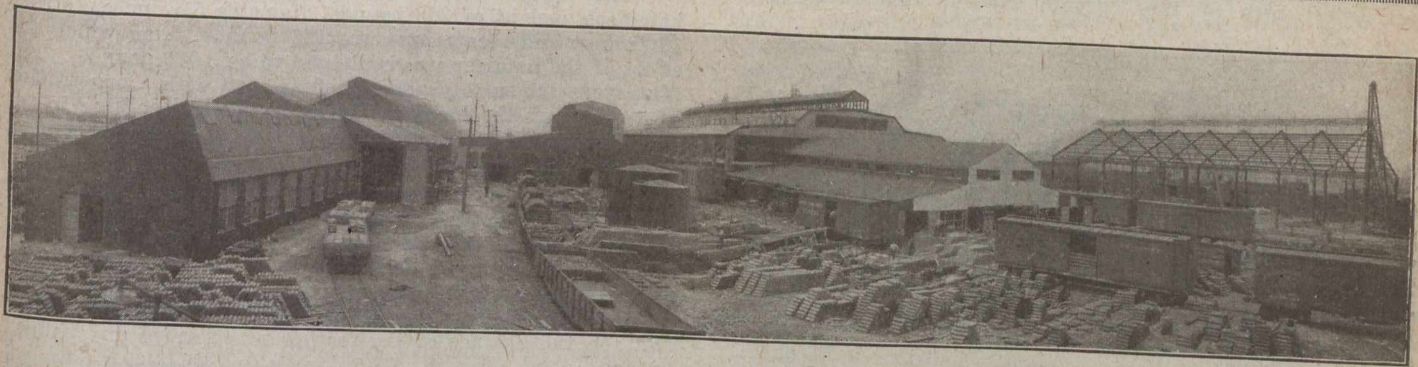
PAGES

MISSING

The Canadian Engineer

A weekly paper for civil engineers and contractors



World's Largest Electric Steel Plant in Toronto

The British Forgings, Limited, Occupies 127.65 Acres in the Eastern Harbor Terminal District—5,000 Lin. Ft. of Concrete Docks, Accommodating Vessels of 24 Ft. Draught—Complete Plant Built for the Manufacture of 6-in. and 9.2-in. Forgings From Raw Material

By GEORGE T. CLARK* and FREDERICK PHILLIPS**

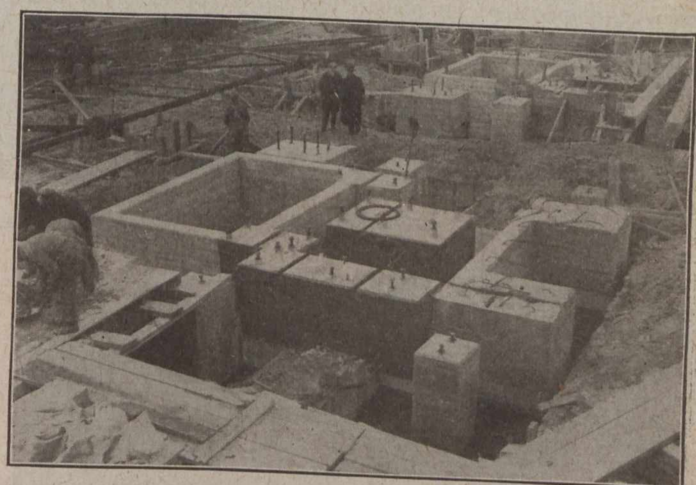
Part of this article was written during the war, and the reader may note the use of the present tense. The article has just been released by special permission of Sir Joseph Flavelle. The plant is no longer being used for munitions manufacture.—EDITOR.

IN 1917 the Imperial Munitions Board was confronted with the problem of ever-increasing production of munitions. Manufacturers had quickly converted many factories into shell plants, all of which forged from cast billets. These forgings were sent in turn to many machine shops situated in various parts of the Dominion. Scrap turnings had accumulated to vast quantities, which, with the prevailing shortage of raw material, were of the utmost value as an additional source of raw material. There was no plant in existence at that time which was capable of rapidly and economically manufacturing billets from these scrap turnings. The construction of the British Forgings, Ltd., was the result of this urgent necessity.

BEARING PILES FOR CONCRETE FOUNDATIONS UNDER ELECTRIC FURNACES IN MELTING HOUSE

*Designing Engineer, Toronto Harbor Commission.
**Assistant Engineer, The British Forgings, Ltd.

The plant was constructed in the most approved and substantial manner, to operate in a dual capacity, the first, and more important, being the installation of a battery of 10 electric furnaces to cast from scrap turnings, the second being, like the ordinary forge plant, to forge billets provided from any source.



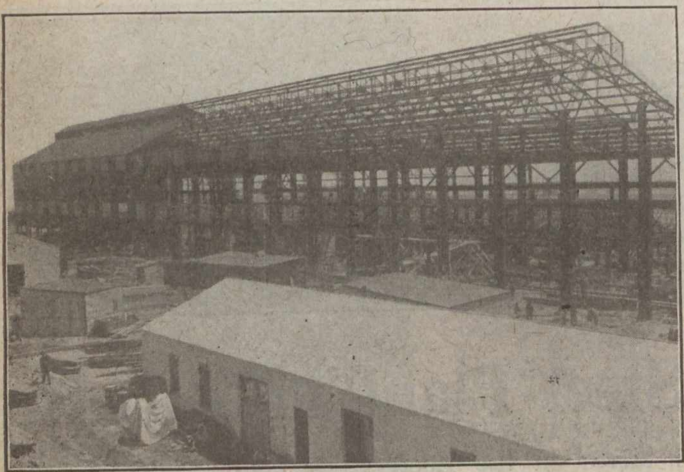
FURNACE FOUNDATIONS, REINFORCED CONCRETE, CAPPING 50 ROUND BEARING PILES UNDER EACH ELECTRIC FURNACE

The site of the British Forgings, Limited, steel plant comprises about 127.65 acres of land in the Toronto Harbor Commissioners' eastern harbor terminal district, formerly known as Ashbridge's Bay. The site, which lies between Commissioners Street and the Ship Channel, has five thousand feet of dockage facilities along the ship channel, which is a body of water four hundred feet wide and seven thousand feet long, ending in a turning basin one thousand feet square (described in *The Canadian Engineer*, issue of August 16th, 1917). The channel itself is dredged to twenty-four feet in depth at mean low water.

In addition to the dockage facilities above mentioned the site is also served with about 7 miles of railway sidings, the connection for these sidings coming from the Toronto Harbor Commissioners' main lead, just east of the Don River.

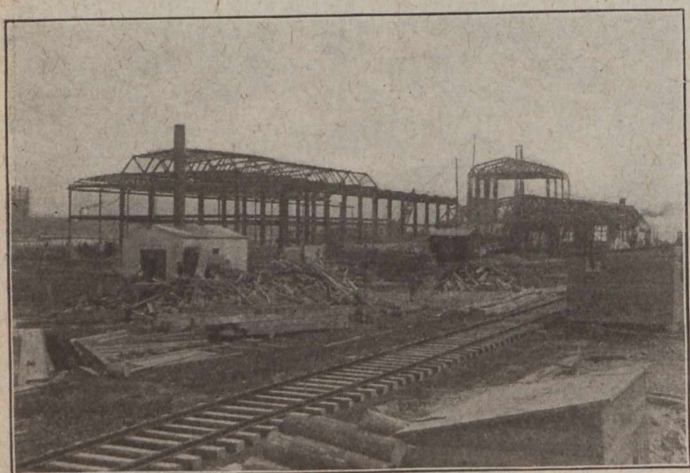
In regard to the transportation of employees, the plant is served with a stub line of the Toronto Street Railway, the transfer point being at Queen Street east, near the Don River.

The elevation of the original ground, at the point where this plant is now erected, was about elevation 243.0 above mean sea level of New York harbor, or approximately two feet below zero of the Toronto Harbor Commissioners' gauge. Before filling was commenced, the land was a continuous marsh with the usual growth of marsh grass and reeds. Filling by hydraulic dredging was carried out in 1915, and the elevation of the ground was raised to elevation 253.0, making a fill of approximately ten feet.



Construction of the Melting House, Showing Framework of the Furnace Operating Gallery—Storehouse in the Foreground

Owing to the fact that the original earth beneath this ten feet of sand fill could not be assigned any bearing value, it was necessary to support all building column piers and furnace foundations on piles. The cut-off of all piles was taken at elevation 245.0, this being considered the highest allowable elevation that would ensure permanent saturation of the wood. The maximum allowable spacing of piles was three feet and maximum allowable load on any pile was twenty tons, except in cases where the live load was a large percentage of the total, and where this load was computed from the greatest possible concentration of all live loads at a single column. In this case the allowable maximum load was twenty-two tons per pile. The total loads on the main building (melting house) column footings A, B and C were respectively 185,000 lbs., 472,000 lbs., and 300,000 lbs. These weights included the weight of the footing itself.



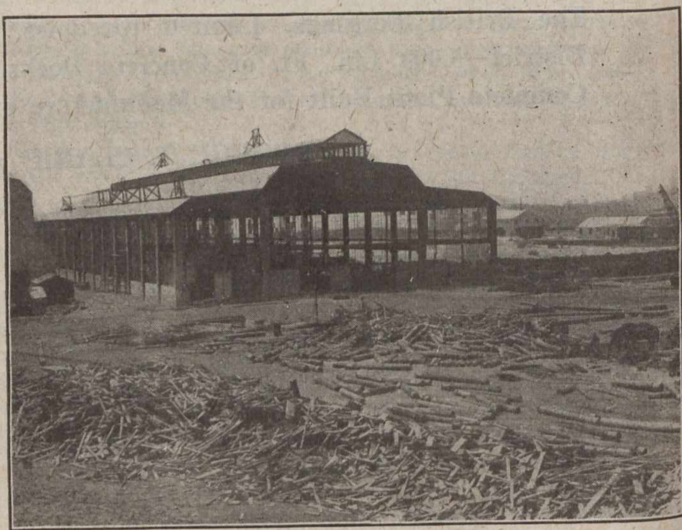
Steel Framework of the Forge Shop and the Timber Framework of the Power House, Showing Extension for the Hydraulic Accumulators

In the matter of pile driving, it was assumed from borings taken that the length of pile required would be thirty feet, and the actual driving of the piles confirmed this assumption. After penetrating the newly placed sand fill, the pile would drop through the underlying layer of bog under the weight of the hammer until it reached the harder strata beneath.

The equipment used were union double acting steam hammers, weight of 363 pounds, diameter 5¼ inches, stroke 12 inches, and steam pressure 125 pounds, from which the effort of the hammer was computed to be 3,070 pounds. The piles were driven to practical refusal and with a penetration of 39 blows to the inch, this gives the piles, according to the Engineering News formula for steam hammers, a bearing value of 24.5 tons each.

In construction, sheet piling coffer-dams were driven and the material excavated to such a depth that the pile would penetrate the concrete footing one foot. The round piles were then driven and after being cut off at the proper elevation the concrete cap was poured, using the sheet piling of the coffer-dam as forms. After the concrete in the cap had set, the balance of the footing was formed and poured.

Particular attention was paid to the furnace foundation of the melting house (steel plant) in order to secure a proper distribution of the loads. This was required on account of the fact that each furnace foundation was combined with the foundations of four building columns, and in addition provision had to be made for the furnace counterweight pit. A symmetrical and well balanced foundation was obtained.



Forge Shop Nearing Completion

In this building about 50,000 lineal feet of round bearing piles were used in the construction of the foundations for the columns and furnaces, and 2,500 cubic yards of 1-2-4 concrete were placed in the footings and furnace foundations.

Steel Plant

The melting house (steel plant) is 608 ft. in length by 75 ft. clear span in 27 bays of steel frame construction. The roof is a fink truss and monitor design covered with corrugated iron. A steel frame lean-to, 25 ft. in width, extends along the entire southerly side. The walls are built-in with hollow tile, and the roof is covered with reinforced concrete.

The main portion is 46 ft. in height and provides a charging platform, of steel and reinforced concrete, from which the electric furnaces are charged and operated. This platform is 12 ft. above the general floor level and is 32 ft. in width. This allows ample clearance for location and operation of the tilting device under each furnace, and provides room for the slag box under the furnace nozzles. The remainder of the floor in the main portion of the building is primarily used for the placing of the moulds, pouring and stripping the billets.

The lean-to portion of melting house is divided into three floors in height. The ground floor is used for bulk storage of minerals used in the making of steel, fireclay, brick, etc., and for repair shops. The first floor, which is level with charging platform, is used for storage of minerals in small quantities in bins, for use at the individual furnaces, space for rebricking furnace roofs, and narrow gauge tracks to each furnace for conveying scrap from scrap shed. On the second, or top floor, are placed the service transformers, and transformers and electrical recording and regulating instruments connected with the furnaces.

Directly south of and adjoining the melting house, is the scrap shed, 608 ft. in length, 80 ft. in width, being constructed of timber with a triangular Howe type truss of 80 ft. clear span. This shed is covered on the outside with galvanized, corrugated iron, it being necessary to cover scrap to facilitate handling with a magnet in winter. The building has a capacity of about 12,000 tons of scrap.

