PAGES

MISSING

The Canadian Engineer

WEEKLY

ESTABLISHED 1893

Vol. 15. TORONTO, CANADA, JULY 3rd, 1908 No. 27

The Canadian Engineer

ESTABLISHED 1893

Issued Weekly in the Interests of the

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER AND THE CONTRACTOR.

Editor—E. A. James, B.A. Sc.
Business Manager—James J. Salmond.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	$2.00	One Year	$2.50
Six Months	1.25	Six Months	1.50
Three Months	0.75	Three Months	1.00

ADVERTISEMENT RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto
Telephone Main 7404.

Montreal Office: B 32 Board of Trade Building. T. C. Allum, Business and Editorial Representative. Phone M 2797.

Winnipeg Office: Room 315, Nanton Building. Phone 8142. G. W. Goodall, Business and Editorial Representative

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office by 10 a.m Monday preceding the date of publication, except the first issue of the month for which changes of copy should be received at least two weeks prior to publication date

Printed at the office of The Monetary Times Printing Co., Limited, Toronto, Canada.

TORONTO, CANADA, JULY 3rd, 1908.

CONTENTS OF THIS ISSUE.

IRRIGATION IN WESTERN CANADA.

We have just received the report of the proceedings of the first Irrigation Convention of Western Canada. Although the report is many months old it is still of great interest. Gradually it is dawning on the minds of Canadians the great development in Western Canada that irrigation will bring about. The engineer has looked upon the mountain streams as a source of water power, and the hydraulic engineer has considered these streams as his especial care. In future he will have to divide with the irrigation engineer.

Irrigation enterprises, private and corporate, now completed in Western Canada comprise an area equal to one-quarter of the total irrigated area of the United States. Yet irrigation in Canada is but in its infancy. Almost a thousand miles of ditch, which serve over three million acres of land, is now in operation. The Rockies contain natural reservoirs, streams and lakes, that require only the touch of the irrigation engineer to make them serve the vast semi-arid areas of the Western plains.

Experiments and investigations have been conducted in other countries as to seepage, suitable grades, rate of flow, methods of measuring water, etc. The results of some of these investigations are available and useful to Canadian engineers, but many are not. Differences of climate, soil and service make many of these investigations of little value to our engineers.

Canadian universities should not neglect the problems met with in this work. The Faculties of Applied Science and departments of Physics of our universities may here find a wide field of usefulness not only in laboratory work, but in connection with investigations that must be carried on in the field.

The slope of repose is usually taken as 1½ to 1, yet some clays have a flatter slope, and some may even stand on a steeper slope. The literature on this question for clays and loams of Western Canada is not very complete. The question of weirs and weir flow has been pretty thoroughly discussed, but a satisfactory value, for coefficients in many of the hydraulic formulæ used in calculating discharge, has not been obtained, as, for instance, a reasonable value of the coefficient of rugosity in Kutter's formula.

The question of seepage and drainage, although agricultural problems to a certain degree, are yet questions with which the irrigation engineer must be thoroughly familiar. He must allow for the one and provide for the other. The services of the irrigation engineer will be yearly in more demand in Canada. Our colleges should be equipped so that they might assist in preparing men for this work.

CANAL SURVEYS.

The announcement by the Minister of Canals and Railways that parties were in the field making surveys for a new Welland Canal has suddenly made the whole question of water transportation in Canada a subject of discussion.

A few months ago we expected to learn the policy of the Government in connection with the Georgian Bay Canal, but without any declaration of policy on this route surveys are commenced on the Welland; and it almost looks as if data were required to estimate the cost of the improvement of our present system of canals, and to compare such cost with the cost of the Georgian Bay Ship Canal. We are told that for the present the engineers are looking for a possible 20-foot canal from Lake Erie to Lake Ontario. A canal of this depth between these lakes would be of little value to Canadian transportation unless the other canals of the Great Lakes system were also enlarged. Already there has been spent on the construction of this system close to one hundred million dollars, and maintenance entails an annual expenditure of one and three-quarter million. To convert a 14-foot waterway into a 20-foot would require a dozen years and perhaps another hundred millions of money, and is a public work that must not be undertaken without a most thorough investigation of conditions and possible requirements of this route in future.

The Georgian Bay Ship Canal if constructed would doubtless be more expensive, yet it would be more to the general advantage to Canadian shipping and Canadian trade if we were to have two canal systems connecting the upper and lower lakes, even if one of the systems only had a 14-foot draught.

Neither the building of the Georgian Bay Ship Canal nor the enlarging of the Great Lakes route should be launched as the design of some crafty politician. Canada has not always been fortunate in the success of schemes promoted by politicians. The Trent Valley Canal, although being constructed at a reasonable figure, the engineering features showing good design, and in some instances unusually high engineering ability, is yet a most wasteful use of public funds. Useless as a national waterway, it is now recognized by two political parties as a dangerous tool in the hands of the party in power. Launched and carried forward as a political scheme it has most lamentably failed.

Any scheme for a Georgian Bay Ship Canal or for the enlargement of the Welland Canal must be treated on its merits. The whole matter must be considered from a business man's standpoint. The cost of construction is but one item, the annual charges, which will not diminish, but increase, must not be under-estimated, nor must the advantages of water transportation be over-estimated. The engineering features of these schemes are not difficult. The engineering profession is always pleased when large construction works are successfully under way, but every time that engineers lend their aid to the launching of unwise ventures and speculative projects they not only injure their own professional reputation, but that of their colleagues. Let the question be thoroughly studied, let our Commissions investigate and report before the error has been made—not after.

THE GAS JOURNAL OF CANADA.

Among the newest of our exchanges is the "Gas Journal of Canada," a monthly publication issued by the Gas Journal Publishing Company, of Toronto, Ont. As a Canadian journal appealing to those interested in gas as a source of light, heat and power it will have a field all its own. tI is to be wondered at that this great Canadian industry has been so long without a journal devoted solely to its welfare. In this industry, as in every other, new methods and appliances are continually being brought forward, while the old and long-used are being perfected. With this feature of the industry the "Journal" will especially deal. The news side will not be forgotten, but great attention will be given to the progress of the industry and allied interests.

Simultaneous with the organization of the Canadian Gas Association the "Gas Journal" appears; working together they should be able to do much to improve conditions in the industry which they represent.

EDITORIAL NOTES.

Western Canada sometimes forgets that down by the eastern sea we have an independent Engineering Society. The Nova Scotia Society of Engineers have just concluded their second annual meeting, and their annual report indicates that this year was a successful one. The membership stands at 134, and with a cash balance of almost three hundred dollars the young society commences another year with bright prospects. During the coming year the matter of establishing rooms will likely engage the attention of the members. Permanent headquarters may be secured together with other scientific bodies having headquarters in Halifax.

TO OUR READERS.

If you are coming to Toronto, Montreal or Winnipeg and wish to have your mail forwarded the offices of the Canadian Engineer are at your disposal. Have it addressed to our offices and we will take care of it until you call or ask to have it re-directed.

CORRESPONDENCE

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. Ed.]

GOOD SHOP PRACTICE.

Sir,—In reply to the letter from "Enquirer" in your issue of June 26th in reference to the punching of tube holes in boiler heads. For your enquirer's information I wish to say that it is not only not good practice to punch the tube holes, but it is exceedingly bad practice to do so. This practice was inaugurated many years ago in the United States for the purpose of cheapening or lessening the cost of the manufacturer. Large punching machines were made for punching tube holes. It had a very detrimental effect on the boiler heads, buckling and bending exceedingly. Then the tube holes were out of round on account of this buckling and bending, and the heads would afterwards have to be straightened and the holes reamed out, and the cost would be practically about the same as if the holes had been bored or drilled in the first place. It is not only bad practice to punch the tube holes, but it is bad practice to punch any of the holes in the boiler plates and in first-class shops very little punching is done in any part of the steam boilers, and particularly for high pressure.

It is after 42 years practical experience in boilermaking and boiler-building that I have arrived at this conclusion.

Yours truly,

Polson Iron Works, Limited,

JOHN J. MAIN,

Vice-President and Manager.

Toronto, June 25th, 1908.

GOOD SHOP PRACTICE.

Sir,—In reply to inquiry as to whether "it is considered good shop practice to punch the tube holes in the boiler heads," etc., I would say it is not good practice to punch the holes in any boiler heads unless sufficient metal is left for reaming out all that in which the particles have been disturbed by the punching. If this amount has been left it is quite allowable in sheets up to say 5-16-inch thick for small tubes to punch the holes as a first operation provided again the punch and die are in first-class condition, and the punching in no way distorts the metal by bending, etc., the bridges between the tubes. The amount of metal necessary to leave for reaming depends entirely on the condition and sizes of the punch and die. The metal found by careful observation and test to be disturbed by punching in a 5-16-inch sheet extends when punches and dies are in first-class order to 1-32-inch outside the edge of die, therefore not less than 3-32-inch should be left all round for reaming or for a two-inch tube the hole punched should not be greater than 1 13-16-inch. It will be seen, however, that the above shows dependence on several conditions and unless the very greatest care and conscientious practice is exercised in keeping up the tools to first-class condition it would not be good shop practice to punch the tube holes as above described. The question may, however, be answered by saying that where good shop practice is followed in care and maintenance of tools the punching as above may be classed as safe practice but where tools are not kept up it would not be safe practice.

Toronto, June 23rd, 1908.

