. Plans may be seen at the office of J. L. Michaud, resident engineer, Merchants Bank Bldg,, Montreal; A. R. Decary, resident engineer, Quebec; department of Public Works, Ottawa, or postmaster at St. Andre de Kamomaska P.Q.

New York.

The Standard Gauge Mfg. Co., Syracuse, N.Y., have moved their plant and main offices to Foxboro, Mass. The manufacturing capacity of the new plant is much greater than the old. The sales offices remain as before: New York, 1770 Hudson Terminal, Fulton Bldg.; and Chicago, 752 Monadnock Bldg.

Regulations Re Engineers' Certificates

Regulations in Regard to the Examination of Candidates for Stationary Engineers' Certificates Approved by Ontario Cabinet November 5. The Other Two Members to the Board of Examiners to be Appointed at Early Date.

Engineers throughout Ontario, and particularly members of the Canadian Association of Stationary Engineers, have been awaiting with considerable expectancy the action of the Ontario Cabinet as to the regulations which will govern the examination of candidates for certificates, and the granting of such certificates under the Act respecting Stationary Engineers, which act was passed by the Ontario Government in April, 1907, and amended in April, 1908; they have also been anxious to know what others would be appointed to serve on the Board of Examiners with Mr. W. C. McGhie, who is chairman.

Just before this issue went to press the Ontario Cabinet took action and on November 5th the following regulations were approved by His Honor, the Lieutenant-Governor, upon the recommendation of the Minister of Agriculture:

Regulations for Examinations.

1. The Board, or any member thereof, when authorized by the chairman, may examine candidates for certificates.

2. Candidates may be examined, subject to appointment, at any time during office hours at the office of the Board at the Parliament Buildings, Toronto, and the Board may conduct examinations twice in each year on such dates as may be determined:

(a) At the city of London; (b) at the city of Kingston; (c) at the city of Ottawa; (d) at the city of Port Arthur; and at such other times and places as may be considered desirable by the Board.

3. Notice of the time and place of holding examinations shall be sent to each candidate living in the district in which the examination is to be held.

4. Candidates for examination shall apply to the Chairman of the Board on the form prescribed by the Board, pay the prescribed fee, answer satisfactorily such questions as are required by these regulations, and obtain testimonials as to character and sobriety before they are competent to take the examination.

5. Candidates shall be examined upon a set of questions prepared from time to time by the Board, and approved of by the Minister of Agriculture, and (except when examined as provided in regulation 6) shall answer correctly at least sixty per cent. of the questions presented.

6. Where the Board so decides the examiner may examine a candidate orally on the questions contained in the examination paper, and have him demonstrate his knowledge of the operation of a steam plant in an engine and boiler room; and in cases where a candidate is examined in this manner, the examiner shall fill in on the examination paper, so far as possible, the replies received to the questions asked, and shall state his opinion of the candidate's ability and whether or not he possesses a practical knowledge of the subject dealt with.

7. Candidates must appear personally before the Board, or an authorized member thereof, for examination, and in no case shall examinations be conducted by mail, nor shall examination questions be sent to a candidate by mail, nor shall he be furnished or made acquainted at any time previous to the examination with the questions upon which he is to be examined.

8. Examination papers shall be passed upon at a meeting of the Board at which all members are present before certificates are granted.

9. The length of time allowed candidates to write on any examination shall be determined by the Board.

10. In the event of a candidate failing in his examination, ninety days shall elapse before he shall become eligible for re-examination.

11. The following shall be the form of certificate of qualification granted under the Act:

Number..........

Ontario Department of Agriculture.

STATIONARY ENGINEERS' CERTIFICATE.

THIS IS TO CERTIFY THAT

....

is entitled under the Act respecting Stationary Engineers (7th Edward VII., Chapter 32) to operate and have charge of a steam plant of fifty horse power or over in the Province of Ontario, during the year 19—, unless this certificate is sooner revoked, cancelled or suspended.

Dated at Toronto........day of.......19..

....

Chairman of Board of Examiners.

....

Minister of Agriculture.

12. No certificate shall be granted by the Board if, after investigation, it is shown that the applicant is habitually intemperate or addicted to the use of drugs, or is of unsound mind, or is physically incapacitated from performing his duties.

13. In the event of a certificate being lost, stolen or destroyed, the Board may issue a duplicate thereof upon presentation of a statutory declaration, or other satisfactory proof, setting forth the facts.

14. Before presenting himself for examination, a candidate shall supply evidence satisfactory to the Board.

(a) that he has had not less than two years' practical experience as an engineer, fireman, oiler or assistant under the supervision of a competent engineer; experience in some allied trade or calling, may, at the discretion of the Board, be counted on the required time; (b) that he be of the full age of twenty-one years.

15. Every applicant for a certificate, or candidate for examination, shall obtain a testimonial signed by three reputable persons stating that the applicant or candidate is temperate in his habits and of good character; but the Board may demand such other testimony as to the character of the applicant or candidate as it may deem necessary.

16. Every certificate shall remain in force from January 1 to December 31, in each year, or from the date of issue until the expiration of the year in which it is issued, unless sooner revoked, cancelled or suspended.

17. The fee for examination (including certificate) shall be three dollars; and in the event of a candidate failing to pass, the fee shall not be refunded nor credited to him if he again presents himself for examination.