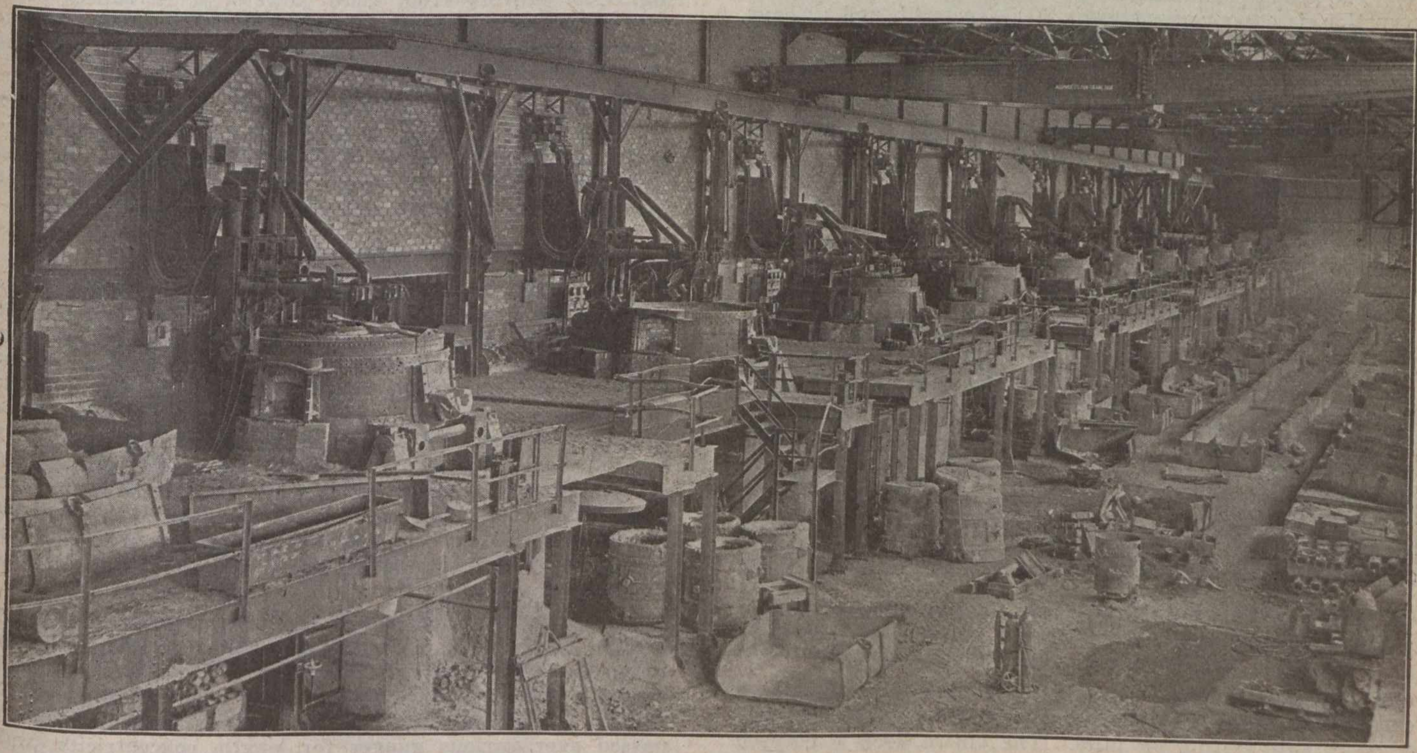
All of the cranes are supported by independent columns, bearing directly on the concrete and pile foundations.

On the pouring floor, or pit, are located jib cranes used for stripping the ingots from the moulds, and the necessary smaller equipment.

The regulation of the furnace is accomplished automatically by means of the Thury regulators, which are common to this type of furnace, and mounted in the transformer room, while the indicating instruments and winch operating controllers are mounted behind the furnaces which they serve. This automatic regulating equipment produces a uniformly constant current at the electrodes, subject to control by the operator in charge.

Each furnace is equipped with three electrodes 17 ins. in dia., supported by water-cooled copper holders, which are in turn supported by an arm at right angles to the mast, each holder being thoroughly insulated electrically from the arm.

The furnace electrodes are raised and lowered by means



BATTERY OF TEN ELECTRIC FURNACES AT BRITISH FORGINGS, LTD., TORONTO

On the north side of the melting house is placed the moulding shop, which is of ordinary frame construction, 100 ft. in length by 40 ft. in width. On the east end are located two core drying ovens, each 36 ft. by 14 ft.

The entire building is provided with standard gauge tracks to provide for incoming material and to convey slag and refuse to the dumps.

Steel Plant Equipment and Operation

There are 10 electric furnaces, each of 6 tons capacity, of the Heroult 3-phase type. They are constructed with a steel plate shell, the sides and the arched roof being lined with silica brick, while the bottom is lined with magnesite brick. Each furnace rests on two trunnions, which are supported by concrete piers on concrete and pile foundations. A brick-lined steel pan is provided under each furnace to protect the tilting mechanism against accidental bursting of the furnace shell. Jib cranes are provided to handle the electrodes and to facilitate general furnace repairs.

The main portion, or melting house proper, is equipped with five overhead electric travelling cranes, with main hoisting capacities of from 15 to 25 tons, each provided with an auxiliary hoist of 5 tons capacity.

In the scrap shed are two 10-ton electrically operated travelling cranes, each equipped with one 55-in. electro magnet used for unloading scrap from the freight cars and elevating same to the charging floor.

of a motor-operated hoisting mechanism or winch, the motors in turn being controlled by the regulator.

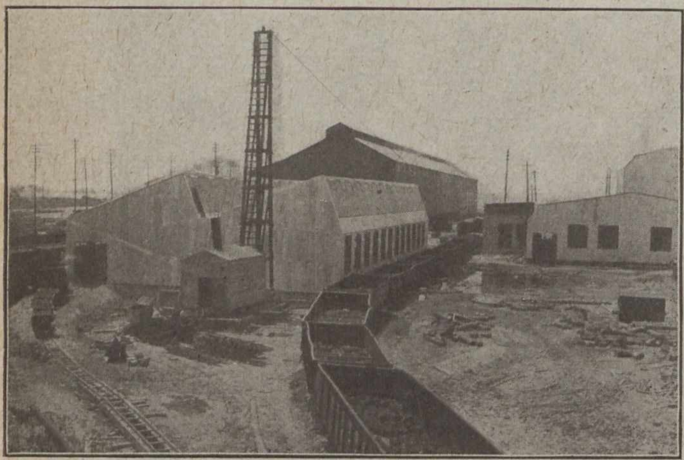
The electrical energy supplied is 13,000 volts, 3 phase, 25 cycle, coming through six feeders connecting the plant with the Hydro-Electric sub-station at Strachan Ave.

During the entire period of the war the plant was used exclusively for the manufacture of shell steel and forgings. The operation in melting house was generally as follows:—

Steel scrap turnings and borings from the various shell machinery plants in the Dominion, were shipped to this plant and deposited in the scrap shed before referred to, or in stock piles on the ground, in different convenient points. The E.O.T. cranes in scrap shed lifted, with the magnets, and deposited this scrap into hoppers, which in turn discharged into small dump cars running on narrow gauge tracks, over the weighing scales, to the sides of each furnace. It was dumped on the floor and shovelled into the furnaces by hand. The process of reducing this to a molten state, and the required chemical composition by the addition of various ferroalloys and fluxing materials, takes about 3½ to 4 hours per heat. When this has been accomplished, and a test made, the portion of floor directly in front of the furnace is raised by a counter weight, and the ladle brought directly under the spout of the furnace, where it is held suspended by an E.O.T. crane. The furnace is then tilted and the molten metal is poured into the ladle, which has been preheated by a fuel-oil burner. The crane carries the ladle to the pit, where it is held in suspension over the ingot moulds. The operator manipulates the stopper in the bottom of the ladle and fills each mould in turn until the contents are discharged. Another method of pouring, which avoids splashing of molten metal, is to place 84 moulds on a steel car which moves to the required positions under the nozzle of the ladle. The shape of the moulds, the hot tops and the careful pouring of the metal insures the absence of piping, except in the top, or crop, end of the ingot. When the ingots cool to the required temperature, they are taken out of the moulds with one of the E.O.T. cranes or by a jib crane, and placed in a power link belt conveyor at the north side of the pit, which carries the ingots to a piling platform at the west end of the cutting and breaking shop, where they are arranged and piled in heats to await the result of the government analyses.

Cutting and Breaking Shop

The cutting and breaking shop is of timber, mill construction, two clear spans, each 30 ft. in width and 12 bays, each 16 ft. in length, with an extension on the east end 38 ft. by 108 ft. The roof is of the saw tooth type, to provide



Cutting and Breaking Shop Nearing Completion—Power House to the Right, Steel Plant in the Background

ample light, and, with the walls, is covered with galvanized corrugated iron. The whole building is supported on 10-in. x 10-in. sills resting on piles. The entire floor is covered with 3-in. birch planking.

The equipment consists of one breaking hammer, which is operated by compressed air at 100 lbs. per sq. inch pressure, and 18 cutting-off machines. There is also a large Ingersoll-Rand compressor supplying air for the pneumatic hoists suspended over each machine, and for the breaker.

After analyses have been taken, the billets are rolled on to a conveyor which carries them to tables placed against every machine. Each operator uses an air hoist to lift the ingot into the cutter, which makes a cut about 1 in. deep, ensuring a straight fracture at breaking. When the break is made the crop end falls down a chute and returns to the melting house. The billets, after leaving the breaker, roll onto another conveyor, which takes them through the building to the different inspection departments. Here they are again sorted into heats and inspected for piping, segregation and bad surfaces, etc. The accepted billets are rolled on to power conveyor running underground, which elevates and discharges on to the charging platform at the back or the north side of the heating furnaces in the forge shop, ready for heating and forging.

Forge Shop

The forge shop is a steel frame building with a centre span of 60 ft. and two side spans of 30 ft. each, making a total width of 120 ft. It is 300 ft. in length, in bays of 20 ft. The exterior walls are built of concrete and brick to 4 ft. above the ground, and filled in with steel sash and wired glass to the eaves. The roof is boarded and covered with ready roofing. The building has a concrete foundation resting on piles. A mezzanine floor runs along the south side, 30 ft. in width and 15 ft. above the main floor. This is used as a machine shop for cutting and machining the test pieces, for a pattern storage room, offices and locker rooms. The east end of the forge shop is extended for a distance of 318 ft., being 80 ft. in width, of frame construction, built on mud sills, and is used for inspection and storage of the forgings.

The forge shop is equipped with six 500-ton presses, each press having a concrete foundation 9 ft. square x 10 ft. deep, resting on nine piles, each driven to refusal.

On the north side, are 13 continuous, oil-feed furnaces, capacity of 160 6-in. billets each. Each furnace is supported by concrete foundation 4 ft. thick, resting on 30 piles, also driven to refusal.

Three air blowers, which are connected to the furnace oil-burners, are located in the north-west corner of the building. The delivery from these blowers, at 12 ounces pressure, amounts to 14,000 cu. ft. per min. These blowers rest on concrete pedestals, which are supported by a concrete mat 12 ft. by 24 ft. by 18 in. in thickness, without piles.

Along the north side of the furnaces and slightly higher than the furnace bottom, is a charging platform of timber, frame construction, being 16 ft. in width, resting on mud sills. It is 300 ft. in length, with a link belt conveyor running along the north side close to the railway siding.

Forge Shop Operation

The billets, which for 6-in. shells weigh about 150 lbs., are received, in heats, on the charging platform, either from the conveyor or from the railway car alongside the platform. They are rolled into the furnaces by gravity, where they are heated to a forging heat. Passing out at the front of the furnace to an automatic raising and lowering gravity roller conveyor, they are fed to the dies on the presses, where they are punched, stamped and ejected. They are then gauged and placed on a conveyor, which takes them to the heat treatment beds, where they are treated according to the analysis of the steel. When cold, the forgings are taken to the east end of the building, in which is located the piling and inspection department.

Test pieces are cut out of a certain percentage of every heat. These pieces, after being machined to standard sizes required, are tested for elastic limit, ultimate tensile strength and elongation, by the government testing department. After the result of this test is known, they are passed over various gauges for length, concentricity, wall thickness, etc., and are fully inspected. The forgings that pass these tests are ready for shipment, while those that do not pass the test are delivered by conveyors to the heat treatment building.

Heat Treatment Building

The purpose of this department is to re-heat and cool in different particular manners, according to the nature of the physical failure of the forging in the above mentioned tests. This invariably results in the saving of shells that would otherwise have been scrapped.

The building is 77 ft. clear span in width and 180 ft. in length. It is of steel frame construction enclosed with corrugated iron, and rests on concrete and pile foundations. It is equipped with one large, car-bottom, heat-treatment, fuel-oil furnace, with two cars. (This allows one car to be filled while the other car is being treated). Each car holds 200 forgings standing on end. At each end of the furnace is suspended an iron plate cover, with louvre shutters, which can be lowered to cover the entire car, when it is necessary to cool the forgings very slowly. To the north of the furnace are two 5-unit, air-cooling machines, each equipped with two blowers, capable of delivering 500 cu. ft. of air per minute at a pressure of 12 ozs. per sq. in. The forgings are treated in this machine when it is necessary to cool them very rapidly.

After the forgings have gone through this process, they are again tested by the Government testing department, and, if passed, are ready to ship to different shell machinery plants to be finished.