J. W. H.

GARBAGE DISPOSAL.

Sir,—The matter of garbage destruction is a live one in every city. Seattle has experimented with the question for some time, and thinking that your readers might be interested in our experiences I send you a few observations on this matter.

The burner which we have cost something in excess of $50,000. It is burning 60 tons of garbage at the present time. The trouble is that our city engineer, Mr. Thompson, (whom I consider to be a man of absolute honesty and great ability in certain lines, (though not in the garbage burning line), insisted that the burner would burn, without fuel, 60 tons a day at a cost of not to exceed 35 cents per ton. Upon this statement he and the then mayor succeeded in forcing on the city this Meldrum Burner. The lowest cost at which they have yet been able to burn garbage has been 79 cents per ton. The crew was put on, I believe, as employees of the street department, the superintendent being paid but $85 per month (and having already served notice to quit, unless he is raised to $125). The work has constantly been in charge of the assistant city engineer, who has been paid a large salary, but whose salary is not charged against the expense of the crematory. It is reasonable to say that it will cost $1 per ton to burn garbage of this class which is at present being burned in the crematory. It is located in a district which is being fed from the retail store district of the city, largely, and from my observation the forenoon garbage is 95 per cent. dry goods, boxes and paper. None of the city's heavy garbage goes into it at present. It requires a large crew of men—I believe six stokers all the time, a foreman and some sorters. The way they are doing it is to take the morning garbage, where it is put out in large piles to offend the public, sort it over and pick out the wood and fuel. Then in the afternoon, when the wetter garbage comes on, the fuel in the morning collection is used to make the afternoon fire. It was necessary to dump the grates several times in the course of a day's burning, necessitating the going out of the fires in those particular cells.

While I personally know little of garbage burners, save what I have read, it must be apparent to anyone that, as a source of steam supply, they are valuable only for what they will produce at the minimum heat of the burners. This, of course, is liable to become very low under a supply of wet garbage.

My own objection to the Meldrum Burner in the first place was based upon the failure at Sacramento, at California, which was complete, it having been found necessary to install oil burners in the furnaces, and I am informed that they have proved worthless.

I am satisfied that, if this burner which we have were to be placed in a position where it became necessary to handle the average city garbage, it would not burn at all without fuel. I have just returned from Spokane, where they are running a Decarrie plant, and installing another. They are burning there at a cost of less than 20 cents a ton. They have a 40-ton burner, which has been in use about six years. They start in the morning with a little fuel and from then on it is self-burning, and the 20 cents includes the cost of the fuel. It possesses the great advantage that all garbage is dumped through a trap door immediately into the burners, and there is no nuisance of a garbage pile, which must always accompany the Meldrum. While I am not seeking to advance any particular burner, it appears to me that this is one great advantage. The ash-heap surrounding the Spokane burner for six years' continuous service is to-day less than the ash heaps surrounding ours for three months' service. The Spokane people tell me that it is impracticable to figure upon any garbage burner as a source of steam supply, by reason of the extreme fluctuation of heat caused by the wet garbage, and this, it seems, must be apparent to any of us.

I wish it distinctly understood that I do not dispute the fact that the Meldrum burner here does not burn 60 tons of garbage per day, but I have always insisted that the same thing could be done with parlor matches and enough ground if expense did not enter into the consideration. The trouble with the Meldrum burner is the extreme cost of operation.

If a cabbage is delivered at the burner here, no pretense is made of burning it. It is placed either on top of the furnaces or in the sun to dry out for weeks, before put in. In order to get through with a given amount of garbage, the suspension over the grates must be so short that nothing but highly inflammable materials can be put through.

Any further information I can give you I will be glad to furnish.

Yours very truly,
H. C. Gill.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

4850—June 10—Authorizing the Silica Brick & Lime Co. to construct trestle over the right of way and line of railway of the Esquimalt & Nanaimo Railway at a point 474 feet east of the 7th mile post from Victoria station, B.C.

4851—June 16—Approving location of C.P.R. Virden-McAuley branch, mileage 5 to 16.5.

4852—June 16—Authorizing the C.P.R. to construct a branch line or spur from a point of its main line, on Lot 71, Concession 2, N.D.R., at mileage 28.84, thence in a north-westerly direction across Lot 70, Concession 2, north, across road allowance between Concessions 2 and 3, and across Lots 70 and 69, Concession 3, north, to a point on Lot 68, Concession 3, N.D.R., County of Bruce, Township of Brant.

4853—June 16—Granting leave to R. A. Darling, of Sheho, Sask., to erect, place and maintain his telephone wires across the tracks of the C.P.R. at a point on north line of Section 9, Township 30, Range 9, west of second meridian.

4854—June 11—Authorizing the C.P.R. to open for the carriage of traffic its Sudbury-Kleinburg branch from mileage 92.5, at Bala, to mileage 127.5, at Parry Sound, and from mileage 189, at French River, to mileage 226 at Romford.

4855—June 11—Authorizing the C.P.R. to open for the carriage of traffic that portion of its Sudbury-Kleinburg branch from mileage 127.5 at Parry Sound to mileage 189 at French River.

4856—June 2—Authorizing the C.P.R. to construct spur to the premises of the Sherwin-Williams Paint Company in the city of Montreal, P.Q.

4857—June 2—Authorizing the C.P.R. to construct a branch line from its South Bank branch on St. Patrick Street, **across the same,** and along Atwater Avenue to a point of connection with the private siding of the Sherwin-Williams Paint Company.

4858—June 17—Approving by-law of the New Brunswick Southern Railway for the carriage of traffic on its lines of railway.

4859—June 16—Amending Order of the Board No. 4752, dated the 14th of May, 1908, so as to provide for the installation and operation by the National Transcontinental Railway of home signals where the same crosses the C.P.R. (N.B. So. Ry.) near Theriault Street North, County of Madawaska, N. B.

4806—June 16—Granting leave to the National Transcontinental Railway to cross with its line of railway the several existing highways, between mileage 190 and 241 of the said railway, and within Townships 10 and 11, Ranges 3 to 13, east of the princ. meridian, in the municipality of Springfield and Whitemouth, Province of Manitoba.

4861—June 16—Authorizing the Montreal Street Railway Company to operate its cars over the tracks of the C.P.R. at the intersection of Papineau Avenue, Montreal, P.Q.

4862—June 2—Authorizing the C.N.Q. Ry. to cross with its line of tracks the tracks of the C.P.R. east of Lorette, at a point on Lot No. 2375 in the parish of St. Sauveur, P. Q., between mileage 0 and 1 of the Q. Lake St. John Railway Junction Spur.

4863—June 2—Granting leave to the Ontario Power Co. of Niagara Falls to erect, place and maintain its electric wires across the track of the G.T.R. near the town of Welland, Ontario.

4864—June 16—Amending Order of the Board No. 4667, dated the 16th of April, 1908, authorizing the C.P.R. to construct its railway across the road allowance on its Pheasant Hills' branch at mileage 423.0, by striking out the figure "24" in the first line of page 5 of the said order, and inserting in lieu thereof the figure "8."

4865—June 2—Ordering the C.P.R. to remove the barbed-wire or other obstruction placed across or in the vicinity of the crossing over the Atlantic and North-Western Division of its railway connecting Crescent Avenue and Fenwick Avenue in the town of Montreal West, P.Q.

4866—June 16—Directing the Montreal Terminal Railway Company to file its standard freight and passenger tariffs for the approval of the Board, within thirty days of the date of this Order.

4867—June 17—Authorizing the C.P.R. to construct bridge No. 2013 on the Soo branch of the Lake Superior Division of its line.

4868—June 17—Authorizing the York & Carleton Telephone Company to erect, place, and maintain telephone wires across the right of way and tracks of the C.P.R. at Green Road in the County of Carleton, Province of New Brunswick.

4869—June 17—Authorizing the York & Carleton Telephone Company to erect, place, and maintain telephone wires across the right of way and tracks of the C.P.R. at Debec, in the County of Carleton, N.B.

4870—June 17—Authorizing the York & Carleton Telephone Company to erect, place, and maintain telephone wires across the right of way and tracks of the C.P.R. at Hodgsden, in the County of Carleton, N.B.

4871—June 17—Authorizing the C.P.R. to re-construct bridge No. 2.28 on the Woodstock section of the Atlantic division of its railway.

4872 June 17—Authorizing the C.P.R. to re-construct bridge No. 53.7 on the Gibson branch of the Atlantic division of its railway.

4873—June 17—Authorizing the C.P.R. to re-construct bridge No. 54.0 on the Woodstock section of the Atlantic division of its railway.

4874—June 17—Authorizing the C.P.R. to construct bridge No. 47.9 on the E. & N. section of the Pacific division of its line of railway.

4875—June 17—Authorizing the C.P.R. to construct bridge No. 33.02 on the Nominingue extension of the Eastern Division of its line of railway.

4876—June 17—Authorizing the C.P.R. to construct bridge No. 87.62 on the Soo branch of its Lake Superior line of railway.

4877—June 17—Authorizing the C.P.R. to construct bridge No. 53.7 on the Woodstock section of its line of railway.

4878—June 17—Authorizing the C.P.R. to re-construct bridge No. 101.2 of the Swift Current Section of its line of railway.

4879—June 17—Authorizing the C.N.Q. Ry. to take part of Lot No. 448, in the parish of St. Stanislas, County of Champlain, Province of Quebec.