The fee for the initial certificate granted under Section 6 shall be three dollars.

The fee for renewing a certificate, and for the issuing of a duplicate certificate, shall be two dollars.

The fee for renewal of a certificate, where the holder has failed to register within the prescribed time, shall be five dollars.

16. The Board may (subject to the provisions of Section 9) cancel a certificate where it is shown to their satisfaction that the holder

(a) is habitually intemperate or addicted to the use of drugs;

(b) has become insane or physically incapacitated;

(c) has proved incompetent or grossly negligent in the discharge of his duties;

(d) has obtained his certificate through misrepresentation or fraud;

(e) has transferred his certificate;

and in no case shall a cancelled certificate be renewed until it be shown to the satisfaction of the Board that the disability for which it was cancelled no longer exists.

Appointment of Members of Board of Examiners.

At the time of going to press the other two members to the Board of Examiners, to serve with Mr. McGhie, the chairman, had not been appointed. One of these will be from Western Ontario and the other from Eastern Ontario.

Provisions of the Act of 1907 and 1908.

The Act respecting Stationary Engineers, passed on April 20, 1907, and amended April 14, 1908, gave the Lieutenant-Governor in Council of Ontario, power to appoint a Board of Examiners consisting of three competent and independent engineers; and also power to make regulations from time to time for the examination of candidates for certificates of qualification, and the granting of such certificates, etc.

The regulations which have just been approved are the first set of regulations, drawn up under the Act; and the Board of Examiners, the chairman of which has already been appointed, is the first board to be appointed under this Act.

THE CHAIRMAN OF THE BOARD.

The appointment of Mr. Wm. C. McGhie to the position of chairman of this Board of Examiners is looked upon with universal favor by those most closely interested.

Mr. McGhie was born in the county of Peel and after passing through the public schools of his county, completed his education at Brampton High School and Collegiate Institute. Some fifteen years ago he commenced the study of engineering and subsequently took a course with the International School of Correspondence, Scranton, Pa. Mr. McGhie's first position as chief engineer was with Matthews Bros., picture frame manufacturers, Toronto, with whom he remained for four years. He was then successively engaged by the Kemp Mfg. Co., the Toronto Street Railway Co., and Rolph & Clark, lithographers, Toronto, and was in his fourth year with the latter company when he received the present appointment from the provincial government.

Mr. McGhie's office is situated in the Provincial Parliament Buildings, Toronto.

AS TO APPLICATION.

Of late the chairman has been receiving very many enquiries as to how certificates are to be secured. In the regulations is contained pretty complete information on the subject. The chairman upon request will send application forms and complete information to those desiring to obtain certificates.

As stated in the Regulations, examinations will be held in Toronto, London, Kingston, Ottawa and Port Arthur.

As well as this there will be a trip arranged for one or other of the examiners which will include practically all the important centres some time during the first year; so that engineers who are examined will not be put to heavy travelling expenses. The regulations also allow some elasticity as to the examinations, so that all engineers now in charge of plants will have opportunity to prepare themselves for examination.

AS TO THE FEE FOR CERTIFICATE.

Engineers will notice that a fee of $3 is charged for a certificate and $2 for a renewal. They no doubt will be interested in comparing this fee with that charged in other places where engineers are licensed .

The following are fees for stationary engineers' certificates in various localities: British Columbia, 4th class, $5.00, and an advance of $2.50 for each higher grade; Saskatchewan, $5.00; Alberta, $3.00; Quebec, $5.00; Buffalo, $3.00, and $2.00 for renewal; Kansas City, $5.00, $3.00 and $2.50, with $2.50 for renewal; California, $5.00, and $3.00 for renewal; Tennessee, $5.00, and $5.00 for renewal; Illinois, $5.00, and $2.00 for renewal; Nebraska, $5.00; Montana, $10.00, $7.00 and $2.50 for renewal; Indiana, $3.00; Maryland, $3.00 and $1.50 for renewal.

It will be seen from this that the fee in Ontario is lower than in any of these places.

AS TO REVENUE AND SALARIES.

There are in the vicinity of 5,000 or 6,000 engineers in Ontario, who will require a license. At $3.00 per license there would be a revenue to the Department of from $15,000 to $18,000 the first year; and from $10,000 to $16,000, subsequent years. Out of this the salaries of the examiners, their travelling expenses and the expenses of the department will have to come. The department will be self sustaining. An advance has been made to carry on the work; but this will be returned when the revenue from the licenses comes in.

This brings up the question of the salaries of the examiners. This has not been settled as yet. When this question is taken up there are several things which should be considered. These positions, especially that of chairman of the Board, are most important ones. Men with good, sound, thorough, practical knowledge are required; as well they should be capable of exercising an extra amount of good common sense and judgment. There will be many cases come up for examination in which allowances for varied conditions will have to be made.

The examining cannot be always a matter of rules and regulations. Much discretion and good judgment will have to be used, in order that justice will be done all. Especially will this be the case during the first year. In addition considerable executive ability will have to be exercised by the examiners, especially by the chairman.

This all goes to show that these positions require good men, and that there should be a good salary connected with them.