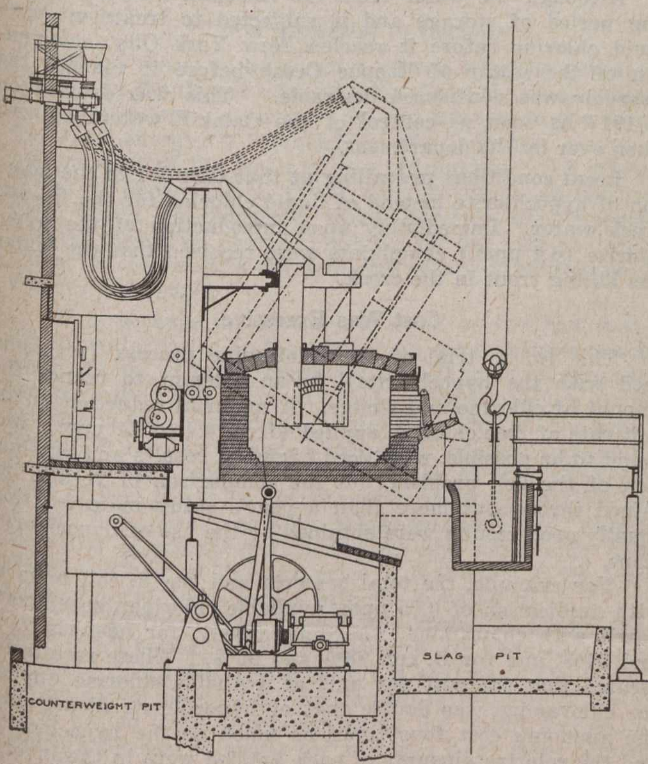
Power House

The power house is of timber construction, with a Warren type roof truss covered throughout with galvanized corrugated iron. It has two spans, each 40 ft. in width, and 13 bays, each 16 ft. in length. The sills are supported on piles driven to refusal, and the floor is built of 3-in. birch planking resting on 4-in. x 6-in. sleepers.

Along the south side of the building are located the ten high pressure, hydraulic pumps, each having a capacity of 200 gals. per min. Each pump is directly connected to Westinghouse motors. Each pump and motor is set on a concrete pedestal, and the whole is supported by a concrete and pile foundation, consisting of a mat of concrete 24 ft. in width extending the entire length of the building and resting on 270 piles driven to rock.

Centrally opposite this battery of pumps are placed the two accumulators, which are 24 in. dia. ram, and 18 ft. stroke, of the weighted tank type. They are each loaded with 450 tons of scrap iron ballast to give a pressure on the hydraulic line of 1,500 lbs. per sq. in. The accumulators are supported by a concrete and pile foundation, the concrete mat being 52 ft. in length x 40 ft. in width and 5 ft. in thickness, resting on 220 piles, spaced 3 ft. centres, driven to rock.

On either side of the accumulators are the steel suction tanks, each 14 ft. x 8 ft. x 8 ft. in depth. These are



SECTIONAL VIEW OF ELECTRIC FURNACE, SHOWING TILTING DEVICE AND FURNACE TILTED

divided with a longitudinal partition, one side being used for the discharge from the presses and returns from the pumps, the other side for the supply to the pumps. Each tank rests on 12-in. x 12-in. timber sills supported by nine piles.

In the power house are also located an Ingersoll-Rand, duplex, belt-driven compressor, supplying air to the forge shop, and the fuel-oil pressure system, which consists of two motor-driven pumps and two 100-gal. receivers, which are equipped with relief valves. The main oil supply is provided by three 9,000-gal. horizontal tanks, with equipment for filling from tank cars, and situated between the forge shop and the power house.

Saw Shop

The saw shop, which was orginally equipped with hacksaws, was re-designed to break gothic section, rolled steel bars for the 6-in. billets. It is a frame building 160 ft. in length x 45 ft. in width, covered with galvanized iron. It is equipped with a special geared breaker or bulldozer, working horizontally and driven by a 150 h.p. motor.

The bars which are 8 ft. to 14 ft. in length, are unloaded by a locomotive crane and piled at the east end of the shop, under a series of air hoists which are arranged to lift and travel. The bars are then conveyed on gravity rollers into the shop, where they are marked with gauges into billet lengths. They are then cut by the standard oxy-acetylene burners to a depth of about ¼ in. Continuing along the rollers to the breaker, they are broken into billet lengths and passed on to an inspection table, where the breaks are inspected and stamped. They are then elevated by a motor-driven elevator to sufficient height to allow them to run on gravity conveyors directly to the cars on the track immediately to the south of the saw shop. From here, they are delivered to the forge shop, or to any outside plant desired.

ELECTRIC FURNACE POURING A HEAT

Sub-Station for General Power Distribution

This building is of brick and concrete construction, fire proof throughout, and is located against the south side of the power house.

It contains three 750 k.v.a., oil-immersed and water-cooled transformers, reducing the voltage from 13,000 to 2,200 volts. This is used to run the 200 h.p. motors connected to the hydraulic pumps, and for the yard distribution and lighting. One 750 k.v.a. transformer of the same type reduces the voltage from 13,000 to 550 volts for all small power motors throughout the plant. The switchboard comprises four panels for the control of transformers and seven panels for the control of current for the various shops and yard distribution.

There are also housed in a separate building one 200 and one 300 k.w. motor generator sets, for 230 volt direct current.

Drainage System

Several large concrete septic tanks equipped with automatic syphons discharging through two 18-in. main pipes into the ship channel, were designed by the Toronto Harbor Commission.

Railway Facilities

The handling and shipping facilities are adequately and admirably provided for. There are about seven miles of standard gauge tracks throughout the plant. At all of the more important shipping and unloading points, covered sheds have been constructed to facilitate this branch of the work during inclement weather.

The plant has its own shunting locomotives and locomotive cranes for handling material.

"ONTARIO HYDRO'S" ELECTRIC LOCOMOTIVES

SIX more electric locomotives are being built for the Hydro-Electric Power Commission of Ontario for use in the construction of the Chippawa-Queenston power canal. Twelve similar locomotives have already been placed in service at Niagara Falls. Following are the general dimensions of each locomotive:—

Length over all, 41 ft.; length of truck centres, 25 ft.; length of main cab, 16 ft.; length of auxiliary cab, 9½ ft.; width over side sills of locomotive, 9 ft.; width over main cab, 9 ft.; width over auxiliary cab, 6½ ft.; height of rail to bottom of side sills, 3 1-3 ft.; height of rail to centre of coupler knuckle, 2 ft. 10½ ins.; height of rail to top of roof, 12 ft. 8½ ins.; truck wheel base, 7 ft.; track gauge, 4 ft. 8½ ins.

Through the courtesy of Frederick A. Gaby, chief engineer of the Commission, *The Canadian Engineer* has received the following description of the locomotives:—

Each locomotive is designed for double-end operation for either switching or road service. Both ends are symmetrical about the centre line across the body, the total weight, including equipment, being 100,000 lbs.

General Description

The trucks are of the arch-bar type, with M.C.B. class C springs. The wheels are 36 in. chilled grey iron, M.C.B., 1912 profile; axles, M.C.B., 5½ in. x 10 in. journals, with centre between hubs of wheels of 50 in. to take motor bearing, and cast steel gears which are pressed on the axle.

The underframe has six 12 in. I-beams at 40 lbs. sills the full length of the locomotive, with 8 in. I-beams at 25 lbs. cross sills rivetted to longitudinal sills; end buffers, 15 in. channel at 33 lbs. rivetted to sides of longitudinal sills; bolster, 1 in. by 14 in. by 9 ft. longitudinal sills.

The locomotives are of the main cab box type, with two side doors, two end doors, four side windows, four end windows and removable doors between the main cab and hoods. Two hoods are located one at each end of the main cab, with two removable doors on one side of each hood. Car lines and posts in hoods and main cab are standard structural shapes, with inside finish in main cab only.

Additional ballast is added in flooring by placing solid cast iron slabs, 2¾ in. thick by 18 in. by 9 ft. long, in the floor under the hoods at each end only. This ballast weighs altogether 24,080 lbs., and brings the weight of body, truck equipment, etc., up to the required 100,000 lbs. total necessary for proper tractive effort.

The electrical equipment consists of four G.E. 66 B motors, 125 h.p. each, two mounted on each truck; type M multiple unit control, consisting of two sets of D.B. 31 contactors, each set consisting of 13 contactors.

There are two D.B. 20 reversers, ten frames of rheostats, two C. 6 controllers, two B.T. 335 junction boxes, the necessary kicking coils, lightning arrester, main switch, motor cut-out switches, fuse-boxes, choke coil control switch, lighting headlight and heater switches, trolleys, etc.

Two Sets of Equipment

Each pair of two motors is wired up in such a way as to give two sets of equipment, separate and distinct from each other, which are paralleled together in each controller, one of which is at each operating end. Located in front of each operating position where they can be readily seen and used in operation and under the hood is one set of contactors, one reverser, air gauges, whistle valve, sander valve, dump line valves, ammeter and all control switches.

All control leads are special standard 19-25 wire, and run in conduit without colors, each individual wire being tested out before connection.

All main leads are special standard extra flexible wire, and are run singly, each one in a separate conduit, with bell-mouths and gaskets in each end for weatherproofing and to prevent wearing of insulation on wires in operation.

Air brake equipment is Westinghouse No. 14 E.L. locomotive air-brake as used by present steam roads, with two 50 cu. ft. motor-driven air-compressors, both located in main cab. Extra features are the dump line operating couplers and valves used for operating 20 cu. yds. dump cars on the Niagara power development.

All compressors and control are equipped with multiple unit features, so that it is possible for one operator to operate two or more locomotives from the one controller.

Four trolley bases are used, due to the double-end operation and side trolley wire construction used. The trolley wire on which these locomotives will operate is located 7 ft. from the centre line of the track and 24 ft. from the rail, requiring the use of four trolley bases with poles bent out to reach this wire.

CHLORAMINE TRIED BY NEW YORK CITY*

APPLICATION of chloramine to the somewhat polluted water of Esopus Creek before it goes into the Ashokan reservoir at the head of the Catskill Aqueduct was described at the February meeting of the New York Section of the American Water-Works Association by Dr. Frank E. Hale, director of laboratories of the Department of Water Supply, New York City.

Although the water from the Ashokan reservoir has a long period of storage and is subjected to treatment with liquid chlorine before it reaches New York City, chlorination of the water of Esopus Creek before it reaches the reservoir was considered desirable. This was decided on in 1917 as soon as control of the Catskill watershed was taken over by the department.

Local conditions prevailing at that time led to the adoption of hypochlorite instead of liquid chlorine for the Esopus Creek water. Immediately upon introduction of the hypochlorite (0.4 ppm.) complaints were received that the water was killing trout in the creek.

Cost Was Excessive

This led to trial of the chloramine process (ammonia used with the hypochlorite), in an attempt to reduce the amount of chlorine and sludge. A material reduction in the unit rate of free chlorine applied (from 0.4 to 0.1 ppm.) was found to be possible, with good bacterial results and elimination of the fish problem, but the comparison of results obtained throughout more than a year's study indicated that equally good results were obtained by the use of hypochlorite alone.

For example, the total bacteria and the B. coli removal with application of 0.05 ppm. available chlorine, bleach compared with chloramine, was, respectively, for bacteria 71% and 74%, and for B. coli 98% and 96%. These results indicated that the cost per unit of available chlorine applied for chloramine was double that of hypochlorite alone, since the ammonia cost four times as much as the hypochlorite, and the relative amounts of each applied were in the inverse ratio of one to four. This ratio was indicated by the experiments to be the correct ratio, the formation of chloramine being shown by a decidedly larger amount of free chlorine in the treated water than when bleach alone was used.

An important point brought out in the paper was that a given amount of available chlorine applied, and found by analysis to be actually in the water, did the same work—that is, percentage removal of bacteria and of B. coli—*at all temperatures*, winter or summer, from 32° F. to 76° F. Another point to be emphasized is that very small amounts of available chlorine may be effective in waters of low mineral and organic content.

The paper and discussion following brought out the fact that chloramine cannot safely be used except where there is very strict laboratory control, since otherwise the hypochlorite and the ammonia are likely to result in a variety of reactions and compounds, depending chiefly upon the proportion of chemicals applied and the strength of the solutions.

*From "Engineering News-Record," New York.

State Aid for Water Power Development

Suggestion for Assuring Fullest Utilization of Power Resources—Government Should Furnish Capital and Control Rates—Complete Ownership by Government Not Essential

By ALFRED M. BEALE
Water Power Branch, Department of Interior, Ottawa

PRODUCTION of power is a key industry and Canada's opportunity lies therein. Every country of which we have information is endeavoring to stimulate its production of electrical energy and, wherever necessary, is providing state aid to supplement or replace private enterprise.

In Great Britain a great deal of attention has been given to the subject and figures have been submitted to prove that the continuance of the upward trend of wages is dependent upon the greater per capita use of mechanical energy. The old idea of restricted output in order to keep up prices and wages seems about to give way to the new one of stimulated output, the greater production of marketable manufactures per capita by the introduction of labor saving devices, automatic machinery, etc., and it seems probable that labor will accept the new regime and share in the rewards of enhanced output.

Power Essential to Industry

There seems to be no good reason why the government of Canada should not take steps to aid in the development of Canadian power resources. Power, usually in the form of electrical energy, is essential for the industry, convenience and comfort of the whole of our population. All manufactures are dependent on power and its supply at reasonable cost builds up industries which develop our unexcelled natural resources, provide products for our own use and for barter in the world's markets and secure profitable occupation for our people.