4880—June 17—Amending Order of the Board No. 4766, dated the 27th of May, 1908, by extending the time within which to instal the electric bell at the crossing of the C.P.R. at Dorchester Street, Quebec, P.Q., from the 1st of June to 1st of July, 1908.

4881—June 12—Authorizing the corporation of the village of Papineauville, County of Labelle, Province of Quebec, to construct a street across the tracks of the C.P.R. between Papineau Avenue, No. 122, of the Cadastre of the parish of Ste. Angelique, and Lots 103, 98, and 99 of the said Cadastre.

4882—June 17—Approving location of the Brandon, Saskatchewan & Hudson Bay Railway Company's station in the City of Brandon, Man.

4883—June 17—Dismissing complaint of J. A. Charette, M.S., Mayor of Notre Dame des Neiges, against the Montreal, Park & Island Railway regarding failure of the said company to file its Standard Passenger Tariffs.

4884—June 17—Ordering the re-classification of military freight tariffs with reference to field guns, ambulances, and projectiles for artillery; classification to be published in a separate supplement to the Canadian Classification No. 13, to take effect not later than July 15th, 1908.

4885—June 18—Approving location of the Quinze & Blanche River Railway Company through part of the Township of Guigues, in the Province of Quebec, across Quinze River, through the adjoining Indian Reserve, Township of Nedelec, and through the Townships of Casey, Harley and Dyment, Province of Ontario, to New Liskeard, covering mileage of 18.77; also rescinding Order of the Board No. 4782, dated the 2nd of June, 1908, approving location of Quinze & Blanche River Railway.

4886—June 16—Ordering the C.P.R. Company to give the British Columbia Sugar Refining Company the same rate on sugar from Vancouver to Portage la Prairie as it gives from Montreal to Portage la Prairie, and the same rate from Vancouver to Winnipeg as it gives from Montreal to Brandon, and the same rate from Vancouver to Brandon as it gives from Montreal to Winnipeg.

4887—June 18—Authorizing the C.P.R. to construct and operate a branch line in the city of Calgary, Alta., commencing from a point on the southerly boundary of the station grounds, thence in a south-easterly direction across 10th Avenue, 6th Street West, and Lots 1, 2, 3, 4, and 5, block 68, Calgary to a lane between 10th and 11th Avenues, thence in an easterly direction along said lane and across 5th Street West, 4th St. West, and 2nd Street West to a point 100 feet westerly from the westerly limit of 1st Street West.

4888—June 18—Granting leave to the G.T.P. Ry. to operate that portion of its line from a point opposite Saskatoon, Sask., to Scott, Sask., a distance of about 115 miles, for the purpose of moving a party of settlers between the said points.

4889—June 17—Directing the C.P.R. to install interlocking plant with derails where its railway crosses the tracks of the G.T.R. in the village of Lennoxville, P.Q., as per Order of the Board No. 4754, dated the 12th of May, 1908, also rescinding Order of the Board No. 4633, dated the 15th of April, 1908, authorizing the C.P.R. and G.T.R. to operate their trains over this crossing without being brought to a stop.

4890—March 17—Granting leave to the corporation of the city of Peterborough to construct, at its own expense, a highway as a continuation of George Street in the city of Peterborough, across the lands and track of the main line of the 8th district of the G.T.R.

4891—June 19—Directing the C.P.R. to construct and maintain a suitable crossing where its line intersects the road allowance between Ranges 15 and 16, Township 18, west 2nd meridian, Saskatchewan.

4892—June 9—Granting leave to the Malahide & Bayham Telephone Co-operative Association, Limited, to erect, place and maintain its wires across the track of the C.P.R. in the village of Eden, Township of Bayham, Ontario.

4893—June 9—Granting leave to the Provincial Light, Heat & Power Company to erect, place and maintain a 44,000 volt transmission line over the right of way of the Montreal, Park & Island Railway at a point one-half mile east of the Rockfield station of the G.T.R., Province of Quebec.

4894—June 19—Granting leave to the Western Canada Cement & Coal Company to erect, place and maintain telephone wires across the tracks of the C.P.R. at Exshaw, Alta.

4895 to 4901 (inclusive)—June 19—Authorizing the Bell Telephone Company to cross with its telephone wires the tracks of the Grand Trunk and Canadian Pacific Railways at various points in Ontario.

4895 to 4901 (inclusive)—June 19—Authorizing the Bell four months of date of Order, an electric bell with automatic cut-off, at the intersection of the G.T.R. with Main Street, Forest, Ontario.

4903—June 19—Authorizing the Bell Telephone Company to cross with its wires the tracks of the G.T.R. at Queen St. West, Ottawa, Ontario.

4904—June 23—Authorizing the C.P.R. to construct bridge over the Old Man River on the Western Division of its line of railway.

4905—June 23—Authorizing the New Brunswick Telephone Company to erect its wires across the tracks of the C.P.R. at Green Road, County of Carleton, N.B.

4906—June 23—Authorizing the C.P.R. to reconstruct bridge No. 3.8 on its Moose Jaw section.

4907—June 23rd—Authorizing the New Brunswick Telephone Company to cross with its wires the tracks of the C.P.R. at road one and a quarter miles north-west of Siegas, N. B.

4908—June 23—Authorizing the C.P.R. to open for the carriage of passenger traffic that portion of its Pheasant Hills branch between Saskatoon & Lanigan, 17.9 miles.

4909—June 23—Authorizing the C.P.R. and C.N.R. to operate their trains over crossing near Lachevrotiere, P.Q., without being brought to a stop.

4910—June 24—Authorizing the C.P.R. to construct a spur to the premises of the Western Canada Cement & Coal Company, Mitford, Alta.

4911—June 23—Authorizing the C.P.R. to put into operation the interlocking plant installed upon the Lachine Canal Bridge, near Highlands, P.Q.

4912—June 4—Authorizing the G.T.R. to take certain lands at Jordan station, Ont., for the purpose of enlarging station grounds at that point.

4913—June 24—Authorizing the Ontario Power Company of Niagara Falls, Ontario, to erect, place and maintain its transmission line across the track of the M.C.R.R. west of its distributing station in the Township of Stamford, Ont.

4914—June 24—Authorizing the Ontario Power Company of Niagara Falls, Ontario, to erect, place and maintain its transmission line across the land and tracks of the M.C.R.R. between Concessions 6 and 7, Lot 23, Township of Crowland, Ontario.

4915—June 24th—Authorizing the Ontario Power Company of Niagara Falls, Ontario, to erect, place and maintain its transmission line across line and track of the M.C.R.R. between Lots 22 and 23, Concession 6, Township of Crowland, Ont.

4916—June 24—Authorizing the city of Brantford, Ont., to lay an 8-inch water main, or pipe, under the tracks of the G.T.R. at Jex Street.

4917—June 24—Authorizing the C.P.R. to construct spur to and into the premises of Manassah-Webber, Didsbury, Alta.

4918—June 24—Authorizing the C.P.R. to construct a spur to and into the premises of the Great West Coal Company, Limited, on north-east quarter of Section 29, in Roche Percee, Sask.

4919—June 24—Authorizing the C.P.R. to construct spur to and into the premises of Shearer, Brown & Wills, Montreal, P.Q., cancelling Order No. 4847, June 2nd, 1908.

4920—June 2—Authorizing the Georgian Bay & Seaboard Railway to cross the tracks of the Lindsay, Bobcaygeon & Pontypool Railway in the town of Lindsay, Ontario.

The securing of suitable material and suitable construction for culverts and waterways has always been a difficult question. The Winnipeg Metal Culvert Company, Merchants Bank Building, Winnipeg, offer as a solution their corrugated galvanized metal culverts. These culverts have been in use for fourteen years in the United States, but it is only recently that they have been introduced into Canada. Long use has demonstrated that they will not rust, crack, break or burn. In price they vary from $1.25 per foot for 12-inch culverts to $8.90 per foot for 72-inch. There is a minimum amount of work in handling them,—they are shipped already for placing; they can be hauled like saw logs. All the work required, is to dig a trench, place culverts, and cover with earth.

THE WATERWORKS OF SOUTH WALES AND THE WEST OF ENGLAND.

The source of the water supply of South Wales and the West of England is really the south-west wind that blows over that area for a large portion of the year. It arrives on the coasts of the counties of South Wales, and of Somerset, Cornwall, Devon and Dorset in the West of England after traversing a large extent of sea, from which it has absorbed a large quantity of moisture. It also arrived usually at a moderately high temperature. It is the warm wind of the district, very much as the "Chinook" is of Western Canada. It will be remembered that the capacity of atmospheric air for absorbing moisture varies with the temperature, increasing very rapidly with increased temperature. Thus, at 40 degs. each cubic foot of air can absorb three grains of moisture; at 60 degs. it is able to absorb six grains; at 80 degs. eleven grains. On the arrival of the south-west wind on the coast it commences to get rid of its moisture, and it is very instructive to note the way in which the rainfall of the district follows the course of the wind and the elevation of the country. Mr. R. H. Wyrill, the Swansea waterworks engineer, has traced the effect of the rise of the country in the path of the wind in a very interesting manner. At Swansea the average annual rainfall is 40 inches; at Morriston, a little higher up, a suburb of Swansea, it is 45 inches; at Ystalyfera, some miles inland and at a considerably higher elevation, the average annual rainfall is 62 inches. Still higher, at Nantyrwydd, it is 75.15 inches; at Bwlch it is 112.9 inches. From this point, which is the highest in the watershed, the rainfall begins to decrease. At the Cray reservoir, No. 1, of the Swansea waterworks, it is 75.69 inches; at Cray No. 2 it is 71.78 inches; at Maescarnog it is 68.11 inches; at Brecon it is 48.5 inches, and at Hereford it is only 30.0 inches. It should be explained that in going to the places named above we are receding from the coast at Swansea. We are ascending until we reach what is called the pass or saddle of the Bwlch, and then we begin to descend, still receding from Swansea, and gradually descending until we reach the comparatively low-lying land of Hereford.