It must also be considered that men accepting these positions probably give up good positions in the practical line, where they have the chance of advancement to very good positions. Positions on the Board should hold out somewhat similar attractions if the best men for the offices are to be secured. A glance over the following list of positions in Toronto with the salaries attached will give some idea of what good men in this line are getting: Chief engineer of large power plant, $4,000; assistant engineer of same plant, $2,500; chief engineer of large office building power plant, $1,500, living apartments, heat, water and light; chief engineer of steam electric plant, $1,500; chief engineer of a manufacturing plant, $1,500; chief engineer of waterworks, $2,200; assistant engineer waterworks, $1,500; chief engineer of large hotel plant, $1,500 and board; boiler inspectors, $1,600 and travelling expenses.

It is felt among the members of the C.A.S.E. that the minimum salary should not be less than $1,800 for the chairman and $1,500 for the other two members. There should be advancements until the chairman received at least $2,000 and the other members $1,800.

This seems very reasonable, and the salaries might with propriety start higher than this, and go much higher say to $2,200 or even $2,400 for the chairman and $2,000 ultimately for the other members of the board. It is thought that this could easily be done and yet have the department self sustaining, and that at the very reasonable fee of $3.00 for licenses and $2.00 for renewals.

This should not be lost sight of: good men are needed, and good men can only be secured and retained at a good salary.

Twenty-First Annual Banquet of Toronto, No. 1, C.A.S.E.

Full Report of the Big Annual Function of the Toronto Branch of the Canadian Association of Stationary Engineers at the Walker House, Toronto, on Friday Evening, November 6th. Many Practical Addresses

It was a brilliant function! The members of Toronto No. 1 of the C.A.S.E. have had so many successful banquets that they have grown to expect them. This year their expectations were more than realized.

Not only were the addresses enthusiastic and instructive; the entertainment of a high order and the supper served exceptionally enticing, but such a wholesome spirit of genialty and good fellowship was shown that everyone enjoyed himself to the limit.

The chairman of the evening was Mr Frank Stubbs, president of Toronto No. 1, while seated beside him at the head table were Controller Harrison and Aldermen McGhie and Saunderson, Dr. J. M. Harper, of Quebec; Principal R. H. Elden and Prof. W. S. Kirkland, of the Technical High School; Executive President, Chas. Kelley, Chatham, Secretary W. H. Crockett, Hamilton, and Treasurer A. M. Wickens, Toronto; W. Norris, London, and E. R. Grandbois, Chatham, and Chas. Moseley, Toronto.

The excellence of the repast may be judged by the following:

MENU.

Stuffed Celery Sliced Tomatoes Olives
Oyster Soup
Darne of Salmon, Sauce Diplomate
Salmi of Wild Duck St. Hubert
Roast Turkey Stuffed Cranberry Sauce
Scotch Kale Butter Beans
Spring Lamb, Mint Sauce
Mashed Potatoes Carrots with Peas
Chicken Salad
English Plum Pudding, Brandy Sauce
Grape Fruit Cocktail
Hot Mince Pie Assorted Cake
Neapolitan Ice Cream
Oranges Bananas Grapes
Pears Apples
Nuts Layer Raisins
Cheese and Crackers
Black Coffee

THE TOASTS.

"The King" was received with musical honors.

Chairman Stubb's opening remarks were brief, consisting merely in proposing the toast, "Canada our Home," to which Ald. McGhie and Dr. Harper responded.

Ald. McGhie summed up a fervent oration by the declaration that only future generations would realize the magnificence of the heritage of the Canadian people.

Dr. Harper introduced himself as a son of an engineer, the inventor of the first turbine engine ever built and exhibited in public. It is, he declared, the engineer who constantly studies, who gives his heart and his brain to

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his work, who will enjoy his work, who will grow to larger usefulness to the community and who will reach the top of the ladder in engineering.

The "Corporation of Toronto" was responded to by Controller Harrison and Ald. Saunderson.

Controller Harrison, after a glowing tribute to Toronto as a residential, industrial and educational centre, reminded the C.A.S.E. that this body had been the first to advocate the establishment of a Technical High School and mentioned that there would probably be an opportunity to vote in January as to whether it was desired to go back to the old plan of having a separate Board to look after that school, so that technical bodies like the C.A.S.E. could have representation on it.

Then Jack Armer, the versatile entertainer of "Power," kept the gathering in a gale of laughter for nearly half an hour.

Ald. Saunderson emphasized the fact that Toronto was an ideal manufacturing city. It was inevitable that it should become in a few years a great industrial centre. As the city's industries grew so would increase the need of capable, well-informed, broad-gauged engineers. The men who would get promotion were those who carried out the ideal of the C.A.S.E. by constant study and steady effort to increase their knowledge of power problems and needs.

"Our Technical Institutions" found able advocates in Principal Elden and Professor Kirkland, of the Toronto Technical School.

Principal Elden made a strong plea for the extension of the building, the accommodation and the scope of work done by the Technical School. The school now has 678 students in the daytime and 1,300 in the evening. If the money for extensions were forthcoming the work of the school could be trebled in magnitude and in effectiveness in each particular branch of its teaching. Shops for practical work such as wood-working shops, iron-working shops, etc. Several applications had been received for a course in steam engineering and if this number was increased sufficiently such a course would be started at once.