It is perhaps unnecessary to dwell on the fact that the use of waterpower is the use of an inexhaustible resource while the use of fuels represents a draft upon an exhaustible one, nevertheless in a country such as Canada where artificial heating is for approximately eight months of the year essential to existence, and where such heating can only be secured economically by the combustion of fuel, the replacement of fuel power by water power wherever feasible, even if the fuel resources were inexhaustible would represent the relief of transportation systems and mine labor to this extent and help to keep the price of fuel down in the face of a demand growing steadily with the population.

Though there is no reason why state aid should not be given to all power developments which are dictated by sound economic principles, this aid is not so frequently essential in fuel-power plants since the capital investment at the outset is not so large in proportion to the initial market, and although the cost of power per unit may be as large or larger than for water power, owing to the fact that the plant grows with the market, the question of financing the project is not often very difficult.

In the case of waterpower, though, owing to the low cost of maintenance and operation, the unit cost of power may be low, nevertheless the capital expenditure is much greater than for fuel power plants. Again, an excellent water power site may be capable of producing much more power than the immediate market can absorb; unfortunately however water-power sites do not lend themselves to piecemeal development and it is generally necessary to incur a large percentage of the total capital expenditure at the outset. This frequently means a certain delay before the development reaches a paying basis; obviously, therefore, financial strength is absolutely essential.

Opportunity for Canadian Capital

Until the great war it was the practice of Canada to seek capital for national development elsewhere, but when the money markets of the world gradually became closed it became necessary to seek capital at home. Under the impetus of patriotism Canadians were taught to lend their money to the government for the successful prosecution of our war enterprises, but as time went on the patriotic appeal began to receive the support of the economic appeal. Canadians who had spent their surplus in real-estate which they found to mean the absolute tying up of their capital plus a yearly tax-bill, began to look upon the new investment with approval; it provided an investment which one could realize upon readily when required; a security upon which one could borrow from the banks, and above all, a periodical interest cheque to help offset the rapidly rising cost of living.

National Thrift

Hitherto the practice upon the North American continent has been to indicate personal financial prosperity by saying a certain individual is worth so many thousands or millions of dollars. In Great Britain wealth is usually indicated by saying a man is worth so many pounds a year. In other words, one speaks in terms of capital, the other in terms of income. It is probably this fundamental appraisement of wealth which has brought about the financial greatness of the Mother country. The predilection of the French people for "Rentes" is proverbial, and it is to this in large measure that France's rapid recovery after 1870 is attributable and we can look for this same predilection to produce a rapid recovery of the same great nation from the storm and stress of the past four years.

In other words, national thrift accumulates national wealth, makes for national stability and produces the capital for the development of national enterprise.

Should not Canadians provide Canadian capital for Canadian enterprise? Possibly this country will need more capital than it can itself supply, but as it progresses from the lot of the debtor towards that of the creditor nation, the proportion of its exports required to pay its debts and interest charges will diminish until ultimately, perhaps, a considerable portion of its imports will, as was the case in Britain, represent payment for financial services rendered.

The government of Canada has expended much money and energy in educating the people to invest in Government bonds; it has built up a bond selling organization of an efficiency undreamed of five years ago. A prominent member of this organization in reply to a question as to its future after the war, expressed the conviction that it should be kept alive and adapted to peace conditions and that when the government needed money for national enterprises that it should use the machinery now at its disposal to secure that money from the people of Canada.

The people of Canada have acquired a taste for Government bonds and it cannot be doubted that having acquired the habit of investing in such securities they would, even with the withdrawal of war enthusiasm, absorb any reasonable amount offered. Particularly if they can be shown that besides securing a safe income they aid in increasing the national development. What more logical purpose than the development of power, is there for the savings of the Canadian people.

Monopoly Must be Controlled

Power, particularly water power, is a natural monopoly and the modern tendency is to avoid competition in its production and sale. Any monopoly, however, is liable to exploit the public for its own benefit unless adequate safeguards are provided. Hence we see the growing tendency both at home and abroad, to treat power production on the basis of a regulated monopoly.

Undeveloped water power sites in this country are principally vested in the Crown, either in the right of the Dominion or in the right of the Province in which they lie. In Ontario the production of power is becoming more and more a state enterprise, and this principle is growing in other jurisdictions. Where the state does not actually develop the power sites it is adopting the principle of lease or license providing for the regulation of rates charged and for the recapture of the development at some future date if it so desires.

In Europe the practice appears to be that of leasing a site for a given period after the expiry of which the complete development reverts to the state without compensation, this entails amortization of the investment during the life of the lease and a corresponding increase in the cost of power to the consumer.

In Canada the preference seems to be for compensation if the state takes over the development at the expiry of the lease, comparatively low rental charges and the regulation of rates charged in the case of public utilities, thus providing the people power for all purposes at the lowest rates consistent with economic principles.

Private Development is Supervised

In order that disaster, material or financial, may not occur, and in order that it may assure itself that any development it may wish to acquire is substantially constructed, of good design and capable of performing the functions for which it is designed, government regulations provide for the submission of the whole scheme to its own experts and grants concessions only on the satisfactory demonstration of its economic soundness; further, complete plans and specifications and data as to the natural conditions at the site have to be submitted and approved before construction can proceed, while during the construction a fully qualified government inspector is appointed to watch the work and enforce the maintenance of the necessary standard of construction.

The most difficult problems water power administration has to face is the control of rates and the fixing of the amount of compensation to be paid if it takes over the works at the expiry of the lease. These problems immediately lead one into the field of finance; stock and bond issues; promotion charges; discounts; construction costs; depreciation, actual or functional; watered stock, and so forth; for without a complete knowledge of the financial end of a big development it is impossible to fairly fix rates or compensation. Further, the public is distrustful of the figures adduced by a public service corporation in support of an increase in rates, and this distrust may lead to actual injustice. If the government could, through a suitable non-political commission, control financing and supervise all accounts, the problem would be much simplified but the exercise of such control is at present difficult.

Were the government to provide a portion or all of the cost of development it would immediately become in a position to exercise this control, therefore why not couple up the Victory Loan organization to water-power development?

Government to Furnish Funds

Let us suppose that a bona-fide promoter, syndicate or municipality desires to develop a water power, it submits its data, both economic and physical, plans, etc., to the commission, which might be the Dominion Power Board enlarged as far as necessary to include eminent financial and legal as well as engineering and administrative representation. This body passes upon the whole scheme and if it approves, provides for the necessary concessions and recommends to the treasury that the necessary funds be provided in exchange for the bonds of the undertaking at a rate sufficient to cover the cost of raising the money and administration.

Thus the bona-fide development would be able to do its financing on a reasonable basis without having to pay the tribute that financial interests sometimes exact. The soundness of the development would be assured and as bondholder the government could exercise that financial control which at present is so difficult to provide for; control of rates and compensation on taking over, would automatically be solved.

To provide the necessary funds the government could avail itself of its existing machinery for providing the people with a safe investment. In short, the public would provide the funds for developing its own resources for its own benefit, with reasonable assurance that its interests were adequately safeguarded by its own representative from the time it invested its money until and during the time it was enjoying the benefit of the utility.

It appears to the writer that this process might apply to both public and privately owned developments, both for public utilities and private purposes. There seems to be no reason why the same funds should not be applied both to the development of a national or international water power on the St. Lawrence and to water power on the frontier of civilization for the purpose of supplying energy say to a nitrogen fixation plant or a pulp mill.

The purpose of this article has been to suggest the linking of two good things for their mutual benefit,—national thrift to national development. That the advantages to be expected from the linking of the new sources of capital with water power should appeal more forcibly to the writer than other combinations is natural; no doubt others who may approve the idea will be able to suggest arguments in the direction of the development of other national enterprises.

Public and private ownership have each their champions, but the fact remains that, public or private, large enterprises are generally financed on borrowed money and every dollar deposited in a bank goes to swell the sea of capital from which funds are dipped to pay for the development of water powers, railways, plantations, etc., all over the world.

Autocracies Must Yield

The war has brought in its train many new conceptions international, national and individual, many prejudices have gone by the board. Democracy has overthrown autocracy in the matter of national government, there are other autocracies that must yield if democracy is to weather the storm.

"All men are born equal" is a saying as common as it is untrue. "All men become equal when they die" is more true in the mundane sense, and high and low have alike shown themselves willing for the sake of a great cause to accept this equality. Nevertheless there are many inequalities that are artificial and these must be ameliorated. The "common people" have demonstrated that they are the nation and will demand an equalization of opportunities and a more equal share of the world's goods. Capital has dictated to labor, labor now in a growing measure dictates to capital, neither can exist alone and prosperity is dependent on the mutual respect and sympathy of each to the rights and duties of the other. Will not such a "rapprochement" be aided by encouraging the public to subscribe at least a portion of the capital necessary for the development of its own labor?

After a lengthy discussion held recently by the city council of New Westminster, B.C., and the directors of the Vancouver Joint Sewerage Board, it was decided to ask City Engineer Stewardson to consult the engineers of the Sewerage Board and to draw up a concrete proposition to be submitted to the council at a later meeting. The Board desires to take over all of the sewerage on Burrard Inlet, including New Westminster, and including all of the sewers already laid as well as those contemplated, and to have full control of the operation of same.

The Victoria, B.C., "Colonist" says: "R. P. Butchart, managing director of the Vancouver Portland Cement Company, Limited, has just returned from the East, where he was engaged in important negotiations with the London, England, interests connected with the Associated Cement Co., Canada, Limited. It is understood that arrangements were satisfactorily concluded for amalgamation of the Vancouver Portland Cement Company, Limited, with the English concern, and that the two companies will be consolidated under the name of the British Columbia Cement Company, Limited, which will conduct the business from now on."

A USEFUL INSTRUMENT

The Abney Hand Level, Pocket Altimeter or Clinometer—Can be Used With Advantage by the Surveyor, Engineer or Architect

By H. L. Seymour
Engineering Assistant to Dominion Housing and Town Planning Adviser

ACCUSTOMED to methods of precision and to reliance upon expensive and refined instruments, the engineer has frequently lost his sense of perspective as to the relative value and advantage of approximate methods and simpler instruments. For example the modern surveyor looks askance at the compass, with which most of our earlier surveys were made. But as a means of quickly obtaining merely approximate results it is frequently superior to the transit, which does not lend itself readily to approximate work in a timbered country.

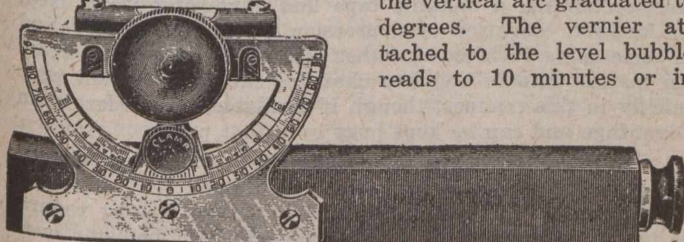
With precise instruments the operator becomes to a large extent the slave of his instrument while in approximate methods the simpler instrument is but an aid and greater opportunity is afforded the instrumentman in exercising his judgment and powers of observation.

For Approximate Work

Of instruments for approximate work of various kinds, the writer feels that the Abney hand level should rank high. The ordinary hand level is found in wide use but the Abney can be used either as a hand level or as a clinometer and possesses certain advantages for the work to be described over other forms of clinometers. It is with its use as a clinometer that this article is mainly concerned. And the next few paragraphs are offered particularly for those readers entirely unacquainted with the Abney.

The total length of the Abney hand level is ordinarily but five inches, though the eye piece may be extended another two inches. In its leather case its fits the pocket or can be carried by a leather strap over the shoulders. The list price is under $20.00.

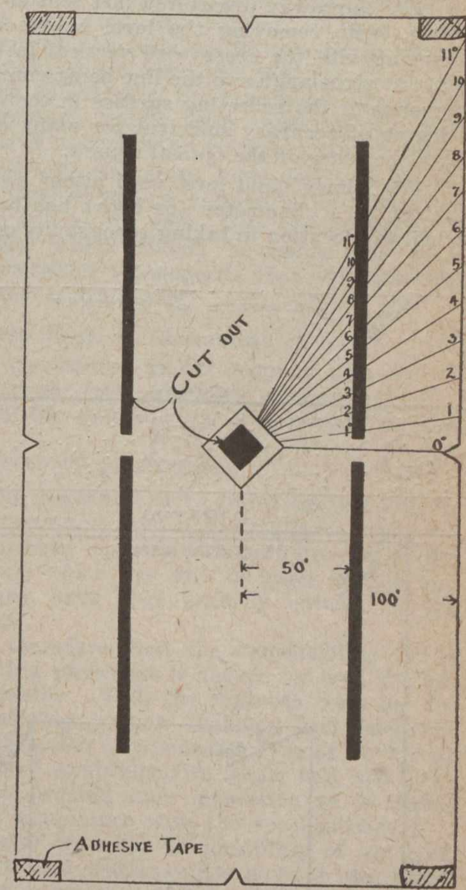
As to operation, there is an aperture in the 5-inch sighting tube below the bubble of the level tube. Here in the sighting tube and at an angle of forty-five degrees with a vertical section thereof, there is placed a polished reflecting surface so arranged that the observer can see any object sighted on and at the same time the reflection of the level bubble. So long as this appears to be bisected by the centre line etched on the reflector, then any point covered by the horizontal cross wire at the far end of the sighting tube is at the same level as the observer's eye when the index is set to zero and if, of course, the instrument be in adjustment. For any other elevation the angular amount of elevation of depression can be read on the vertical arc graduated to degrees. The vernier attached to the level bubble reads to 10 minutes or in some instruments to 5 minutes and is moved backwards or forwards until the reflection of the level bubble appears in the centre of the reflector. With a little practice this operation is performed very rapidly.