The writer has given the above figures, as it appears to him to illustrate the matter so well. The moisture-charged south-west winds meet the hills in their track and become cooled by contact with them, the heat of the air being abstracted by the colder ground of the high lands, and the winds are gradually cooled, and are made to deliver up more and more of the moisture they have carried. After passing the highest elevation, where presumably they have been cooled to the greatest extent, they begin to get warmer, owing to the sheltering action of the mountains over which they have passed, and also having been so largely deprived of their moisture in their passage over the highest portions of the mountains they have not as much to part with, and hence the deposit becomes less and less, and with it the rainfall. The same thing rules pretty well upon every part of the coast, and the whole configuration of the coasts of South Wales, of Somerset, Devon and Cornwall, though varying very much from point to point, has a great similarity. The mountains of South Wales are very much higher, and extend very much farther back than the hills of Somerset and Devon, but there is the same action going on. The hills of Somerset and Devon trap the moisture of the south-west winds, just as the mountains of South Wales do. The hills of Somerset and Devon, however, not extending so far back as the mountains of South Wales, the south-west winds are able to pass over them without the same deposit of moisture as rules in South Wales, and hence the gathering grounds for the cities and towns of the western English counties and those a little inland are not as good as those for the Welsh towns. So much so is this, in fact that one of the largest cities of the Midland counties, Birmingham, has brought its water from the Welsh mountains, just at the back of the district mentioned, the Bwlch, where the rainfall is so great.

Methods of Collecting the Water for the Towns.

There are two methods employed, both in South Wales and in the Western English counties, for collecting the water by making use of the springs that are formed in the higher grounds, and sometimes in the lower grounds, and by damming up one or more valleys and collecting the whole of the water which falls upon the hills opening on to the gorge that is dammed, and thereby creating a reservoir. For the reservoirs of Bath springs are almost entirely used, and for the earlier reservoirs of Cardiff springs were also largely employed. In the high lands above Bath there are two sets of springs, one set at a high level, and another at a considerably lower level. The surface of the ground in the neighborhood of Bath is largely covered by the Oolite formation, the Bath stone, for which the district is famous, and of which large quantities are employed in building. The Oolite formation is an exceedingly porous rock. It is stated by geologists to have been formed by the action of marine animals, who lived in enormous numbers, myriads, and who dies on the spot, and it is their carcasses which go to form the porous mass. On the high ground around Bath, under the Oolite formation, is a layer of the substance known as fuller's earth, which is able to arrest the water which is deposited on it in rainy seasons for a certain time, but is not able to retain it permanently. Some distance below the fuller's earth is the lias formation, a close and almost impervious clay, which retains a very large portion of the water that descends to it from the higher ground. In rainy weather the water descending upon the downs around Bath is first arrested by the fuller's earth formation, and the springs which rise from that are then very prolific for a short time. Shortly afterwards the fuller's earth allows the bulk of the water to pass onwards, and it is trapped by the lias clay lower down. Instances of the difference in the delivery of water from the higher springs will be interesting. One of the springs on one of the higher downs, immediately after rainy weather, will deliver as much as 1,000,000 gallons per day, and shortly afterwards will only deliver about 7,000 gallons per day. Another spring on the high downs varies from 230,000 to 300,000 gallons per day. The lower springs also vary in the quantity of water they deliver, but they are very much more reliable and very much more uniform than the higher springs. They can practically always be depended upon for a certain quantity, except in dry seasons.

In the neighborhood of Bath, however, the variability in the rainfall has obliged the corporation to establish reservoirs, which are really what their name implies, and not what the other class of reservoir really is, a gathering tank. The Bath Corporation have two or three reservoirs, one in particular having a capacity of 51,000,000 gallons, and occupying a water area of nine acres, but it is only drawn upon when the springs fail.

Another perhaps interesting point in connection with the distribution of water to consumers in Bath and its neighborhood is the fact that for several of the districts supplied the water has to be pumped to distributing tanks. The city of Bath and its suburbs occupies a somewhat peculiar position, from the point of view of the waterworks engineer. The city of Bristol occupies a somewhat similar position. The business portion of the city occupies the lower ground in the neighborhood of the river, but the residential portion and some of the limited manufacturing portion in Bath has climbed up through the many valleys opening out of the main valley through which the river passes and right up on to the down above, which are from 500 to 700 feet above sea level. The storage tanks into which the springs deliver are generally a long way below the elevation of the higher parts of the suburbs, and, therefore, the water from some of the springs is pumped to what are practically service tanks, at sufficient elevation to supply the districts at the high elevations by gravity.

The total yield of the springs from which the Corporation obtain their supply ranges from 1,500,000 gallons per day as a maximum to 1,116,000 gallons per day as a minimum. The average daily consumption is about

1,500,000 gallons, or 21.71 gallons per head per day. The reason for the reservoir of 51,000,000 gallons mentioned above and the smaller reservoirs will be apparent when it is remembered that dry seasons sometimes come two or three together. The consumption per head, 21.71 gallons per day, includes water used for trade purposes. The writer understands that the average consumption for domestic purposes is about 20 gallons per head per day. Bath is not a manufacturing town, though there are a few manufacturers in it, and, therefore, the trade consumption is small, the only trade consumption of any consequence being for hydraulic lifts, of which there are fairly large numbers, considering the size of the town.

The writer is indebted to Mr. Jules Dent Young, the waterworks engineer of Bath, for the information with reference to the Bath supply.

One point that may be noted with reference to the Bath water supply is, it is very hard. Naturally, its passage over the limestone formation brings this about. No filters are employed, the earth through which the springs percolate acting as filters, and very efficient ones.

Cardiff Waterworks.

The development of the waterworks supplying Cardiff and the district is exceedingly interesting. For a number of years Cardiff grew almost as quickly as so many Canadian and American towns have. From the time when it was discovered that the coal in the Welsh hills had such a high commercial value, the expansion of the town went on by leaps and bounds. Every census found its population at least doubled. The coal within a certain radius of Cardiff was quickly leased on royalty, and, as a large portion of the mineral rites belonged to the Marquis of Bute, who was largely instrumental in the development of Cardiff itself, there was a clause in all the mineral leases issued by the Bute estate office, obliging the lessees to ship a certain proportion of their coal at Cardiff. The Cardiff docks were the earliest of any consequence in the district, and they were added to gradually from time to time, and their existence also tended to draw the coal from the other collieries, of which the Marquis of Bute was not the lessor, and hence the development of Cardiff. In the early days of Cardiff the water was obtained very largely from springs. The successive Acts of Parliament which were obtained by the Cardiff Corporation and the company which floated them enumerate the acquisition of the right to impound the water of the different rivers emptying themselves at Cardiff and of a large number of streams, springs, etc., which found their way into the rivers. The springs from which the early supply was obtained were in the neighborhood of the River Ely, and the supply was obtained by building culverts of brickwork, with open joints on the top and sides, through which the water percolated into the culverts from the springs and from the natural drainage of the ground. The water ran through the culverts into a pump well, from which it was pumped to a reservoir a little above the town, from which again it supplied the town by gravitation. These springs are still available for the supply of the town if required, and they furnish about 1,500,000 gallons per day in wet weather and 800,000 gallons per day in very dry weather. The water from these springs, however, is very hard. Later on, as the town extended, reservoirs were constructed a little farther out and at a little bit higher elevation, and this went on for some years, unil it being apparent that the extension of the town might go on almost indefinitely, and it being also apparent that other towns in the Midlands and elsewhere were looking to the Welsh mountains for possible supplies of water, it was determined by the Cardiff Corporation to secure Parliamentary powers, giving them a sufficient supply for practically all time. For that purpose powers were taken to construct three reservoirs, one above the other, in the neighborhood of what are known as the Brecon Brecons, and in the area from which the principal rivers draining Glamorganshire and Monmouthshire take their rise. The upper reservoir is thirty-five miles distant from Cardiff, and the fall is such that if the balancing reservoirs mentioned below were not supplied the pressure at which the water would arrive in Cardiff would be very high. The highest is the Beacons reservoir, which has a capacity of 345,000,000 gallons, the top water area being nearly fifty-two acres, and the top water level being 1,340 feet above Ordnance Datum. The depth of water in the reservoir when full is fifty-two feet.

The second reservoir, known as the Cantreff, has a capacity of 323,000,000 gallons, its top water area measures forty-four acres, and the top water level is 1,073 feet above Ordnance Datum, and the depth of water when full is seventy-three feet.

The third reservoir, which has not yet been constructed, but for which powers have been obtained, will have a capacity of 906,000,000 gallons; its top water area will cover one hundred acres; the top water level will be 840 feet above Ordnance Datum, and the depth when full will be sixty-five feet.