Prof. Kirkland congratulated the banquet committee on the excellent banquet, unquestionably the best ever. He referred to the class in steam engineering which had been under his charge as one of the most satisfactory he had ever been associated with. The Technical School needs such equipment as engines, modern and obsolete, pumps and many other power equipments, so that technical information might be made clearer and more practical to students. He had come to the conviction that no technical school could produce mechanics, but it should broaden and deepen the knowledge of mechanical principles and technical theories.

"Manufacturing Industries" was responded to by Mr. John J. Main, of the Polson Iron Works, Toronto.

Mr. Main referred to the first banquet of the Association in the Old Mansion House twenty-one years ago and could not help complimenting the organization on the great progress made.

He drew attention to the fact that the Canadian Manufacturers' Association had through a strong committee prepared standard boiler specifications and were now prepared to move for legislation in the various provinces asking that a uniform standard be adopted throughout the Dominion. This would be in the interests of all concerned, engineers and manufacturers. Mr. Main added his tribute to the need of technical education, the value of the work done by the Technical School and his desire for further extensions of that work.

The "Executive Council" was responded to by President Chas. Kelley and Secretary W. H. Crockett. President Kelley who made a glowing address suggesting to members of Toronto No. 1 that each member should endeavor to constantly educate himself and increase his knowledge of engineering. He had spent 26 years in the engine room yet he found it necessary to study continually. Manufacturers of power equipment are constantly devising new equipment and if the engineers do not study constantly they will soon be out of date.

Secretary Crockett opened with a practical suggestion. The Canadian Manufacturers' Association had at their Montreal meeting made a grant of $5,000 toward a study of the problem of technical education and had appointed a strong committee to look into the matter. He suggested that the C.A.S.E. might put before the committee referred to above the proposition that if the Canadian Manufacturers' Association and the Government would give grants to supply working models of power equipment the C.A.S.E. would look after the work of having these models taken from centre to centre and fully explained to engineers throughout the country.

Mr. Crockett, as Secretary of the National Executive, made the pleasing announcement that four new lodges were seeking charters. This was conclusive proof of the growth of sentiment favorable to the C.A.S.E. throughout the country. He concluded with an enthusiastic reference to the educational purposes of the association.

Bro. W. Norris, of London, responded to the toast "Sister Societies," by an earnest appeal that when the Toronto and other lodges in large centres were considering the need of greater technical education they should remember the needs of the smaller centres, even to the man running a plant in the outlying districts. There should be made, he emphasized, an effort to let each lodge benefit from new ideas and increased knowledge imparted to members of other lodges.

God save the King.

Manufacturers' Catalogues

QURIDE GEARS—That an unnecessarily noisy factory reduces the efficiency of employees, is the claim made by the Pichrome Hide Co., in a booklet just issued on Quride gears. Quride is a remarkably tough, dense, insoluble substance produced by subjecting hides to a patented chemical treatment which changes the albuminoids to fibroids. Quride is, therefore, peculiarly adapted to use in gears whenever the elimination of noise is desirable, and has proved successful in many places where, on account of the presence of oil, grease, naptha, or other solvents, rawhide or fibre could not be used. Quride gear blanks in sizes up to thirty inches are furnished to many manufacturers, who cut and mount their own gears. Other uses of Quride are almost unlimited, as by slight modification of the process any degree of hardness or flexibility can be produced. Its use for car seat covering is illustrated in another booklet recently issued.

Either of these booklets will be sent on request to John Millen & Son, Limited, Montreal, who are the Canadian distributors.

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THE C.A.S.E. PREAMBLE.

"This Association shall at no time be used for the furtherance of strikes or in any way interfere between its members and their employers in regard to wages. It shall recognize the identity of interests between employer and employees and shall not countenance any project or enterprise that will interfere with perfect harmony between them. Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the promotion of educational, professional and mechanical knowledge."

TO SELL OR NOT TO SELL.

(Hamlet's Soliloquy in its commercial application.)

To sell or not to sell?
That is the question.
Whether 'tis better to send the goods
And take the risk of doubtful payment.
Or to make sure of what is in possession,
And declining, hold them.
To sell, to ship, perchance to lose—
Aye, there's the rub!
For when the goods are gone
What charm can win them back
From slippery debtors?
Will bills be paid when due?
Or will the time stretch out till crack of doom?
What of assignments, what of relatives,
What of uncles, aunts and mothers-in-law,
With claims for borrowed money?
What of exemptions, bills of sale, and the compromise
That cooly offers a shilling a pound?
And no lawyer's fees.

Use of the Low Pressure Steam Turbine*

Instances of Where the Output of a Power Station Has Been Increased Without Increasing the Boiler Capacity by Installation of Low Pressure Steam Turbine and, in Case of Non-Condensing Engines, Condensing Equipment; Thus Reducing Materially the Cost of Power.

By Chas. B. Burleigh

In this period of keen competition, when the profit in almost every line of manufacture is represented by the value of what was discarded as worthless but a few years ago, it becomes not only desirable but absolutely essential to the success of any undertaking to carefully investigate each item which goes to make up the cost of the finished product.

To analyze and discuss all of the items which when combined represent the manufacturing cost is beyond the scope of this paper. The writer will, however, endeavor to present for your consideration some facts which it is hoped may be of material assistance in reducing to a minimum one of these items, the importance of which varies materially with the class of goods manufactured, namely, the production of the power for operating the producing machinery.