Abney Hand Level—Manufactured by Nearly all Instrument Makers

With the ordinary hand level, a levelling rod is a necessary part of the equipment to be carried around. The rod is often dispensed with when a clinometer is employed, though a "rodman" generally is an advantage and frequently a necessity. The first essential is to note what point on this human target rod is at the same height as the observer's eye. The rodman's duties then consist merely in standing at the points the angular elevation of which are to be read. A very inexperienced person may act as rodman.

To adjust the clinometer the observer stands at a point A and sights on a predetermined point on rod or "rodman" at a point B, the vertical angle being noted. Then with the observer at point B and rodman at point A, the vertical angle is again read. If, except as to sign, the angle read is the same in both cases, the instrument may be considered in adjustment. If not, the mean of the two readings gives the true angle of elevation to which the vernier should be clamped. With this setting and sighting again from A to B or B to A as the case may be, the bubble is brought to the centre of the level tube by the capstan screws provided for that purpose.



Paper Protractor for Platting Cross Sections from Clinometer Readings; Vertical Scale Ten Times Horizontal Scale

In chaining, instead of depending on the often doubtful judgment of chainers as to when the chain is level, the tape may closely follow the ground surface, the angles of elevation or depression being quickly read by the clinometer, thus avoiding the delay of "breaking chain" and the possible attendant errors. For convenience, correction tables are prepared; the versine of the vertical angle multiplied by the slant distance giving the amount to be added to the slope distance. With the clinometer, tapes as long as eight chains have been used though probably four chain tapes are a better length as a rule.

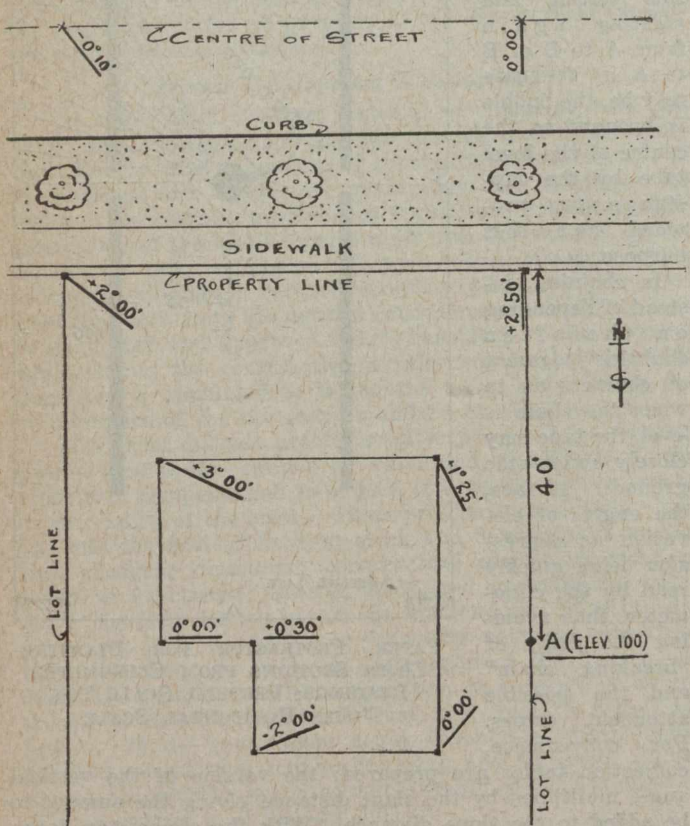
Several years ago on Dominion Land Surveys the writer developed the idea of obtaining differences in ground elevations by clinometer readings. Tables were prepared, the sine of the vertical angle multiplied by the slant distance, giving the difference in elevation. A comparatively accurate profile of lines chained were thus obtained with a greater degree of accuracy and with much greater detail than by the use of the aneroid barometer prescribed for the purpose of obtaining differences in elevation. It is now the practice on Dominion Land Survey work to record all clinometer readings for the purpose mentioned.

Tests by D.L.S. Controller

A. M. Narraway, Controller of Dominion Land Surveys, carried out last spring a series of tests over a ¾ mile course. He was convinced that with the clinometer in adjustment (or allowance being made for the index error) and when the eye piece was extended, the elevations determined by clinometer readings of vertical angles over chained distances could be depended on within 3 feet—without extending the tube within 5 feet. Or one might expect on the basis of Mr. Narraway's findings an error of the order of from about 1 vertical in 1,300 horizontal to 1 vertical in 750 horizontal. Prof. Edwin R. Stuart states in his "Map Reading and Topographical Sketching" that with the military clinometer and with paced distances the elevation should be determined within 5 feet in a mile or an error of about 1 vertical in 1,000 horizontal. In the writer's experience the best results showed an error of the order of only 1 in 10,000 but it was also demonstrated that an error of 1 vertical in 500 horizontal was about the limit in the other direction.

Mr. Narraway discovered last season another use of the Abney. By removing the level bubble and using the instrument with the cross wire vertical instead of horizontal, points at right angles to the line being run can be determined, by means of the reflecting surface in the sighting tube, with a degree of accuracy sufficient for many offset purposes. It takes the place of the optical square.

The Abney hand level used either as an ordinary hand level or as a clinometer (or both) has been in common use in railway location in taking topography on either side of the



Typical Field Notes for the Determination of Ground Elevations by Clinometer Readings

centre line. In highway work the clinometer is of even greater value. H. R. MacKenzie, chief field engineer, Highway Department, Province of Saskatchewan, in a paper read last August at a general professional meeting of the Engineering Institute of Canada, gave the following information in regard to the method of locating side hill grades:—

"When a reasonably accurate estimate of the obtainable grade has been made, a trial line is staked out on the ground by means of the clinometer. In the absence of bush the only assistance required for this work is a rodman; and the entire equipment consists of the clinometer, two pickets equal in length to the height-of-eye of the observer, a bundle of small stakes about 15 inches in length, and a hand axe. The clinometer is set and clamped at an angle corresponding to the estimated grade percentage and starting from a desirable and apparently feasible point of landing at the crest of the valley, the rodman proceeds down the slope carrying one picket and the bundle of stakes. Having proceeded a distance of not more than 100 ft. the rodman holds the picket in a vertical position, and moves in a transverse direction up and down the slope until the clinometer held firmly on top of rear picket shows the cross wire cutting the top of the rodman's picket. The point at the base of forward picket is then a point on the grade and is preserved by means of a stake. The observer then moves ahead to this stake, while the rodman is proceeding still farther down the slope and the process is repeated. Several points on the grade line could often be located from one station, but the writer has found it advisable to follow closely behind the rodman in order to see in advance any obstacles to construction which it is necessary to avoid.

Difficulties Easily Overcome

"It will frequently happen that on approaching the bottom of the valley, it becames evident that one is unable to reach the desired objective, at the grade provisionally adopted. The process is then reversed and by using good judgment in the correction of the grade percentage, a grade line can be run up the slope from the required point in the valley, which will reach the summit at or near the desired outlet.

"There are several complications that arise in connection with the location of side hill grades, such as the crossing of tributary ravines without loss of height and at a reasonable cost, and the providing for a reduction of grade on sharp curves, but these difficulties are easily overcome by the experienced road builder and a very satisfactory road location can be secured by means of the clinometer, with a great saving in time and energy as compared with locating the same length of roadway by means of a transit. The grade line located in the manner above described is not to be considered as the centre line of the roadway except on straight even slopes where the transverse cross-section of the finished roadway would give a balance between cut and fill. On all sharp curves the grade line is to be taken as indicating only the elevation of the finished roadway, which is to be constructed largely by excavation, or largely by embankment, according as the requirements for correction of alignment may determine.

"The above described method of locating side hill grades is, with certain modifications, followed by several of the highway engineers in this Province, and the credit of introducing this method into Saskatchewan is due to W. T. Thompson, a member of our society and one of the efficient pioneer road-builders of Western Canada."

New Application at Halifax

As far as the writer knows, the following particular application of clinometer methods to cross-sectioning in highway work is new: At Halifax, in connection with the replanning of the "Devastated Area," traverse lines approximating to the location of the final centre lines of streets were posted at every fifty feet and the ground elevations at these points obtained by levelling in the ordinary way. For cross-sectioning, a metallic tape and clinometer were used, the angular elevation or depression for points 50, 100 and in some cases 150 feet on either side of the line being read. An instrumentman and two chainers can cross-section very quickly in this manner, though if available a recorder is an advantage and can be kept busy by a fast party.

By cross-sectioning to a good depth on either side of the proposed street, information is obtained that is useful in determining the best location of buildings, having regard to the topography. The advantage of the clinometer over a hand level for rough ground is that only one "set up" is required, and that a considerable error in chaining may make very little difference to the result unless there is some very pronounced sudden change in the slope of the ground. For example, if only 95 feet were measured off by mistake instead of 100 feet and the slope read was 10 degrees, then ordinarily with the clinometer the error in plotting would be but a tenth or so, while if a hand level were used the error would probably be about 1 foot. It might be mentioned that for cross-section work, elevations can be plotted without reduction by the use of a protractor which the draughtsman can make out of stiff paper for the particular vertical and horizontal scales to which he is working.

For rough and timbered country, with the establishment of but a few control points with transit and level, the compass and clinometer save much time and produce results sufficiently accurate for ordinary road or street location.

In the foregoing, some uses of the clinometer to the surveyor and engineer have been given. It is useful too in drainage work, in the determination of height of trees and buildings and in works where slopes are to be quickly determined. For the architect, or for the surveyor or engineer obtaining information for the architect, there is another important use for the clinometer. The method is convenient and speedy.

The accompanying figure shows a building lot and the proposed location of a building, the corners of both lot and building site being marked by stakes, let it be assumed. It is desired to determine the ground elevations at various points. As a rule it is necessary to set up only at one point. If in the figure the observer stands at point A, which in the absence of other information may be assumed at an elevation of 100 feet, then by reading and noting the angles of elevation or depression from the observer's eye to the predetermined height on the "rodman," who moves from point to point, the relative elevation of each corner or point can be deduced. The office work consists in plotting the various points whose distance from the point A are then determined by scaling. Tables can be readily prepared giving the difference in elevation for various angles, but up to say 6 degrees or even in ordinary cases to even 10 degrees it is sufficiently accurate to take the feet fall or rise in 100 feet as 7/4 the number of degrees of slope.

Example

For example from point A (assumed at an elevation of 100 feet) to the northeast corner of the lot the distance is 40 feet and the angle of elevation read is 2°50′ (170′).

$$\text{Then } \frac{40}{100} \times \frac{170}{60} \times 7/4 = 2 \text{ feet;}$$

or elevation of the northeast corner of the lot is

$$100 + 2 = 102 \text{ feet.}$$

If no "rodman" is used and the ground elevation can be observed directly, the angle read would be in such a case 4°25′ (265′) if observer's eye is at a height of 5.1 feet above the ground.

$$\text{Then } \frac{40}{100} \times \frac{265}{60} \times 7/4 = 3.1 \text{ feet,}$$

and elevation becomes

$$100+5.1-3.1=102 \text{ feet, as before.}$$

With any reasonable care, results should not show an error of more than 1 horizontal in 1,000 vertical. This is but 0.1 foot from calculated elevation for a point 100 feet distant from instrument; or as close as the local variation in ground level. It is therefore quite satisfactory for the determination of elevations of the surface of a building lot, so far as accuracy is concerned.

When we are willing to concede the point that very often attempts at precision are ill-advised and that our purposes could be served by intelligent approximations, we will find that the Abney hand level has a permanent place among our instruments.

J. L. Neilson & Co., of Winnipeg, who are the agents for Western Canada for the "Baker" line of road machinery, are appointing agents in unrepresented districts.

In a paper on "Engineering and Ocean Transportation," read before the Montreal branch of the Engineering Institute of Canada, A. W. Robinson, consulting engineer, Montreal, states that the total allied shipping losses will probably be made good early this year. "The figures recently given out," said Mr. Robinson, "showed that the world's total loss of merchant tonnage from the beginning of the war to October, 1918, by enemy action and marine risk, were 15,053,786 gross tons. During the same period, vessels totalling 10,849,527 tons were constructed, and enemy tonnage totalling 2,392,675 was captured, making a net loss of tonnage during the war of only 1,811,584 tons."

PAVEMENT GUARANTEES

Report of Committee on "Economic Status of Guarantees of Pavements on Roads and Streets," Presented February 28th at the Annual Convention of the American Road Builders' Association

In view of the looseness with which the terms "guarantee" and "maintenance" are often applied to paving contracts, your committee, in discussing the subject assigned to it, wishes to make clear that it believes the two terms should be regarded as separate and distinct and that the guarantee period should not be longer than the reasonable life of the pavement without repairs, except those rendered necessary by reason of defective materials or workmanship or both.

This is in accord with numerous court decisions in connection with assessment work and automatically settles the question of legality and at the same time clearly indicates the maximum period which should be called for in a guarantee. Your committee recommends that the maximum period should be fixed at five years.

Three Types of Guarantees

Three types of guarantees are in common use:—

a. Bond—preferably from a surety company.

b. Retention by the municipality of a certain amount of cash.

c. Bond and retained percentage.