It is, perhaps, interesting to note that it was found impossible to construct the Cantreff reservoir, the first of the three to be taken in hand by contract. Two contractors failed to complete, and it was finally constructed under the direct supervision of the engineer, the total time occupied being six and a half years. The Beacons reservoir, the second to be carried out, was constructed under the direct supervision of the engineer, and it occupied about four years in construction.

The Corporation of Cardiff have to allow 7,750,000 gallons per day compensation water to riparian owners and tenants on the River Taff and its numerous tributaries. The water from the three upper reservoirs is delivered to the reservoir at Llanishen, which is just outside, and practically a suburb of Cardiff, by conduits, with balancing reservoirs, to be described below, on the way. There are three balancing reservoirs, as they are called, roughly dividing the fall between the Cantreff reservoir and the Llanishen reservoir into four sections. The balancing reservoirs have a capacity of 500,000 gallons, and the top water levels are respectively 782 feet, 505 feet and 330 feet above Ordnance Datum. The delivery pipe from the Cantreff reservoir to the first balancing reservoir is 24 inches in diameter, from there to the last balancing reservoir it is 29 inches in diameter, and from the lowest balancing reservoir to the Llanishen reservoir, the reservoir supplying the city and district, it is 24 inches again. The pipes were designed for a capacity of 12,000,000 gallons per day, but owing to incrustation they will now only deliver 9,000,000 gallons per day. There are the usual scour pipes, air valves, regulating valves at different points.

The arrangement of the balancing reservoirs is as follows: The water runs from Cantreff reservoir into the first balancing reservoirs at Cefn. When Cefn reservoir is full, the water runs from it to the second reservoir, Blackbrook. When Blackbrook reservoir is full, the water runs from it to the third reservoir, Rhubina, and when Rhubina is full, the water runs into the Llanishen reservoir.

The Llanishen Reservoir.

As mentioned above, the Llanishen reservoir is just outside of the city of Cardiff, in the village of Llanishen, which is now practically a residential suburb of Cardiff, though not included within the city boundaries proper. The capacity of the Llanishen reservoir is 317,000,000 gallons, its top water area being nearly sixty acres. Water is delivered from the Llanishen reservoir to the city of Cardiff by pipes 26 inches in diameter. The supply pipe from Llanishen is joined outside of the Llanishen reservoir by a pipe from Lisvane, an earlier reservoir, the water from both being carried to the filters at the Heath, a spot lying between the Llanishen reservoir and the city. The land taken for the purpose of filtering the water from the Llanishen and Lisvane reservoirs at the Heath is nine acres in area, the filter beds having a capacity of 1,250,000 gallons per day. The trunk mains from the Heath filter beds to the city are 30 inches and 15 inches in diameter. At each of the balancing reservoirs there is a caretaker's cottage and bye-pass mains, connecting the supply pipes above and below. The caretakers at each of these reservoirs are required to walk over the line twice weekly and report to the engineer as to any interference, leakage, etc.

With the increase of the town and the overflow of the residential parts on to some of the higher ground in the rear difficulties arose as to the supply of water to some of them, and for that purpose special arrangements were made. At Rhubina filter beds having a capacity of 1,000,000 gallons per day were laid down, and two power water service reservoirs, with a capacity of 660,000 gallons, together with one open and one covered storage reservoir, having a total capacity of 2,200,000 gallons. Another reservoir was constructed at Penylan, one of the higher residential districts, just outside of the city, with a capacity of 3,000,000 gallons, its top water level being 213 feet above Ordnance Datum, and a water tower was also fixed in connection with the reservoir, the tank in the water tower having a capacity of 14,000 gallons, and being fifty feet above the reservoir. The Penylan reservoir is filled from the Rhubina storage reservoir by gravitation, and the combined storage at Rhubina and Penylan is about 6,000,000 gallons, sufficient to last the high level district supplied by it for twelve days at the average rate of consumption, or from nine to ten days in a very dry summer.

A similar arrangement was made for supplying the higher parts of Penarth, another residential suburb of Cardiff, by the construction of a high-level reservoir at Llandough. The capacity of the reservoir is 2,000,000 gallons, its top water level being 300 feet above Ordnance Datum. This reservoir is supplied at present by pumping from some of the lower levels in the district, which are supplied by springs, etc., from some of the earlier works, but it is intended later on to supply it by gravitation from Rhubina.

A bye-pass main has been constructed from the supply conduit, leading from above into the Llanishen reservoir to the Heath filters so as to keep the filters going when the Llanishen reservoir is being cleaned out, the supply from the Lisvane reservoir not being sufficient, with the increased consumption, to provide for the city. The total area supplied by the city of Cardiff Corporation Waterworks is 30,148 acres, and the total population supplied is estimated to be about 222,000. In addition to the city of Cardiff itself the rival shipping port of Barry, which has grown up almost alongside of Cardiff, and which is included for Board of Trade purposes, within the port of Cardiff, is also supplied, as well as Penarth, which is a residential suburb, and also a rival shipping port, it having a comparatively large dock, owned and worked by the Taff Vale Railway Company. In addition to this, a number of the surrounding villages are supplied. The total length of mains, including trunk and distributing mains, is about 240 miles. The total quantity of water consumed during 1907 was 2,176,000,000 gallons, and the average consumption per head of population per day for all purposes is 27.34 gallons, over 11 gallons per day being for trade purposes.

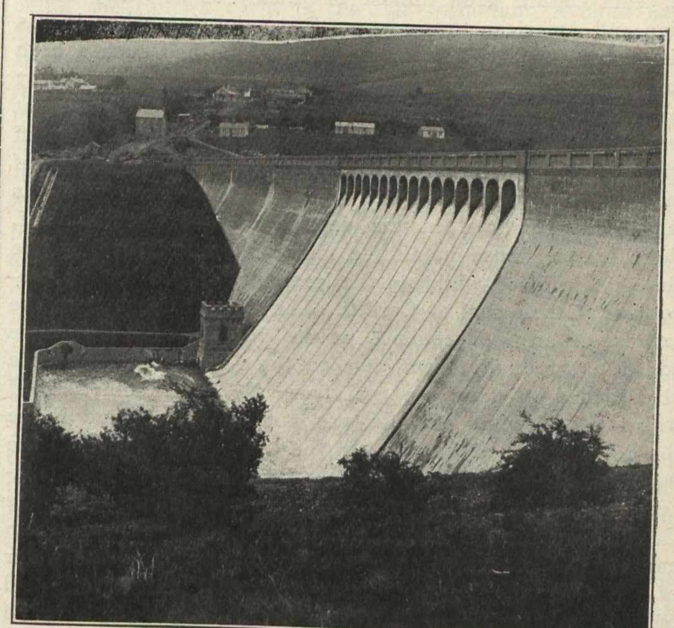
The writer is indebted to Mr. C. H. Priestley, M.I.C.E., Corporation city waterworks engineer, for the information contained in the above and for the maps which accompany.

Newport Waterworks.

The history of the Newport (Mon.) waterworks illustrates once again the difficulties that so frequently arise in carrying out undertakings of the kind. There is such a large element of uncertainty in the work that has to be done in the formation of reservoirs. Newport derives the whole of its water from a large reservoir, having a total drainage area of 1,604 acres, and the reservoir has been formed in the usual way, by damning up the entrance to two valleys. The reservoir has a capacity of 370,000,000 gallons. It is ninety feet deep, and the water surface has an area of about forty acres. The top water level is 450 feet above Ordnance Datum. The dam is of earth, built up in layers, and almost entirely with materials procured from the bed of the reservoir. The reservoir is constructed on the old red sandstone formation, which, when the trench was opened to construct the puddle wall for the dam, was found to be much broken up and fissured to a considerable extent and to a great depth, the reason apparently being that the carboniferous limestone comes to the surface a short distance below the dam. In building the dam a trench was sunk of different widths and of depths varying from 82 to 190 feet, the lower part of the deeper portion being filled with concrete, while the upper part is filled with clay puddle.

It was owing to the fissures and the peculiar condition of the old red sandstone formation mentioned above that the difficulty arose in constructing the reservoir by contract. A contract was made in the first instance with a Glasgow firm for the sum of £94000 odd, but when the disturbed character of the strata was disclosed the contract was terminated and the whole thing was rearranged and put under the supervision of a London specialist, the whole thing being then carried out at the expense of the Corporation under his supervision. The total amount expended on the waterworks by the company who originally owned them and by the Corporation who took them over is £400,000.

There are two smaller reservoirs a little distance from the main Llanvaches reservoir, the smaller reservoirs being connected with the larger one by tunnels. The tunnels and brick culverts, which connect the smaller reservoirs with the larger are also driven through the old red sandstone rock, and the work was done largely by blasting with the aid of rock drills driven by compressed air.



Swansea Reservoir.

The main reservoir has a valve tower 116½ feet high. The water is drawn into the tower by six inlets, each controlled by a balance valve on the outside of the tower and an ordinary sluice valve inside. Each inlet has a copper screening chamber, with washout pipes and valves. Valves are also provided within the tower for controlling the compensation water and the supply of water to the town. The outlet from the valve tower consists of a culvert of six feet internal diameter, which passes from the tower under the embankment, and contains two lines of 18-inch cast-iron pipes. Candy's polarite pressure filters to to be fixed below the reservoir, and beyond there a Venturi meter is fixed, with a continuous registering apparatus.