You will agree with me that this desirable result can be accomplished if every pound of steam generated in your boilers can be so utilized as to deliver in useful work from 25 to 100 per cent. more available power than is at present being obtained under such conditions as not to increase the cost of the other items.

The prime object of this paper is, therefore, to call to your attention a recent engineering development which will effect immense gains in capacity and economy in existing power plants without involving any sacrifice or abandonment of any part of the present equipment, accomplishing this result with a minimum of additional investment.

While the reciprocating steam engine is a highly efficient piece of apparatus for utilizing the available energy of steam between boiler pressure and atmospheric pressure, it is a comparatively inefficient piece of apparatus for utilizing the available energy of the steam in its lower ranges below atmospheric pressure.

On the other hand the supremacy gained by the steam turbine has been largely due to the fact that it as efficiently utilizes the available energy of steam in the lower as in the higher pressure ranges, and there being as much available energy in steam below the atmospheric line as there is above it we are led to the investigation of the results to be obtained from the use of the reciprocating unit in its most economical field (the higher pressure ranges) combined with the turbine for the most economical transformation of the low pressure ranges.

The Low Pressure Turbine.

The low pressure turbine is designed to take steam at one pound gauge pressure and efficiently utilize its energy in the lower ranges to one-half pound absolute, or, in other words, a 29-inch vacuum, at water rates from 30 to 50 pounds per kilowatt-hour at the switchboard, in accordance with size and local conditions.

The low pressure turbine can be advantageously applied in any case where reciprocating engines are now used, and their application will always afford a large improvement of economy and increase the power output without increase of boiler plant.

This applies whether engines are now operated condensing, or non-condensing, delivering their output electrically or mechanically, and also applies to engines which operate on intermittent loads, since the delivery of low pressure steam can be equalized by suitable steam regenerating apparatus.

In many existing plants engines are operated non-condensing because cooling water is not conveniently available.

Such practice may be legitimate with reciprocating engines because the gain by condensation with engines is comparatively small and, in many cases, may not pay for the additional complication and expense incident to the installation and operation of cooling towers or condensers.

If low pressure turbines are used, however, we can expect to obtain about as much power from the turbine working below the atmosphere as we do from the engine above the atmosphere, and with this great gain obtainable there can be no question as to the economy of installing condenser facilities and low pressure turbines, even where cooling towers would be required.

There are already in existence plants where low pressure turbines have been installed in connection with engines previously used non-condensing, and by such installation with cooling towers, the output of the plant has been practically doubled without any addition to fuel consumption or attendance. Permit me to be specific in this statement and cite a 1,000 h.p. non-condensing engine plant operating 3,000 hours per year at 2.5 pounds of fuel per h.p., or 3,750 short tons of coal per year.

By the addition of a 1,000 h.p. low pressure turbine with a suitable cooling tower, made necessary by local conditions, capable of maintaining a 28-inch vacuum, the plant was made to deliver 2,000 h.p. 3,000 hours per year at 1.25 pounds of fuel per h.p. hour, or 3,750 short tons of coal per year. The plant as doubled in output required no addition to the boiler equipment, nor was any additional labor made necessary.

The most ready field for the introduction of low pressure turbines is found in existing condensing plants which operate with reciprocating engines. In such plants immense gains can be accomplished by the use of low pressure turbines either with existing condensers or with improved condensing facilities. The gain by high vacuum in turbines is so much greater than in engines that it will generally be worth while to install condensing facilities of the most improved kind with the most improved pumping facilities. Where low pressure turbines are installed, the exhaust pressure of engines will be above the atmosphere. There will, therefore, be no air leakage around piston rods and valve stems, and it will be possible to maintain better degrees of vacuum than those which are generally experienced in condensing engine plants where there is more or less leakage of air and little incentive for the production of high vacuum.

The possibilities of the low pressure will be more readily understood if we consider the available work in different ranges of steam pressure. If saturated steam operates from a pressure of 150 pounds gauge to a pressure of one pound above the atmosphere, the available energy is about 132,000 foot pounds per pound, and if saturated steam operates from a pressure of one pound of steam above the atmosphere to a vacuum of 28½ inches, the available energy is 146,000 foot pounds per pound of steam. In a mixture of steam and water issuing from an ordinary steam engine exhausting at a pressure of one pound above the atmosphere, the above available energy is reduced to about 132,000 foot pounds per pound if we work to a vacuum of 28½ inches. Thus under these very ordinary conditions there is as much work available in the low pressure ranges as in the high. In a turbine properly proportioned for such work the efficiency in these low pressure ranges is better than the high pressure part, while in the reciprocating engine the return from the low pressure steam is relatively very small.

In most condensing engines the gain over non-condensing conditions does not exceed 30 per cent. even under the most favorable conditions of load, and under overload conditions the gain by condensing is much smaller. In most cases a reciprocating engine which is operated condensing will give at least 75 per cent. of the output with the same steam used non-condensing. This steam being taken into a low pressure turbine with good condensing facilities will add nearly, if not quite, as much work as it gives in the engine. We can, therefore, under ordinary conditions get a net gain of 50 per cent. over existing condensing engine service by installing low pressure turbines, and under overload conditions where the efficiency of the engine falls off and where its gain by vacuum is greatly diminished, the rate of improvement will be much better.