The intent of the guarantee is to guard against defects in material and workmanship and non-compliance with the specifications, but in many cases defects may develop in the pavement or roadway which are due to other causes and conditions which may have been entirely outside of the scope of the contract.

It is apparent, therefore, that the responsibility for a satisfactory and lasting pavement is shared by both the engineer and the contractor. With the engineer rests the responsibility for providing proper drainage and adequate foundation and the selection of a suitable type of pavement and the preparation of comprehensive plans and specifications. He must also provide such inspection as is necessary to insure strict compliance with the specifications.

With the contractor rests the responsibility of carrying out in a satisfactory and workmanlike manner the plans and specifications and instructions of the engineer.

The safeguarding of the public welfare lies, therefore, in the hands of the two parties above mentioned, with the following possible exceptions:—

In a number of instances pavements have failed, due to causes which may or may not have been controllable by the engineer or the contractor:—

Defective street railroad construction;
Settlement of trenches for underground service pipes;
Improper system of cleaning the pavements;
Leaky gas or water mains.

Engineer Responsible to Community

The engineer is directly responsible to his community and if he is negligent or incompetent should, and presumably can, be removed. Generally speaking, the question of public welfare or economics in this connection is not directly involved in the guarantee clause of a contract except in those cases where an incompetent or negligent engineer has prepared faulty specifications and as a consequence thereof has asked a contractor to guarantee a pavement which is likely to fail through causes other than defective materials and workmanship.

Assuming that the plans and specifications are entirely competent and proper, the next duty devolving upon the engineer is that of inspection, which includes testing of the materials to be used. This requires a laboratory equipped for physical and chemical testing and the services of some one who has made a specialty of testing paving materials, as such work does not come within the scope of an ordinary chemist. Most states and a number of the larger cities maintain their own laboratories and testing staff. Smaller municipalities may and frequently do avail themselves of consulting and testing experts, but a certain proportion of them do not, and, on the contrary, permit their pavements to be laid with only such supervision and inspection as their engineers can personally give to the work, and in many instances these engineers are not well qualified in this particular line and would gladly avail themselves of expert help were they permitted to do so.

In addition to the preliminary testing of materials, provision must be made for the inspection of the work as it progresses. Where the pavement is manufactured in a plant and then delivered to the street, inspection at both the plant and the street is essential. For example, in the case of a large asphalt plant where 200 or 300 batches of mixture are sent out daily, involving 600 to 900 separate weighings, a rigid inspection, such as would justify the total elimination of a guarantee clause, would require two inspectors. The preparation of the subgrade, the mixing and laying of the concrete base, and the laying of the wearing surface would similarly require two or three inspectors and these must all be trained men, not haphazard appointees.

Reputation in Inspectors' Hands

From the standpoint of a municipal engineer this is a very serious problem. His reputation, as judged by the lasting qualities of his pavements, might often rest in the hands of inspectors whose appointments and qualifications were entirely outside his control.

In the abstract, it has been justly said that with competent inspection, guarantees could and should be entirely eliminated, but from an economic standpoint there remains the question of cost of sufficiently adequate inspection and the difficulty of securing it.

The drawbacks and defects in the guarantee system are too well known to require elaborate discussion in this report, but it is a fact that present inspection systems have been devised and carried out with a view to providing reasonable (but not absolute) security, having in mind the certain or uncertain amount of additional protection accruing from the guarantee clause inserted in almost all paving contracts. If this is to be abolished the inspection must be made more rigid and therefore costly, and the lines must be drawn more tightly than heretofore both as to materials and workmanship.

Engineering is not an exact science so that in all cases a certain factor of safety must be employed and there is no such thing as a hair line division between good and bad. When the results are guaranteed, even though the guarantee is far from perfect, it is human to require a somewhat lower factor of safety than would otherwise be insisted on. Where the contractor assumes no responsibility for his finished work, the inducement to slight it and thereby save money, is greatly increased and the inspecting force must be still more competent, vigilant and trustworthy than would otherwise be necessary.

The cost of a guarantee bond to the average contractor does not exceed 1% of the total cost of the contract. On a pavement costing $3.00 per square yard this would amount to 3c. per square yard, which would barely cover the increased cost of inspection above described without taking into consideration at all the increased bidding price likely to result from increased severity of inspection.

Increased Bids Not Necessary

Assuming that the guarantee is only for the normal life of a pavement without repairs, there exists no legitimate reason for the contractor to increase his construction bid by more than the cost of his bond.

As between a reliable and established contractor and one who is lacking in experience, resources and equipment, it is easier and cheaper for the reliable contractor to secure his bond and this can only be regarded as a legitimate advantage to him. As a general rule, he will favor a guarantee bond.

Where contractors do not have an established plant or organization in the municipality or locality where the pavement is being laid, some guarantee for the repair of such defects as many develop would seem to be a necessity. In many smaller towns a single contractor may remain for two or three years and then withdraw after the available paving area has been completely improved. It may be years before any new paving is done and it is often very difficult to get the contractor to return and make any repairs during the guarantee period.

It is sometimes claimed by the contractor that where the specifications are closely drawn and compliance with them is insisted upon, he should be relieved of the responsibility of guaranteeing results. Your committee believes that after having examined the site of the improvement and studied the specifications, he is or should be fully familiar with conditions, and if after doing so he signs the contract and guarantee, he has no reasonable ground for subsequently opposing the engineer in his desire to carry out the provisions of the specifications, and that such insistence on the part of the engineer does not and should not relieve the contractor of his guarantee obligations.

Not Compelled to Bid

If he believes the specifications are faulty, he is under no compulsion to bid on the work, and if he does so, he acts with his eyes open and has no one but himself to blame. The history of court decisions would appear to show that the contractor is at least as well protected as the city when the matter comes up for legal adjudication.

We also recognize that certain large cities may have within their confines three or four large paving plants and that conditions are such that it may be difficult for an outsider to break in. In such cases it is possible to imagine an arrangement between bidders whereby the city would pay excessively for their guarantees, but such conditions are exceptional ones and under them the same city would probably pay an excessive price for its pavements even if it eliminated the guarantee provision from its contracts. This condition could be and has been met by the establishment of large municipal plants capable of doing a considerable portion of the necessary paving.

It has also been urged that it is not logical or legitimate to ask for guarantees on pavements because buildings are not guaranteed. The cases are not parallel. The factor of safety in a building is much greater and its life expectancy is much longer. If the average life expectancy of a building were but ten years and defects might be expected to develop within five years which might render it useless unless rebuilt, the cases might be more nearly parallel.

Having in view the facts as set forth in this report, your committee believes that notwithstanding its admitted defects, the guarantee clause serves an effective purpose and in the light of experience is economically justified.

Uniform Guarantee Not Logical

We do not believe that a uniform length of guarantee for all pavements or for the same pavement under varying traffic conditions is logical or justifiable. Certain pavements are composed of blocks which in themselves have a very long life and but little variation is to be looked for in the blocks themselves. Defects which would develop would be almost wholly defects of workmanship and two years should be the maximum period required to make this evident, and therefore, the guarantee should be limited to that time. Other pavements are composed of blocks which vary very greatly in hardness and resistance to wear and for this type we would advocate a guarantee period for the full life expectancy of the pavement without repair, as it is obviously impossible to test every block used in it. Where a pavement ultimately fails through the abrasion or disintegration of the pavement itself and is likely to disintegrate prematurely through improper materials, or mixing, or proportions, we believe that owing to the great difficulty of absolutely preventing these errors by inspection, the pavement should be guaranteed for its full life expectancy without repairs, and this can be reasonably varied to meet different traffic conditions.

We believe that the guarantee clause should be fairly worded, so as not to impose upon the contractor responsibility for conditions arising after the completion of the pavement and over which he had no control, and, as covering these points, would recommend for consideration the form adopted by the Association for Standardizing Specifications at New Orleans in January, 1912. It should also clearly set forth and be agreed to by the contractor that he accepts the guarantee as being within the reasonable life expectancy of the pavement without repairs.

In northern latitudes if the pavement is completed and accepted between November 1st and May 15th, the guarantee period should be extended so that it will expire on the first of June first following in order to insure weather conditions being such as to permit of thorough examination and the making of all necessary repairs before the final taking over of the pavement by the city. This provision may be omitted when climatic conditions render it obviously unnecessary.

Owing to the admitted defects and shortcomings of guarantees covered by surety bonds alone and the frequent difficulty experienced by cities in having even those repairs due to poor workmanship and materials made on time, we believe that the bond should be supplemented by a cash retainer, legal interest being allowed to the contractor on the amount retained.

For new construction involving grading, foundation and wearing surface, we would recommend that 10% of the aggregate cost of these items be retained.

For resurfacing on an old foundation, we would recommend a retainer of 20%.

When "Hold-Back" is Forfeited

In the case of a 2-year guarantee, the whole of the retained moneys should be payable at its expiration and not before. In the case of a 5-year guarantee, one-fourth of the retained moneys should be payable two years after the completion of the pavement and the balance in three equal annual instalments. The date when payments of retained moneys become due shall be governed by the clause previously recommended for pavements completed and accepted between November 1st and May 15th. If the contractor, having received 30 days' notice, fails to make and complete the ordered repairs at the time any annual instalment (or the whole amount) of the retained moneys becomes due, he shall forfeit to the city the total amount then due unless he shall have obtained in writing from the engineer an extension of the time, when the same provision shall apply at the expiration of the extension period.

FEDERAL AID FOR HIGHWAYS

HON. J. D. REID has introduced in the House of Commons the resolution upon which will be founded the government's promised highway legislation. The resolution calls for the payment by the Dominion government during the five years beginning April, 1919, of $20,000,000 for the construction and improvement of highways. Out of this sum, $80,000 is to be paid yearly to each province. The remainder of the money is to be distributed equally among the provinces in proportion to population. Any highway for which federal aid is granted, must be constructed or improved in accordance with the terms of an agreement between the federal and provincial governments, setting forth the cost, description and specifications. The amount of assistance to be granted by the government is to be 40 per cent. of the actual cost of the work done. The Minister of Railways says that the Dominion will grant aid only for the construction or improvement of main roads, as distinguished from roads merely affording access to market centres and roads leading to main roads and market roads. It was further pointed out that when an agreement has been made between the Dominion and a province as to the location and specifications for a main road, the Dominion government will, through its inspector, see that the work is done in accordance with the specifications.

Wanted, one copy of the November 12th, 1914, issue of *The Canadian Engineer* for a subscriber who desires to bind his papers. Anyone having a copy of that issue is requested to communicate with the Circulation Department, *The Canadian Engineer*, Toronto.

RECOGNITION OF THE PROFESSION

How Shall It Be Obtained? Address Delivered March 17th in Chicago at a National Conference of United States Railroad Engineers

By W. W. K. Sparrow
Chief Engineer, C. M. & St. P. R'y

WHILE I understand the question many of us are perhaps most interested in at this time is the economic welfare of the engineer and how to secure more adequate compensation for his services, yet I feel that we should not confine our discussion or energies to this phase of the question only, but should also endeavor to secure greater appreciation and recognition of the profession socially and politically and in the problems of reconstruction with which not only this country but the whole world is to-day confronted.

There is a regrettable lack of recognition of the engineering profession, not only in the matter of compensation, but also in the administration of public affairs. As an illustration of this, take the present administration of our great railway systems, the greatest in the world, and largely the handiwork of our profession.

Railway Development Engineering Problem

It seems to me that if there is one position in the cabinet of the Director-General of Railroads which the engineer is peculiarly fitted to fill, it is that of Director of Capital Expenditures. The problem of the development of our railways, their economic requirements in the way of additional facilities and improvements, is certainly largely an engineering one.

While this is evidenced by the fact that practically every employee in that department is an engineer, and in every case the assistant to the Regional Director in charge of capital expenditures, is also an engineer, yet we find this important position first occupied by a lawyer and now by a gentleman who graduated from the traffic department of one of our railroads.

The same lack of recognition is found in the representation on the Interstate Commerce Commission, a body charged, among its other important duties, with one of the greatest economic and engineering tasks of the day, the valuation of our railroads; and in like manner in the representation of the state commissions, the national commission on the development of waterways and other similar bodies. This lack of recognition is sometimes almost grotesque, as for example, when a few years ago the governor of the State of Missouri appointed a lawyer as State Highway Engineer of that state.

Greater Recognition Lately

While in the past few years engineers have received greater recognition, as for example in the appointment by the Federal Government in August, 1915, of the Naval Consulting Board, consisting of two representatives from eleven engineering and scientific societies to co-operate with the Naval Advisory Board for the purpose of obtaining the most advanced experience and thought in technical research and engineering developments; in the important positions some have been called to fill in the administration of the affairs of our large railroad corporations in the situation they at present find themselves; and also in the administration of the municipal affairs of some of our large cities in the capacity of City Manager, yet I feel that the profession is far from taking its proper place in the affairs of our nation, states or cities.

I think that this is more marked in the United States than in some other countries, at least that was the impression I gained when I first came to this country. It is certainly true of England and South Africa, where I spent some years of my life.

Just about the time I left South Africa, where, by the way, the railroads and harbors are all government-owned and operated, it was decided to change from the British system of organization to the American system, and it was interesting to observe that the greater number of the newly created general superintendents and superintendents were drafted from the engineering department.

This may have been due, to some extent, to the fact that under the British organization the engineering department has complete charge and supervision of all track and structures, but I think it was also largely attributable to the standing and recognition attained by the engineering profession.

What is the Cause?