In all British waterworks the question of compensation is a most important one. Wherever springs are taken or drainage areas or streams, there are always users of the water to be taken who have rights in them, and Parliament only allows the water required by the Corporation to be used conditional upon its supplying the owners with a sufficient quantity to perform whatever requirements they have and can show what they have been using the water for. The Newport Corporation have to supply compensation water from the Llanvaches reservoir to the extent of 300,000 gallons per day. The writer is indebted to Mr. R. H. Haynes, Newport Borough and Water Engineer, for the above information.

Swansea Waterworks.

The interesting observations made by Mr. Wyrill, the Borough and waterworks engineer at Swansea, upon the rainfall in the different districts behind Swansea, have been referred to above. Swansea has passed through the usual course through which other towns have as its population has grown and as the demand for water has increased. In the early days the town was supplied by the lower Lliw reservoir, which has a gathering ground of 1,740 acres, and is situated about ten miles north of Swansea. In the spring of 1873 the lower Lliw reservoir was found to be leaking, and the Blaenant Ddu reservoir was constructed to relieve the lower Lliw and allow it to be repaired. The Blaenant Ddu reservoir has a gathering ground of 735 acres, and holds 127,000,000 gallons, its greatest depth being 57 feet 4 inches. The lower Lliw reservoir is constructed in a valley produced by denudation in the coal measures, and this apparently is the cause of the leakage. A shaft 30 feet by 20 inches was sunk from the top of the embankment, on the line of the puddle trench, and carried down to the bottom. It was found that the bottom of the embankment had been formed of concrete of poor quality, and was porous, and the springs from the adjoining hillsides, under the influence of heavy rains, had passed freely through the concrete and erroded the bottom of the puddle wall. The embankment was repaired by putting in cement concrete in the bottom of the trench, and it remained good for a few years, but it then again began to leak, and it became evident that further supplies would be required. Mr. Wyrill then designed the Upper Lliw reservoir, which is situated two miles above the old Lliw reservoir, and is formed by placing an embankment across the River Lliw. The reservoir is constructed in the shales and sandstone of the coal measures, immediately overlying the Upper Pennant series. The trench is carried down twelve feet below the level of the stream in the centre of the embankment, it being sixty feet deep at the deepest portion of the east end and ninety feet at the deepest portion of the west end of the trench. For about two-thirds of its length the trench is founded in hard shale, the remaining half at the east end being on hard rock. A lining of blue brick in cement and cement concrete is provided where the shale requires it to prevent the action of any springs on the puddle. The puddle trench is twenty-six feet wide at the deepest part, decreasing to twelve feet at the ends and at the top of the puddle wall.

The Upper Lliw reservoir has a water area of thirty-five acres, a depth of sixty-eight feet, and contains 305,-000,000 gallons. The discharge tunnel is 113 yards long, and is driven through solid strata round the west end of the embankment. The tunnel commences in the valve shaft, which is constructed of blue brick in cement, with a circular-domed valve-house of stone, containing the valves controlling the discharge from the reservoir. The valves are worked by direct-connected hydraulic cylinders, the necessary pressure being obtained from a spring on the hillside. The water for the town supply is taken at 21 feet 6 inches and 41 feet 6 inches below the top water level of the reservoir. Decanting valves are employed, 18 inches in diameter. The embankment is seventy-five feet deep in the middle, and the water side has a stone toe twenty-five feet high, which contains about 15,000 cubic yards. The embankment is 158 yards wide at its base and eight yards wide at the top, and contains about 210,000 cubic yards of material The height of the overflow weir of the Upper Lliw reservoir is 616 feet above Ordnance Datum. The average rainfall at this reservoir is 53.42 inches per annum, and the water is unusually soft, having 1 degree of hardness in winter and 1½ degrees in summer. From the reasons mentioned the Corporation of Swansea soon found it necessary to provide further water supply, and it has been obtained in the Cray valley, which is on the other side of the Bwlch Pass. The rainfall there is from seventy-two inches to seventy-six inches per annum. The watershed is 2,640 acres in extent of probably the wettest portion of South Wales, and the reservoir contains 1,000,000,000 gallons, and is 100 acres in extent. The top water level is 1,000 feet above the sea, and the water is impounded by a dam thrown across the River Cray, 1,250 feet long and 144 feet deep from the foundation to the top bank. The dam is sunk into the rock foundation to the extent of thirty-seven feet. The whole of the gathering-ground and the site of the reservoir are on the old red sandstone formation. On the site of the dam it was found to contain many minute cracks that had been caused by ice pressure, this being a valley of ice denudation. The cracks were followed down and worked out, nearly 50,000 cubic yards more excavation being required than would otherwise have been necessary. It will be noted that the experience in this case was very similar to that of Newport at Llanvaches. The heart of the dam is constructed of cyclopean masonry, made from the local supply of stone, faced with blue Staffordshire bricks. Mr. Wyrill is of opinion that this method of construction has saved time and money, and will give much higher relative watertightness. The water from the Cray reservoir is taken through a tunnel, commencing at the bottom of the reservoir, and through the hill into the watershed of the River Tawe, which runs down to Swansea. The tunnel is three miles long, and is internally 5 feet high and 3 feet 6 inches wide, and is lined with three half-brick rings of brindled Staffordshire bricks in two to one cement mortar. The water entering the tunnel is controlled from the water tower, placed at the west side of the reservoir, by valves arranged to decant the water at 20 feet, 50 feet, and 80 feet below overflow level. The upper valves are 18 inches in diameter and the lower ones 24 inches, all in duplicate, and of the design known as roller bearing valves. The valves are all worked from the top of the valve tower, which is reached by a footbridge from an abutment on the side of the reservoir. The water passes from the tunnel into a gauge basin, where screens are provided, after passing through which it enters the mains for Swansea. There are two sets of mains, one 17 inches and the other 24 inches in diameter. The 17-inch main discharges 2,500,000 gallons per day into a service reservoir at Town Hill at an elevation of 580 feet above Ordnance Datum, immediately overlooking the town of Swansea. This main is 23½ miles long. The second main delivers water into another service reservoir, 350 feet above Ordnance Datum.

The Corporation of Swansea were somewhat severely punished in the matter of compensation for taking the water of the Cray valley. The Parliamentary Committee who investigated and passed the Bill, allowing the Corporation of Swansea to take the Cray water, inserted a clause allowing any water authority, any part of whose district came within one mile of the main pipe line of the Swansea Corporation, to demand and obtain from the Swansea Corporation's pipe line a supply up to twenty-five gallons per head for their requirements. The authorities covered by this clause are the population of the Swansea valley and the outlying Swansea districts. The Swansea valley is increasing in population, owing to the development of collieries there, and the population demanding compensation is steadily increasing. At the present time it is 60,000, and is rapidly growing. The engineer of the Corporation has arranged to supply 1,500,000 gallons per day, through three-foot pipes, into the River Cray for the riparian owners and fishing interests on the Rivers Cray and Usk in addition to the above. The cost of the Cray works was £566,000, and they have been in successful operation since June, 1906. A photo of one of the dams is given.

Bristol Waterworks.

Bristol differs from the other towns whose waterworks have been described, in that its water requirements are provided by a company, where the others have all been supplied by their Corporations. Bristol, it will be remembered, is a very old city, indeed. In the days when the comparatively small rivers of Great Britain fulfilled the same office as the enormous rivers of Canada, viz., as the highways of the country, Bristol was an important place, because, like London, it could be reached by the River Avon, which flows past it, and it was a convenient spot from which to reach the inland districts.

The water supply of Bristol is partly from springs and partly from a gathering ground. It is interesting from the fact that Bristol itself lies largely in one valley while a portion of the water supply has to be taken from another valley. The earliest supply was taken from springs on the Mendip Hills at an elevation of 450 feet above sea level. The Mendip Hills range to a height of 1,000 feet above sea level, and there are a large number of springs available in different parts of them. The first springs employed by the Bristol Waterworks Company were from the carboniferous limestone in the neighborhood of Chewton Mendip, about twelve miles south of Bristol. The springs are collected into a small gathering reservoir, and are carried by an aqueduct, partly underground and partly in the open, partly of masonry and partly of iron tubes of oval section, carried on piers. The masonry aqueduct ranged from 4 feet 7½ inches by 3 feet 6 inches to 7 feet by 6 feet. Where the aqueduct crosses steep valleys iron pipes are used, and in one case at least a syphon is employed. The water from the springs is stored in a reservoir at Barrow Gurney, five miles south of Bristol, at an elevation of 320 feet above sea level. The reservoir has a capacity of 150,000,000 gallons, and the water is conveyed into Bristol from there by gravitation through cast-iron pipes. The pipes bringing the water from the Barrow reservoir deliver it to a service reservoir having a capacity of 5,000,000 gallons in the parish of Clifton at 200 feet above sea level, the lower portions of Bristol being supplied en route directly by gravitation. Very early in the history of the Bristol Waterworks however, Clifton, which has always been a fashionable resort, began to climb up to higher levels that could not be supplied from the service reservoir at the 200 foot level, and a high-level reservoir was, therefore, built for the special supply of the residences at the higher levels having a capacity of 600,000 gallons and an elevation of 320 feet.