An Example of Power Gained.

The Philadelphia Rapid Transit Co., in 1905, installed at its power station on Thirteenth and Mt. Vernon streets an 800 kilowatt Curtis low pressure turbine. This station was equipped with four 1,500 h.p. and one 2,200 h.p. Wetherill Corliss engines which had always been operated non-condensing for the reason that cooling water was not available.

An Alberger condenser having 8,000 square feet of cooling surface together with a cooling tower, was installed for use with the low pressure turbine.

* Abstract of Paper before National Association of Cotton Manufacturers, September, 1908.

The rotary pumps in circulating the cooling water are direct connected to a 120 h.p. interpole motor.

The average vacuum obtained is 28 inches.

The 1,500 h.p. engines are each direct connected to a generator which develops an average of about 2,000 amperes at 575 volts.

The turbine takes steam from the common exhaust main at a pressure of one pound above the atmosphere and is provided with four wheels, each with a single row of buckets.

Exhaust steam from one engine when delivering 2,000 amperes is sufficient to deliver an output from the turbine of 1,300 amperes at 575 volts, with no increase of back pressure on the engine.

As about 150 amperes are required to operate the auxiliaries the net gain from the turbine is from 1,000 to 1,200 amperes or approximately 66⅔ per cent.

As the maximum gain possible from the use of a condenser without the turbine would not exceed 25 per cent., it will at once be seen that the turbine produces a gain of 41⅔ per cent. over this arrangement.

The generator used in conjunction with this turbine is a direct-current machine, six pole, 1,200 revolutions, but the unit is not fitted with a governor.

With the turbine taking steam at atmospheric pressure with 2 inches absolute back pressure in the condenser a water rate of 36 pounds per kilowatt is guaranteed at full load. The conductors from the turbine generator are connected by common bus bars with the leads from the engine driven units.

As before stated, this turbine is peculiarly simple, consisting of nothing but the wheels, shell and generator without governor. It is prepared therefore to take all the steam delivered to it at all times from the reciprocating units, and the cycle of operation is somewhat as follows:

If the engine driven generators tend to take more than their proportion of load, the engine governors admit an additional volume of steam to produce the necessary energy, and the engines in turn deliver more steam to the turbine, tending to speed it up, thus increasing the voltage on the turbine driven generator, which tends to take more work, thereby lightening up on the engine driven generators, which makes the regulation automatic.

As the load conditions were such as required further increase, a second 800 kilowatt Curtis low pressure turbine, condenser and cooling tower was installed early in 1906 under similar conditions, taking steam from the same exhaust header and delivering current to the common bus bars.

All the auxiliaries required in connection with the turbines, condensers, and cooling towers, are motor driven, with the exception of two dry air pumps and one step bearing pump and two discharge pumps, the exhaust from which is utilized for heating the feed water, and the current required to operate them is about 14 per cent. of the output of the turbines.

The two turbines are operated about eighteen hours a day, and the only attention required is commutator attention and the usual attention given to pumps.

The coal consumption for all purposes at this station the first six months of 1905, before the turbines were installed, averaged 4.48 pounds per kilowatt-hour.

The coal consumption for all purposes for first six months of 1906, after the turbines were installed, averaged 4.08 pounds per kilowatt-hour, showing a saving of 0.4 pounds of coal per kilowatt-hour.

As the total output of the station for the first six months of 1903 was 20,346,890 kilowatt-hours, this shows a saving of 4,069 tons of coal, or 8,138 tons for the year, which figured at $3 per ton, amounts to $24,414.00.

As these two turbines are not using all the exhaust from the five engines, it is plain to be seen that when their load requirements necessitate further increase, the installation of additional low pressure turbines capable of utilizing all the exhaust steam will cut their coal consumption down to at least three pounds per kilowatt-hour. and pay a handsome return on the investment.

Looking at this plant from a first cost point of view, the original steam equipment cost somewhere in the neighborhood of $100 per kilowatt, and to have increased their capacity on its original lines would have required an investment proportionately equal to the original investment; the low pressure turbines, with cooling towers, however, were installed at an expense of approximately $50 per kilowatt, and as the turbines were utilizing the energy in the steam previously unused, the fuel consumption was not increased a pound, or in other words, considering one of the 1,500 kilowatt units operating with one of the 800 kilowatt low pressure turbines under the new arrangement, 2,300 kilowatts were made available at no more expense as regards fuel and attendance than was previously necessary to deliver 1,500 kilowatts to the distributing mains.

The Scranton, Pa., street railways were equipped with four simple non-condensing Corliss engines, as follows:

	Rated h.p.	Kilo-watts.
No. 1 Allis, 42x54, at 97 rev....	1,400	1,000
No. 2 Dick'n, 26x48, at 80 rev...	400	300
No. 3 Cooper, 26x48, at 80 rev...	400	300
No. 4 Cooper, 30x38, at 97 rev...	750	500
	2,950	2,100

Engines operated at an initial pressure of 115 pounds.

No. 1 and No. 4 were connected direct, and the other two belted to individual generators of the capacities named.