I have dealt somewhat at length on what I believe we all recognize—the failure of the engineering profession to take its proper place in the ranks of society and the affairs of our country—not only for the reason that I believe that with a better understanding and appreciation of the engineer's work on the part of those outside the profession, and the service he renders to our industry, health, comfort and welfare, would come more liberal compensation, but also because I have lost none of the ideals of the greatness and nobility of the profession, and the desire to see it receive at the hands of the general public the recognition and standing which, as one of the greatest professions of the world, it ought to receive.

I believe there will be little or no disagreement with what I have said so far; in fact, I think it is a condition of affairs we have recognized for some time, and what we are most interested in is not a discussion of this situation, but how to remedy it.

I think the training of our profession teaches us the law of Cause and Effect, and that to every action there is an equal and opposite re-action. Consequently there must be a cause for this lack of recognition and interest in us. Therefore, before prescribing a remedy, we must first ascertain the cause. To me the answer to this question is largely our own lack of interest in affairs outside of our profession, and also our lack of organization and concerted action.

The engineer, as a rule, is diffident and modest; he has stood aloof from and taken little interest or activity in matters of public and political importance, and the activities of our societies and associations have been largely, if not exclusively, confined to technical matters within the profession, and even in those affairs little or no effort has been made to bring to the attention of those outside of the profession the part that it has taken and is taking in the progress of the world.

I have stated that as a profession we have taken little interest in other than technical matters, and as an illustration of how the profession suffers as a result of such lack of interest, I would call your attention to the Newlands Bill, introduced in the United States Senate at the first session of the 64th Congress, for the purpose of creating experimental stations in engineering, similar to the experimental stations already inaugurated in agriculture.

Lack of National Regulation

The introduction of the bill was the result of the awakening which the war produced and which led to fresh and renewed activity among the advocates of Federal support for technical and engineering research, which it was felt would greatly assist in the development of all industrial resources. The bill failed, and I am sorry to say that its failure was mainly due to the lack of active interest on the part of engineers and those interested in the development of our industries.

Another contributory cause is, in my opinion, the absence, with few exceptions, of state or national regulation in the practice of the profession. In the majority of our states, any one who so desires may start to practice the profession of engineering without let or hindrance. Our profession in this respect is in about the same position as the medical profession was about one hundred years or more ago when any apothecary could practice medicine, just as any plumber can to-day practice engineering as a sanitary engineer.

Everyone to-day knows that a doctor must be licensed by the state to practice medicine, and that before he is able to obtain that license he must be properly qualified. In England the social class is, or was, more distinctive than in this country, and there was, and is, unless the war has eliminated it, still a distinct line of separation between classes, and the social class to which he belongs is distinctive of a man's position in life. Before the medical profession was subject to state license and when any "quack" could legally practice medicine, a doctor, or "leech," as he was often termed, had little or no social recognition, and ranked in about the same class as an undertaker. In England to-day the medical profession has taken its place in society and receives the recognition of all, and the first step in placing it on the plane it now occupies was in requiring everyone who practiced medicine to be licensed to do so by the state.

In South Africa, land surveyors, or government land surveyors as they are known there, must be licensed by the state to practice. In transferring or subdividing land, the deed or legal document must be accompanied by a plat giving the necessary information in a prescribed manner, prepared by a government land surveyor. The plat and survey must be submitted to the surveyor-general's office, where it is checked and a record made of it. No transfer, subdivision or plat of land has any legal standing unless the work is done by a government land surveyor, and the survey passed through the surveyor-general's office.

South African Land Surveyors

The qualifications of government land surveyor are high. He must pass a very rigid theoretical examination, and if successful in that, a practical one. It requires about three years' hard work to qualify. The result is that the Cape Government surveyor has regular fees which give him a better return than the average engineer in that country, and his profession, which is only the kindergarten of engineering, has received recognition and standing both in the country and out of it. I have heard it said on more than one occasion, and I believe with truth, that nowhere has the practice of land surveying been brought to the standard of South Africa.

A further cause, I believe, lies in our education, which I think has been too much along technical lines and not enough attention paid to education of a general nature. The result is that the outlook and view of the young engineer leaving college is inclined to be too narrow and technical, and he is often not sufficiently well informed upon or his interest aroused in questions other than those of a technical nature.

Summarizing what I have said, my views as to the three prime requisites to obtaining greater recognition for the engineering profession may be stated as follows:—

(1) Organization;
(2) Licensing;
(3) Broader education, interest and activity in other than purely technical matters.

A letter in a recent issue of the "Engineering News-Record" advocated an engineering union affiliated with the American Federation of Labor, and I desire to state clearly and beyond possibility of misunderstanding that I am unalterably opposed to any organization along the lines of the labor unions, or perhaps it will be more correct to say, to the methods adopted by those unions, as it is not the organization but their methods to which I am opposed. The question of organization is receiving the thought and attention of many engineers, and we must be quite clear and definite as to the kind of organization we want.

Objections to Trade Union

It would be outside the range of this discussion to enter into an argument upon the merits and demerits of the struggle between labor and capital, but I am convinced that the engineering profession as a whole would never countenance the adoption of methods destructive to our economic welfare. Strikes and lockouts are economically unsound, and an extensive application of the movement must inevitably lead to economic disaster. No matter what the argument, genuine or specious, made in support of the use of the strike threat, the cumulative result is the undermining and destruction of governmental authority and industrial enterprise. Our profession is constructive, not destructive, and we cannot countenance for a minute the adoption of such methods. There are other objections to the methods of trade unionism, one of which is that it destroys individuality and initiative and tends to reduce the efficient to the level of the inefficient.

Concerted Action Necessary

It is not, in my judgment, necessary in order to secure recognition of the qualifications and accomplishments of the engineering profession and readjustment of the compensation paid, so as to be adequate for the services performed in comparison with and in relation to the compensation paid to others, to resort to or adopt the methods of organized labor, and to do so would lower, instead of raise, the standards of the profession.

Unity and concerted action are, however, necessary, and what I would like to see brought about would be an organization known as the United States Association of Engineers, similar to the United States Chamber of Commerce, which is the national organization of the business men of America, and which would embrace all branches and existing organizations, civil, mining, electrical and mechanical.

Such an organization would have for the different branches of the profession its section devoted to technical discussion and research; its section devoted to the promotion of the economic welfare of the engineer; and its section devoted to matters of political and public interest, as for example, education of public opinion to the advantage and desirability of having engineering representation on public bodies having to deal with questions and problems involving engineering knowledge and experience, the appointment of engineers to public positions involving similar knowledge and experience, the adoption of a National Department of Public Works, and many other similar and important questions. Such an organization, with its supreme executive council, made up of representatives of all branches of the engineering profession, would command the attention and respect of the nation.

This may seem to many an impracticable dream, but to-day when we are dealing with Leagues of Nations, why not a League of the American Engineering Associations and Societies? The framing of such a constitution ought to be simple compared to that of the League of Nations.

Individualistic Age is Passing

Whether for good or for ill, the individualistic age is almost a thing of the past. We have in the last ten or fifteen years seen some great changes, but the changes in the next ten or fifteen years will, I think, be much greater. It is not so very long ago when a man could beat his horse or his child as much as he liked. To-day he cannot, and as an illustration of the restriction that is being placed on the individual, he has not, or soon will not have, the privilege of abusing himself by drinking what he likes.

The movement of the day appears to be in the direction of organization by classes, and the engineering profession ought to be, and I trust is, alive to the movement. Therefore, let us invite the co-operation of all and use our influence in every direction to build up a national association which will embrace all branches of the profession and have as its object not only the advancement of technical research, but the economic, social and political welfare of the profession as a whole.

Members of the Engineering Institute of Canada, resident in the Niagara (Ont.) district met March 11th, in Niagara Falls and formed a "Niagara Peninsula" branch of the institute. The branch has an initial membership of nearly thirty. The following officers were elected: Chairman, A. C. D. Blanchard; vice-chairman, W. P. Near; secretary-treasurer, R. P. Johnson.

CLASSIFICATION OF SALARIES

Principles and Procedure in Standardization of Engineering Salaries, Particularly in Regard to Railroad Positions, Are Summed Up in Address Before the Chicago Railroad Conference

By J. L. Jacobs
Consulting Industrial Engineer, Chicago

ONE of the far-reaching results of the world war is the creation among the industrial leaders of all sides of a desire to unite on the work of the industrial and social reconstruction. The policy of industry in the future, is to be based on democratic co-operation as against the policy of autocratic exploitation.

This frank and full-hearted co-operation of all the human factors concerned is vitally essential to the success of any plan dealing with economic and social problems. With a determined endeavor to do justice to the greatest number, to remove causes of industrial friction and to develop the spirit of national service, there is bound to come about incalculable economic, social and political benefits to all.

Human Element Vital Factor

The realization that the human element is the most vital factor in service and production, has brought nation-wide and intensive consideration to the problem of employment. An important result of this consideration has been the evolution of the movement, referred to as the classification and salary standardization movement. Employment classification and salary standardization has made great headway, because through it there comes justice and fair dealing, and better understanding and harmony, both of which are indispensable in this day of competition for efficiency and production.

Inequalities in salary rates for positions having similar duties and responsibilities; interpretation and readjustment of salaries and working conditions without definite and sound bases; lack of standards of duties, responsibilities and qualification requirements; multiplicity of misleading and unnecessary titles; inequitable and unsystematic practices concerning selection, assignment, promotion and other employment conditions,—all these have a demoralizing and stagnating effect on employees, employers and the community.

This constructive programme contemplates not only the elimination of inequities and inequalities in the compensations and opportunities of employment, but has for its objects the formation of sound and definite bases for the determination and regulation of salaries and employment conditions; the development of practical standards of service, duties and qualification requirements; the establishment of clear and uniform understanding of the obligations and advantages of employments; the introduction of definite procedures governing selection, advancement, promotion and retirement on the basis of merit and seniority; and detailed fact bases and organization necessary for effective administration of all matter of employment.

Will Aid Railroad Officials

The work now under way by the group representing the railroad professional engineers in the setting up of standards and uniform salaries and employment conditions for professional engineering positions in the railroad organizations will be of great aid to the railroad officials, to the railroad adjustment boards and other agencies, and will give impetus for similar action on the part of other professional engineers and employers. As a result of this work there should be made available for the first time, equitable, clear and systematic bases of dealing with and settling problems of the relations between men in the engineering profession and the industrial world.

The establishment of uniform and fair standards for the regulation of salaries and employment conditions for professional engineers is particularly opportune because of some steps already taken by governmental departments and representative organizations of workers and industrial concerns. Regulations already established by some of the industrial, governmental and labor organizations and included in agreements between employers and workers of many industries, and the labor policies established by a number of governmental agencies, are good examples of the steps already taken to develop more equitable and uniform methods of compensating employees for services rendered.

Essential Principles

Essential features and underlying principles for sound classification and salary standardization have been developed as a result of intensive studies, experiences and observations of employment situations in many services. Professional engineers and employers would do well to adopt the constructive method and principles that have been evolved in various industrial and governmental services and are considered by many to be the most significant development of the method to improve industrial and economic conditions. These essentials and principles are set out as measuring standards for the classification and standardization of the railroad professional engineering positions as well as for other professional engineering groups.

As the plan proposed for the railroad professional engineers measures up to these standards, so will the broad purposes be attained. The programme of service and standardization of all the professional engineers should be the programme of the railroad professional engineering group and that programme should include the following fourteen essentials:—

Fourteen Points in Programme

(1)—Equitable and logical basis for fixing and adjusting salaries in relation to duties and qualification requirements and cost and standard of living.

(2)—Definite wage differentials for different positions based on special work and qualification requirements, location and other special employment conditions.

(3)—Classification of positions into functional classes, all positions being placed into classes according to general character of duties and into grades according to responsibility and difficulty of work.

(4)—Standard and distinctive titles for all positions having similar duties and work requirements.

(5)—Definitions of duties and responsibilities for each position.

(6)—Definitions of qualification requirements for each position.

(7)—Definite and equitable plan for recognition of efficient service and seniority through periodic advancement,—particularly applicable to the lower grade positions.

(8)—Definite lines of promotion for employees in the various groups and grades.

(9)—Definite regulations for the determination, adjustment and control of salaries and working conditions.

(10)—Standards of service for use as a basis of advancement, transfer and increases based on efficient service and seniority.

(11)—Basis for the establishment of co-operative relations and measures between employees and management to improve social, economic and industrial conditions.

(12)—Definite plan of administrative machinery for insuring equitable and orderly handling of problems of classification, salaries, working conditions and other matters of mutual interest.

(13)—Definite formation of effective and fully representative associations for studying, developing and advising on the industrial, economic and public matters which are of common interest to all and for mutual support.

(14)—Definite proposals for the next steps in the improvement of the status of professional engineering and the development of positive methods and ideals for service and employment.

General Procedure

The following general procedure could be successfully applied in connection with the broad program of classification and salary standardization for railroad professional engineering positions as well as for the other professional engineering groups:—

(a)—Establish co-operative relations with representatives of professional engineering groups and associations, employers, and governmental agencies with a view of obtaining common understanding, full-hearted consideration and support in the development and establishment of the standardization programme.

(b)—Determine the divisions of professional engineering groups and the order in which classification and salary standardization for the same are to be developed.

(c)—Collect for analysis, information and date from reports and documents containing laws, rules and regulations and descriptions of the organization, work and qualification requirements of the positions under consideration.