Later on, the houses at Clifton and its neighborhood, Durdham Town, climbed up still higher to a level that could not be supplied from the 320 foot service reservoir, and these houses are supplied by a standpipe at the high-level reservoir mentioned above. The standpipe consists of an inverted U pipe, the top of the U being 75 feet above the level of the reservoir. Pumping goes on day and night, water being constantly forced through the U pipe, and any supply required in the district served from the standpipe being obtained from it with the aid of the 395 feet obtained at the top of the U. The water that is not used passes back into the reservoir.

Later on a second reservoir of 200,000,000 gallons capacity was constructed at Barrow, and was supplied from springs at Chelvey, a short distance away, the springs being in the new red sandstone formation. The pumping station is about 60 feet above sea level, and the water is pumped from it up to the 325 foot level at Barrow by pumping engines of at the present time 800 horse-power and a pumping capacity of 5,000,000 gallons per day. The 5,000,000 gallons per day can be delivered into Barrow reservoir or direct to Bristol. Later on, a further reservoir was constructed at Barrow having a capacity of 500,000,000 gallons, and powers were taken to construct a reservoir at Yeo having a capacity of 1,700,000,000 gallons at 147 feet above sea level. The Blagdon reservoir, as it is usually known, is formed by damming the River Yeo just below the village of Blagdon, which is situated under the Mendip Hills, and about ten miles south of Bristol. Water is obtained from the River Yeo and from the Rickford and Langford springs. A pumping station has been erected at Blagdon, just below the dam, with rotary beam pumping engines of 680 horse-power, and capable of pumping 10,000,000 gallons a day to Barrow reservoirs through 30-inch cast-iron pipes. The water from the Blagdon reservoir is pumped to the Barrow reservoirs, and is there distributed as mentioned above.

The Barrow reservoir forms a storage and distributing centre for Bristol, the water from the Churton Mendip and the Chelvey springs and that from the Blagdon reservoir being delivered there, and nearly the whole of the city of Bristol, with Clifton and the outlying portions, being supplied from Barrow. There are, however, two or three other supplies for districts of Bristol. Another spring, known as the Sherborne spring, is taken in the Mendips at an elevation of 300 feet above sea level, and supplies a portion of Bristol direct by gravitation. There are pumping stations also in other districts, where the houses have climbed up to higher levels, and water towers in connection with the pumping stations. Water is pumped up into tanks at different heights above sea level, and the different districts are supplied from the tanks by gravitation. There are ten sand filter beds at Barrow having an area of 7½ acres and a filtering capacity of 18,000,000 gallons per day.

The writer is indebted to Mr. J. W. McPherson, the waterworks engineer of Bristol, for the above information.

RUSTING OF STEEL IN CONCRETE.

Some time ago Sir John Brunner requested the National Physical Laboratory to report "On the Effect Produced on Samples of Mild Steel Embedded in Concrete." Dr. Glazebrook and his staff experimented and reported.*

More recently the question of the rusting of steel reinforcement has been taken up in Germany and a series of tests carried out with a view of securing fuller information.

The results of these tests show in a fairly conclusive way that, provided the steel reinforcement has not been stressed to beyond its elastic limit, the cracks formed in the concrete are insufficient to cause rusting. This is undoubtedly very satisfactory. The method of testing was as follows: Beams, 6 ft. 3 in. by 8 ft. 6 in., in cross section and something over 59 in. long, were prepared with the various kinds of reinforcement that are in use commercially. The steel was in each case situated 1¼ in. above the bottom of the beams, and formed 1.03 to 1.31 per cent. of the area above the centre line of the steel. The concrete was mixed in 1:2:4 ratio, 10.1 per cent. of water being added. This amount was found to be sufficient to give a quite plastic mass. Twenty-four hours were allowed to elapse before the forms were removed. For three months the beams were then stored, some in the open air, some in wet sand. In each case water was sprinkled over them every day. During the next three months load tests were made on the beams with a view to finding the various physical properties of reinforced concrete beams, namely, first point of cracking, stress in concrete, stress in steel, and ultimate strength. Fifty-eight beams in all were made, and of these twenty-six were broken during these tests.

Rusting Tests.

The remaining thirty-two beams were subjected to a rapid rusting test under load, which was usually about the same as that to which the beam had been previously subjected. This load varied from considerably below up to the elastic limit. The gear for the rusting test consisted of levers for applying fixed load to the beam at two points, and a sheet iron casing round the middle third of the beam, through which a mixture of carbon dioxide, oxygen and water vapour passed. Previous tests had shown that, although carbon dioxide and water vapour had no effect on steel with oxygen added, a bar would be quite covered with rust in twenty-four hours. Each beam was kept in the rusting atmosphere from 7 a.m. to 4 p.m. for three consecutive days in most cases. The concrete below the steel was then chipped off to enable the steel to be examined. In twenty-seven cases no rusting at all was observed. These twenty-seven beams had been subjected to loads causing stresses in the steel varying from 18,000 pounds to 35,000 pounds per square inch. In all cases in which the steel had been stressed to from 35,000 pounds to 44,000 pounds per square inch, rusting was found to have taken place to a greater or less extent. The composition of the cement may be worth noting. It was given by the makers as: Silica, 21.86 per cent.; alumina and iron oxide, 10.3 per cent.; lime, 62.5 per cent.; magnesia, 1.67 per cent.; sulphuric acid, 1.69 per cent. On ignition it was found to lose 1.32 per cent. Its specific gravity was 311.45.

*See Canadian Engineer, Vol. X.V, page 381.

THE ELECTRIC POWER PLANT OF THE CHICAGO DRAINAGE CANAL.

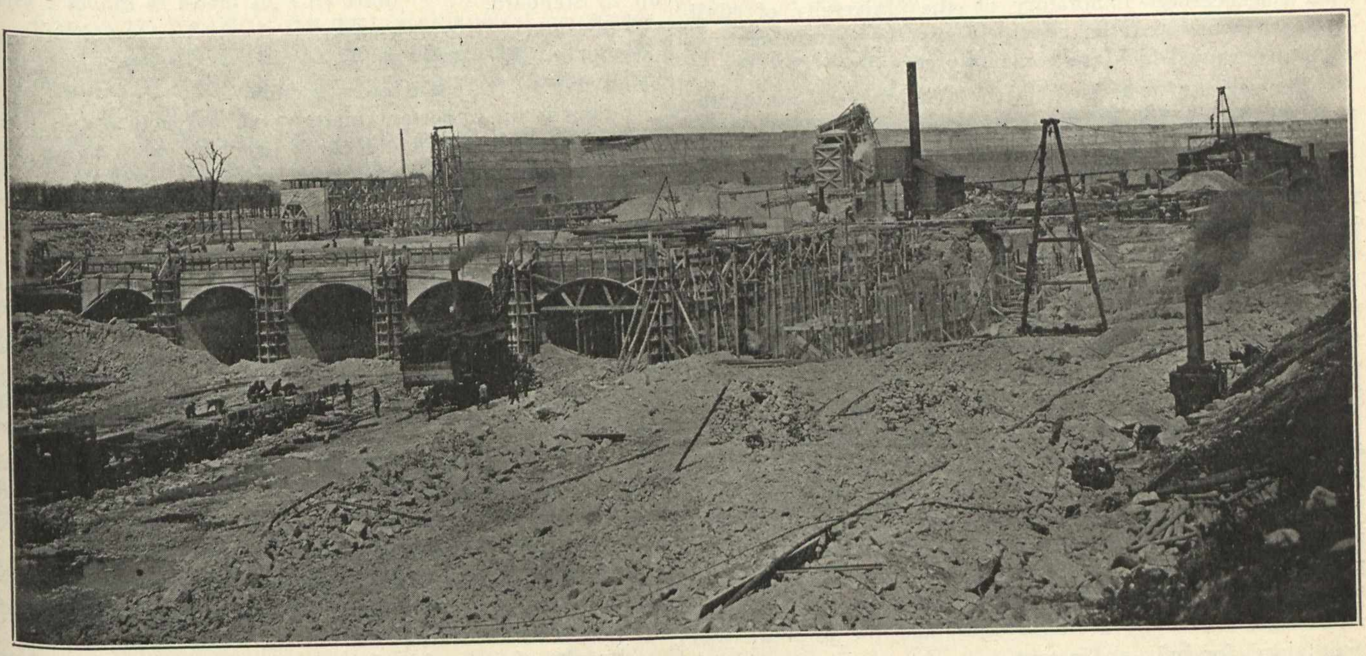
By Frank C. Perkins.

The hydro-electric power plant and equipment on the Chicago drainage canal at Lockport is shown in the accompanying illustrations. This power transmission plant, owned and operated by the Sanitary District, Chicago, has a capacity of 16,000 kilowatts for the present development with extensions provided for a power-station of an output of 32,000 horse-power. The drainage canal and power plant has cost over fifty million dollars. The canal extends a distance of 29 miles from the Chicago River to Lockport, Illinois, where it discharges into the Desplaines River, and the water flows finally through the Illinois River and empties into the Mississippi River, and thence at last into the Gulf of Mexico.