The average output of this plant is 1,500 kilowatts while the maximum requirements, of short duration, taxed the entire plant to its utmost.

The exhaust of these four engines led into a common tee, from the top side of which emerges a 30-inch free outlet to the atmosphere.

Early in 1906 a 500 kilowatt Curtis low pressure turbine was installed taking steam through a 14-inch pipe connected to the 30-inch outlet, and exhausting through a condenser supplied with cooling water brought from the Lackawanna River, a distance of 450 feet, with a lift of 54 feet to the condenser head, at mean height of the river.

The turbine, therefore, works between the atmospheric pressure and 28-inch vacuum at a water rate of about 35 pounds per kilowatt hour, or less than 20,000 pounds of steam per hour at its full-rated capacity, while the engines, aggregating about 3,000 h.p., will, at 30 pounds per h.p. exhaust, when working at their rated capacity, 90,000 pounds in the same time.

There is here, therefore, an excellent opportunity for the installation of at least two or three similar low pressure units as soon as the load conditions warrant further increase. The method of using the turbine output is similar to the case previously mentioned.

Low Pressure Turbine with Compound Condensing Engine.

There is a plant in East St. Louis in which is installed an 800 kilowatt low pressure turbine equipped with a 500 volt, direct current generator, which is used in multiple with the engines from which the turbines receive their steam. This equipment is utilized for operating the railroad. There is also installed in this station a 1,000 kilowatt low-pressure turbine equipped with an alternating current generator taking steam from the same exhaust header and delivering its output for an entirely different purpose, that is, the operation of lights and stationary power throughout the district.

For the benefit of those who are inclined to feel that while the advantages of the low pressure turbine may be all that are claimed for it when used in conjunction with a non-condensing engine or possibly with a condensing engine which gives poor economy, but are inclined to be extremely sceptical as regards its usefulness when used in conjunction with a first-class compound condensing engine, which by itself is producing exceptional results, I would like to familiarize you with the results of an investigation and recommendations which I recently had occasion to make in one of the most economical steam-electric power plants in New England. The general arrangement of this plant is as follows:

The boiler floor level is considerably below the engine floor level; the basement is still lower. This arrangement leaves nearly 14 feet clear height in the basement, and gives excellent space for the primary heaters, air pumps, exciter engine and the rest of the machinery there installed. Babcock & Wilcox boilers, each having 3,964 square feet of heating surface, 67.6 square feet of grate surface and 125 square feet of superheater coils, are installed. The feed pumps are Blake duplex outside-packed plunger pumps, driven by tandem compound steam cylinders.

The feed passes through a main heater in the main engine exhaust pipe, through a closed auxiliary heater where it receives heat from the feed pumps and air pump exhausts, and then through a Green economizer to the boiler. The condensers are Blake vertical twin jet condensers.

The cooling water is taken direct from a river flowing by the plant.

The engines are two McIntosh & Seymour vertical, two-cylinder, cross-compound 18 inches and 38 by 42 inches, each developing 760 indicated h.p. at 0.24 cut-off with 135 pounds initial steam pressure and 26 inches effective vacuum, and each direct-connected to 600 kilowatts, 60 cycle alternating current generators operating at a speed of 120 revolutions per minute.

Each high pressure cylinder is jacketed on the barrel, and both heads and the jackets are piped in series; the steam enters the jacket on the top head, passes into the barrel

jacket, goes to the jacket on the lower head and then to the reheater coils. There being no separate steam supply to the reheater coils, nor any separate drain from the high pressure jackets, it is not possible to use either jackets or reheater alone.

The receiver is a large cylindrical drum at the back of the engine and close to the cylinders.

The reheater consists of one or more coils of pipe in the receiver. The low-pressure cylinder is unjacketed.

I have gone into the principal details of this plant that you may appreciate the fact that the highest economy was sought in its design and that the desired results were accomplished is evidenced by the fact that when tested by Lionel S. Marks, Assistant Professor of Mechanical Engineering at Harvard University, engine No. 1, operating at 139.5 pounds pressure at the throttle, superheated 75° F., exhausting into a vacuum of 26.27 inches, carrying a load of 485 kilowatts, produced a water rate at the switchboard of 19.52 pounds of steam per kilowatt.

Engine No. 2, operating at 133 pounds pressure at the throttle superheated 55.5° F., exhausting into a 26-inch vacuum, carrying a load of 577 kilowatts, produced a water rate of 19.51 pounds of steam per kilowatt.

The condensers previously mentioned were capable of maintaining a 28-inch vacuum under full load conditions, but the gain made by the engines from this vacuum not being commensurate with the expense of maintaining it a vacuum between 26 and 27 inches was ordinarily maintained.

The location of the condensers with relation to the engines was such as to offer ample floor space for the installation of low pressure turbines between the exhaust from the low pressure cylinders and the condenser by simply taking out a section of the exhaust and introducing the turbine.

The load conditions in this plant being such that the daily output is from 750 to 900 kilowatts continuously and required the running of both units partially loaded day in and day out, and under these conditions they operated at an average water rate of 27 pounds per kilowatt.

A careful investigation of these units developed the fact that each was capable of developing from 15 to 20 per cent. over full load when exhausting to atmosphere at a water rate of 25 pounds per kilowatt at full load and 27.5 pounds at 10 per cent. over full load.