(d)—Collect for analysis, information and data on cost and standard of living, hours of work, and other working conditions for the respective positions by districts and for the country as a whole.

(e)—Develop groups of occupations setting forth standard and distinct title designations, definition of duties and qualification requirements; character of occupations; and lines of advancement and promotion.

(f)—Establish factors and standards for the determination of basic salaries and differentials dependent on educational requirements, cost and standards of living, working conditions, and special qualifications.

(g)—Develop standards of service as a basis for selection, assignment, transfer and advancement according to service and seniority.

(h)—Prepare code of regulations and conditions as part of the general standardization plan.

(i)—Hold conferences with representative of engineering groups and employers with a view of obtaining suggestions as to changes in classification, standards and factors, and approval of the general plan.

(j)—Prepare regulations and procedure on the manner and method of applying and administering the standardization programme.

QUEBEC'S ROAD PROGRAMME

By Romeo Morrissette
Three Rivers, P.Q.

As a result of the announcement that the Federal government will appropriate money to aid in the construction of good roads, the Quebec government has been asked to help finance a number of new highway activities. Hon. J. A. Tessier, Minister of Highways for Quebec, has received requests for roads from every part of the province. To satisfy all the demands would require the expenditure of $100,000,000. However, the most urgent will be constructed immediately.

Mr. Tessier announced recently that this summer work will be done on the following roads:—

Hull to Montreal, Sherbrooke to Montreal, Sherbrooke to Three Rivers and Levis to Sherbrooke. At the same time, work will be actively resumed on the Grand 'Mere to Three Rivers and Sherbrooke to St. Lambert roads. The total expenditure to be involved will be $2,000,000 for 1919.

A request has been submitted to Mr. Tessier by a delegation from the northern section of the county of Champlain, to continue the Grand 'Mere to Three Rivers highway so as to pass through the parishes of St. Theophile, Ste. Tite and Ste. Thecle, to Harvey Junction. A gravel road has been suggested. The minister has promised to consider the question seriously and the department's engineers will be asked to report on the extension.

Mayor Desaulniers, of Shawinigan Falls, and A. J. Meunier, have asked Mr. Tessier for aid in the construction of a concrete road on Melleville Island.

Representatives of Shawinigan Falls were also in Quebec last week to arrange for the floating of a loan to cover the construction of a new section of the local aqueduct, new sewers and other public works.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	**$1.75**	**$1.00**	**10c.**

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

JAMES J. SALMOND, President and General Manager
ALBERT E. JENNINGS, Assistant General Manager

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

PRINCIPAL CONTENTS

THE CHEMIST AGAIN PROVES HIS WORTH

TO the chemist, the engineer owes many debts. Yet most of the chemist's work is fruitless without the added knowledge and ability of the engineer. The two professions are mutually dependent upon each other for some of their greatest triumphs, and the co-operation between them is only beginning. Chemistry will play an ever-increasing part in engineering.

In the last issue of "The Little Journal," an interesting "house organ" published by Arthur D. Little, Inc., chemists, of Boston, Mass., there is related a striking instance of the assistance that chemists can give to engineers and contractors. In one of the Southern concrete shipbuilding yards, all conditions were favorable except that there was no rock or gravel at hand. Sand was in abundance and so was clay.

Clay is curious stuff. Chemically speaking it is a mixture of hydrated aluminium silicates, with impurities in great variety. Its geologic history, however, is often more important than its exact chemical composition, for the conditions under which it has existed for the preceding hundred thousand years or so, have a great bearing upon the size and structure of its particles; and in practice the physical nature of the particles of a substance has a great deal to do with its chemical behavior.

The children of Israel needed straw to make brick, not that the straw fibre should serve as a binder, but because of a colloidal substance contained in straw which caused the particles of defective clay to bake into first quality product. It was a mean trick of the Egyptians to withhold straw, and it was bad manufacturing practice, too.

Research with the Southern clay showed that if it is fixed at the proper rate and temperature, very hard and porous lumps of the desired size result. Concrete made with them has practically the same crushing strength as that made with crushed rock. So proper apparatus was installed and the product was used as aggregate. Owing to its porous nature, the aggregate is very light, but the completed ships stood up to all the tests and proved to have a carrying capacity compared to dead weight considerably above that of wooden or other concrete ships, and nearly equal to ships built of steel. The yards did not have to be moved nor did gravel or crushed rock have to be hauled long distances to the yards,—thanks to the engineer's good friend, the chemist.

THE CONTROL OF INDUSTRY

THERE is a constitutional way of dealing with labor demands and the relation of labor to any particular industry, and there is the way of the I.W.W. and the Bolshevists. In the United Kingdom, the Dominions and the United States both labor and capital have made most progress by negotiation, deliberation and compromise. Some of the labor unions have achieved prosperity for their members and the good-will of the employers by the fairness of their attitude to capital and the judicial stand they have taken. There is not wanting evidence, however, that goes to show that the tried leaders of some of the most important unions on both sides of the water are being browbeaten and threatened by that type of agitator who has done his best—or his worst—work in Russia. In the United Kingdom, for example, the shop "stewards" have usurped functions never entrusted to them, and are virtually ignoring trade union leaders in all matters of dispute that arise between master and men.

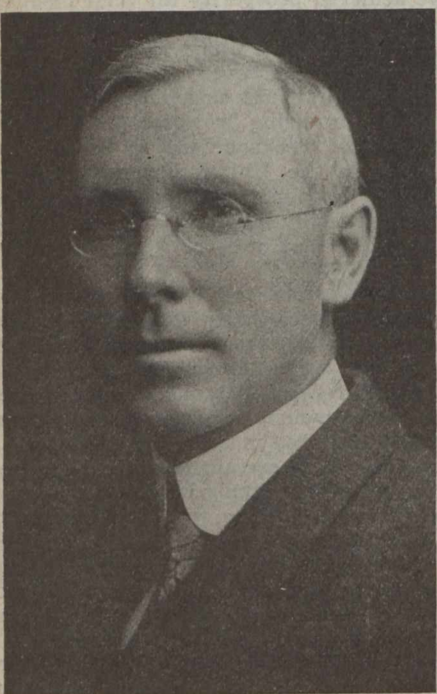
The high wages, high prices and general scarcity of labor during the war have caused many workers to lose all sense of proportion in presenting their demands to capital. It was possible to pay high wages during the past two or three years for the simple reason that market prices were high. But these high prices cannot continue: already there has been a sharp decline of prices in some directions and a heavy falling off of orders. It is certain that the European countries devastated by war will buy only imperatively necessary supplies at present prices. They will wait, to secure the materials required, until prices have fallen, or until they can be supplied by their own labor and industry. Labor cost is almost always the biggest factor in the costs of production, and it cannot go beyond a definite level without putting an end altogether to the industry in question.

The Colorado Iron and Fuel Corporation has made remarkable progress within the last two or three years in harmonizing the interests of employer and employes. Boards, in each industrial centre, have been established upon which the men and the company are alike represented. By friendly negotiation and compromise, wages, hours of work and general social conditions have been established to the satisfaction of all concerned. Those who recall the strikes, the turmoil and disturbances that almost approached civil war in Colorado, because of the gulf that formerly separated the company and the men, will realize best what a wonderful change has taken place. And in Great Britain Lord Leverholme, the director and business manager of the great industries at Port Sunlight, has announced recently that he proposes to overwork machinery rather than men, and cut the working day to a minimum. It is the sheerest absurdity to assert that it is impossible, under the present organization of business, to get labor and capital together to their mutual benefit.

The Russian Soviets have demonstrated what the common ownership and control of the machinery of production will do for a people. To-day Russia is not merely on the brink of starvation—the people are actually dying by the thousands from want and starvation. Yet, in the United Kingdom and the United States and elsewhere, labor agitators and visionaries demand that private enterprises be appropriated for the benefit of the working class. It is even suggested at Washington that the railroad brotherhoods take over and operate the railways of the United States. How efficient and effective committee management by workers can be is shown by the fact that Lenine and Trotzky have been compelled to appeal, and pay high salaries, to former industrial managers of mines, factories, railroads and the like. Canadian and American workmen have achieved the highest standard of wages and living conditions in the world; and their sound sense can be relied upon to reject the appeal of the agitator to throw upon the scrap heap what has taken generations of effort and sacrifice to construct.

PERSONALS

Lt.-Col. Charles Hamilton Mitchell has accepted the recently offered appointment as Dean of the Faculty of Applied Science and Engineering of the University of Toronto. It is understood that the appointment was suggested two years ago but Col. Mitchell refused to consider it until the war was over. The appointment will be deservedly popular, as Col. Mitchell's personality, ability and record have won thousands of friends. Col. Mitchell was born in 1872 in Petrolia, Ont., and graduated from the University of Toronto in 1892 with the degrees of B.A.Sc. and C.E. His appointment as assistant city engineer of Niagara Falls, N.Y., followed; from 1894 to 1900 he was city engineer of Niagara Falls, Ont., engaging also in private practice in hydraulic engineering and water power development. From 1901 to 1905 he was engaged as principal assistant engineer of the Ontario Power Co., and during 1906 travelled in Europe, studying hydro-electric power developments. Since 1906 he has been in consulting engineering practice in Toronto, in partnership with his brother, Percival H. Mitchell. Col. Mitchell is a member of the Institution of Civil Engineers, the Engineering Institute of Canada and the American Society of Civil Engineers. From 1901 to 1911 he was a member of the Civic Improvement Commission of Toronto, and from 1910 to 1912, vice-president of Toronto Civil Guild, and president in 1914. Since 1913 he has been a member of the Board of Governors of the University of Toronto, and for twelve years prior to that he was a member of the "Senate" of the University. At the outbreak of war, Col. Mitchell was a Major in the Corps of Guides, and Divisional Intelligence Officer on the General Staff, Second Division, at Toronto. He was promoted to Lieut.-Col., General Staff Officer (Intelligence) with the First Canadian Division overseas. Subsequently he became General Staff Officer (Intelligence) to the Canadian Corps in France; General Staff Officer (Intelligence) Headquarters 2nd Army, B.E.F., in France; General Staff Officer (Intelligence) General Headquarters B.E.F. in Italy. Col. Mitchell's war awards include the following: Mentioned in despatches on six occasions; received the Distinguished Service Order, June, 1916; Companion of the Order of St. Michael and St. George, June, 1917; Officer of the French Legion of Honor, March, 1916; Officer of the Order of Leopold, Belgium, July, 1917; Croix de Guerre, Belgium, 1917; Companion of the Bath, 1918; Officer of the Crown of Italy, 1918; and the Italian Cross of War, 1918.



Col. Mitchell will continue his connection with the firm of C. H. & P. H. Mitchell, and will devote a portion of his time to consulting work.

D. T. Black, formerly city engineer of Welland, Ont., has been appointed city engineer of Niagara Falls, Ont., Last week it was erroneously reported that Mr. Black had gone to Owen Sound, Ont., as town engineer.

David H. Fleming, of the city engineer's staff, St. Catharines, Ont., has been appointed town engineer of Owen Sound, Ont. Last week it was erroneously reported that D. T. Black, of Welland, had received the appointment.

E. C. Peterson, formerly Montreal district manager of the Northern Electric Co., Ltd., has organized the Imperial Trading Co. with head office in the Herald Bldg., Montreal. The president of the company is Major G. A. E. Bury, son of Sir George Bury. Before going overseas Major Bury was a barrister in Winnipeg. Mr. Peterson graduated from Iowa State College in mechanical and electrical engineering and become manager of the production department of the Western Electric Co., Chicago, later joining the Northern Electric Co. The new concern will deal in iron and steel and other metals, and in railway equipment and other machinery. One of the features of their business will be the sole agency for Canada of various Oriental products.

OBITUARY

J. B. Buchanan, contractor, of Winnipeg, Man., died of influenza March 13th, aged 60 years. Mr. Buchanan was a native of Brantford, Ont., but had been a resident of Winnipeg since 1884. He was a railroad and bridge contractor and had built parts of the C.P.R. main line.

CANADIAN MINERAL PRODUCTON IN 1918

Mineral production in Canada during 1918 totalled $210,204,970 in value, according to a preliminary report just issued by the Mines Branch, Ottawa. This figure is an increase of 10.8 per cent. compared with the value for the year 1917.

Iron ore shipped from Canadian Mines in 1918 was valued at $863,186, an increase of 13.8% over 1917. The total production of pig-iron in 1918, with a value of $33,000,000, shows an increase over 1917 of over 31%. Steel ingots and steel castings produced during 1918 totalled 1,893,000 short tons, an increase over 1917 of 8.4%.

Portland cement decreased 24.7% in quantity of production and 8.4% in value. Lime decreased 4.5% in quantity, but increased 19.1% in value. Stone decreased 11.3% in value.

Mineral Production in 1918

Materials.	Quantity.	Value.
Portland cement	3,591,481 Bbls.	$7,076,503
Brick, common	171,922 M.	1,915,490
Brick, pressed	38,318 M.	626,311
Brick, ornamental	......	43,442
Brick, sand-lime	16,825 M.	213,680
Building blocks	......	43.087
Kaolin	863 Tons.	19,299
Sewer pipe	......	699,784
Drain tile	19,616 M.	499,135
Lime	6,271 M. Bush.	1,856,819
Sand and gravel	5,685 M. Tons.	1,786,528
Granite	......	645,850
Limestone	......	2,134,283
Sandstone	......	93,042
Fire clay	......	397,458
Slate	933 Sq.	5,124
Fireproofing	27,912 Tons.	224,587