Therefore operating one engine non-condensing at 575 kilowatts at a water rate of 27.5 pounds would deliver 15,812 pounds of steam per hour.

The quality of this exhaust steam for 75 degrees Fahrenheit contained in the steam delivered to the engine 100 per cent.

The water rate of a 500 kilowatt 1,800 revolution turbine supplied with this steam at atmospheric pressure and exhausting into a 28-inch vacuum, which their condenser is capable of maintaining, would be 33 pounds per kilowatt.

It will be readily seen that the engine will deliver enough steam when operating 575 kilowatts to enable us to obtain from it 480 kilowatts from the turbine or a total of 1,055 kilowatts from the combined unit, at a water rate of 15 pounds per kilowatt.

That while they are now operating 900 kilowatts at 27 pounds of steam per kilowatt hour, using 24,300 pounds of steam per hour, an investment of less than $20,000 will reduce the steam consumption to 17 pounds per kilowatt hour, which would require only 15,300 pounds of steam per hour.

Figuring an evaporation of 10 pounds of water per pound of coal this would represent a saving for 300 days of 10 hours each of 1,350 short tons, or at $3.00 per ton a yearly saving of $4,050, which would pay for the turbine complete in five and one-half years plus an 11 per cent. interest on the investment.

By piping the exhaust of both engines to the turbine and connecting it through suitable valves with both condensers, the turbine can be used with either engine, thus making either engine a spare for the other.

Immense benefit can be derived from the use of low pressure turbines in mechanically operated manufacturing plants. Take for instance a mill or other manufacturing establishment mechanically operated by means of belts or ropes where an increase is desirable and either due to the shape or position of land available this addition cannot be economically or satisfactorily reached by belting and shafting, the low pressure turbine offers an ideal solution of the problem, permitting the electrical operation of the sections which are awkward to reach mechanically.

In closing caution should be made not to entertain a wrong impression of the idea intended to be conveyed, that is, I feel that the turbine will more economically utilize the steam energy, both above and below the atmospheric line, than the reciprocating engine and therefore is entitled to first consideration in a new installation, but where an increase is necessary to an existing reciprocating plant, the low pressure turbine can oftentimes be used to better advantage than any other piece of apparatus, without entailing increase in boiler plant or buildings proportionate to the increase in capacity, and in many cases without any increase of the items mentioned.

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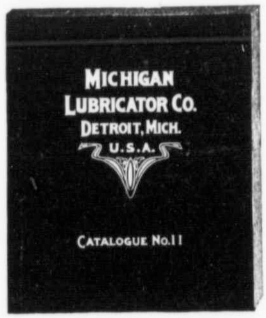

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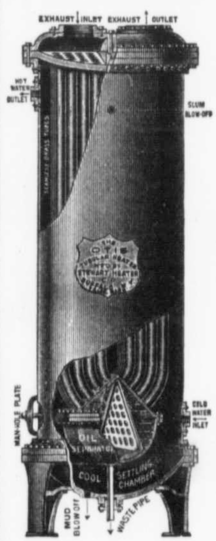

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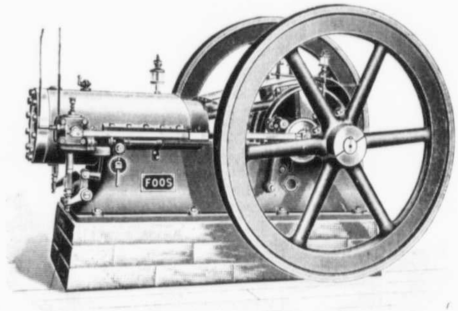

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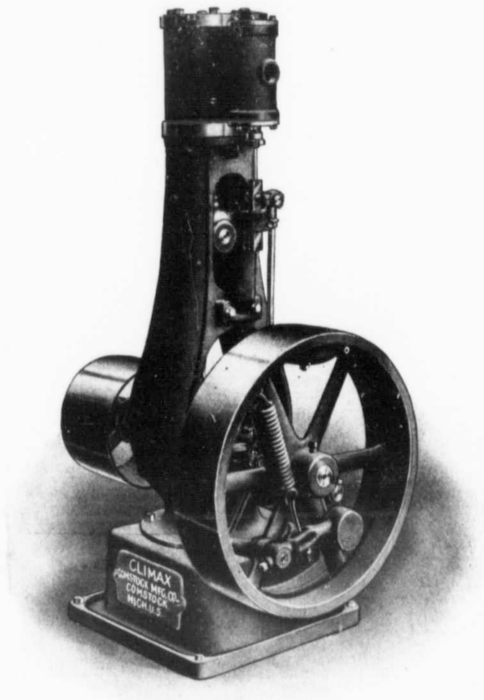

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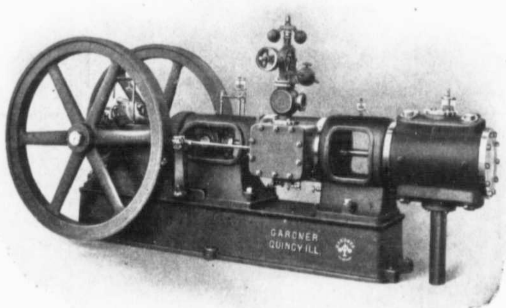

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