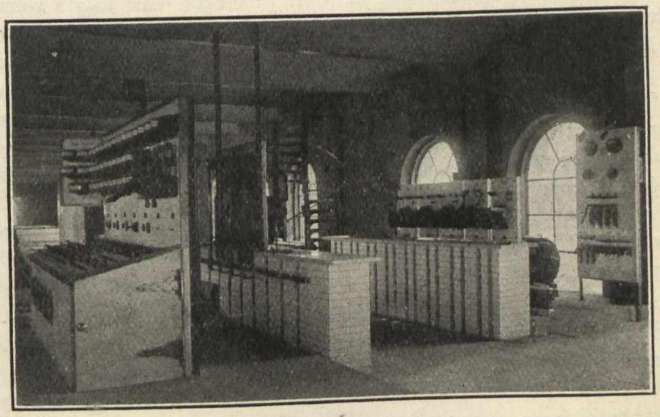
The power house is situated at Lockport about three miles from the city of Jolliet, where there is a regulation flow of more than a quarter of a million cubic feet of water per minute with a fall of twelve feet, the water being regulated by means of a "bear trap" dam. The power-house is 385 feet long, and 47 feet high, with a width of 70 feet, and is of steel and concrete construction of plain but neat design. By extending the channel to a point about two miles further down from the point above-mentioned, instead of 12 feet fall there is a fall of 34 feet and here the power-house was placed, with a retaining wall for the channel 40 feet high, bringing the water-level on the receiving side near the top of the power-house. The turbines have been installed in chambers at the floor-level, and work under a head of 34 feet discharging through the chambers to the tailrace. The controlling works or movable-crest dam is to the east joining the power-house, and is designed to regulate the flow of water in the canal.

There are four water-wheels installed which have been constructed by the Wellman-Severn-Morgan Company, and a fifth unit will be installed this spring. Each of the main turbines drives a three-phase alternator of 4,000 kilowatts capacity. There are two water-wheels of the same construction driving direct-current exciter dynamos, each of a capacity of 350 kilowatts. This plant was designed for eight alternators and turbines of 4,000 kilowatts each, and three exciter sets of 350 kilowatts each. The power-house is provided with a 40-ton electric overhead travelling crane of 35 feet span, moving over the generator space along the north side of the power-house, which is 385 feet long. The water-wheel for each unit is in a chamber adjoining and has a capacity of 6,000 horse-power at a speed of 163 revolutions per minute. The exciter sets have water-wheels of 600 horse-power each, each of these units being capable of supplying direct current sufficient for exciting the fields of several alternators.

It may be stated that the 4,000 kilowatt three-phase generators are of the Crocker-Weller type with revolving fields, and are wound for a pressure of 6,600 volts at 60 cycles. The switchboards and step-up transformers, as well as the bus-bars, oil switches, and circuit-breakers are on the south side of the power-station, and the transformers are on the main floor, with the bus-bars and oil-switches on two galleries overhead. There are twelve oil and water cooled step-up transformers of the general electric single-phase type in the transformer installation, each having a capacity of 1,333 kilowatts. There is an aluminium transmission line of 44,000 volts pressure, which conducts the current from the hydro-electric plant a distance of nearly 30 miles to a sub-station in Chicago, where the current is transformed down to 12,000 volts for local distribution. This transmission line consists of two circuits of three aluminium wires each mounted on insulators fastened to 60 feet steel masts, the wires being spaced about 6 feet apart. The masts or poles weigh about two tons each, and are of steel bridge construction, having a square base. Each mast is provided with two cross-arms, the top arm weighing 300 pounds and measuring 12 feet in length, while the lower arm weighs double this amount and is 18 feet long.



Lockport Power House.



Power House.

The transmission wires on the lower arm are 47 feet above the ground, mounted on insulators 12 inches high and 14 inches in diameter, tested to more than 1,000,000 volts. These high-tension insulators are provided with four petticoats or shells, and are mounted on a metal pin, the whole being designed for a horizontal strain of 5,000 pounds. The poles are placed 350 feet apart, and on the top of the poles an iron ground wire is carried the whole length of the line, and this conductor is expected to receive any lightning which may strike the transmission line, the iron poles carrying the discharge to the ground, being excellent conductors with their concrete supports.

A concrete sub-station 42 feet high and 70 feet in width, with a total length of 124 feet was built at Chicago. The sub-station is equipped with the usual step-down transformers and switch equipment, with motor-driven centrifugal pump for supplying cooling water to the transformers. The sanitary district of Chicago has contracted with the municipality of Chicago for the supply of 7,000 kilowatts for the electric department of the city. The Chicago sub-station will also supply current for the pump of the north channel, where 450 horse-power motors of the slow-speed type are used.

RIVETED CONNECTIONS.

The results of a series of tests recently made at the Civil Engineering Laboratory of the University of California demonstrated the effect, if any, of certain features of riveted work which are commonly considered defects.

The series of tests included: (1) Well-made joints having punched and reamed holes; (2) joints having holes punched without reaming; (3) joints in which the heads of rivets were cooler than customary when driven; (4) joints in which the heads were hotter than customary when driven; (5) joints in which the pressure on rivets was maintained longer than usual; (6) joints containing burned rivets, the rivets having been heated in the forge until they "split" upon removal, then carried to riveting-room and placed in regular petroleum heater; (7) one joint having extra large holes; (8) joints having holes eccentric. All plates were of ½-inch Carnegie "tank steel"; rivets were ¾-inch soft steel of Carnegie manufacture. Except in (7) the holes were 13-16-inch in diameter. Riveting was done with an Allen pneumatic riveter. The fact that specimens were small and were held by hand while riveted may have had the effect of reducing the quality of the work, since in large work the plates are held stationary, and thus afford better opportunity for a direct blow from the machine. In general, rivets were driven by a single blow, and the pressure was maintained for only an instant.

Rivets were heated in a petroleum heater; scale was knocked from all before driving—a practice which is not always followed in ordinary work. Only lap joints were used, and each contained two rivets, although there were two designs or types of joint—the first being in the nature of a single-riveted lap joint (see Fig. 1), 2¾ ins. c. to c. of rivets; and the second having the pitch line of rivets in the direction of stress 2½ ins. c. to c. of rivets. All joints were designed to fail in the rivets, although in some cases the plate itself gave way at a point very near to what should have been the ultimate strength of the rivets. The edges of all joints were planed off near the centre to allow the proper attachment of brackets for deformation measurements. In the first type of joint holes were drilled in each edge of each plate just opposite the rivets, and the holes were tapped to receive a No. 8 screw. In the second type holes were drilled midway between rivets and were tapped as before.

The tests were made in the 200,000 pound Olsen machine, and deformations were measured with an Olsen compressometer. After the joint had been clamped in the jaws, and the planed edges brought into vertical position, brackets were screwed to the edges. Each bracket contained a small, accurately finished brass plug, upon which the points of the compressometer arms rested.

Loads were applied in increments of 1,000 or 2,000 pounds, and the test carried to failure without stopping the machine except in the special cases noted. Each joint behaved in a very satisfactory manner. Many of the specimens bent to a certain extent before failure. Rivet failure was always in shear, giving silky fracture.

The results of the series of tests may be summed up under seven heads. There are no positive proofs of the various points, but the indications are as follows:—

First. That the strength of rivets in a joint having holes punched without reaming is greater, rather than less, than in one in which holes are punched small and reamed to size.

Second. That the exact temperature of the rivet or of a particular part of it is immaterial to the strength of the joint.

Third. That a maintenance of pressure for thirty seconds materially increases both the strength and rigidity of the joint—the first sometimes by as much as 40 per cent.

Fourth. That rivets burned so that they split when taken from the fire do not necessarily cause a weakness in the joint, although they do not properly fill their holes.

Fifth. That a rivet 3-16-inch smaller than the hole which it is to fill will fill the space tolerably well, though not perfectly.

Sixth. That joints in which the holes are not perfectly concentric lack rigidity, but give ultimate strengths about up to standard.

Seventh. That the shearing value of a rivet is materially greater after driving than before, this probably being due to increased cross section.

This is an important matter, and our colleges in their testing laboratories should check over this work again and again until some definite and reliable conclusions are reached.

JOINTS IN CAST IRON PIPE.

It has always been a difficult matter to secure a satisfactory join when using cast-iron pipe. Caulking with molton lead was difficult, expensive and not always a sure operation.

Recently engineers have been experimenting with lead wool, a preparation which consists of thread of lead twisted into strands of various sizes. By means of special tools this material is forced into the join.

Recently J. J. Trail, Demonstrator of Hydraulics, University of Toronto, made some experiments with cast lead and lead wool and reports as follows:—

Results of tests of lead wool and cast lead joints in cast-iron pipe; made in the Hydraulic Laboratory of the University of Toronto, on May 13th, 1908.

Cast Lead.

Size of pipe—4-inch.

Weight of lead used—4 lbs. 8½ ozs.

Joint began to sweat at 400 lbs. per square inch.

Joint leaked freely at 610 lbs. per square inch.

By raising the pressure slightly above 610 lbs.—it being at no time greater than 700 lbs.—the joint failed completely, the spigot pulling out of the socket.

Lead Wool.

Size of pipe—4-inch.

Weight of lead used—2 lbs. 8 ozs.

Joint began to sweat at 800 lbs. per sq. in.

Joint leaked freely at 1,150 lbs. per sq. in.

In an attempt to make this joint pull out as the cast lead joint did the pressure was raised to 1,200 lbs. at which pressure the cap on one end of the pipe failed.

From this it would appear that in every way lead wool has a great advantage over cast lead, and it is more than probable that with pipe of larger diameter lead wool would show to even better advantage.

RAILROAD EARNINGS.

	Week ending	1907	1908	Change
C.P.R.	June 21	$1,619,000	$1,287,000	—$332,000
C.N.R.	June 21	202,300	151,200	— 51,100
G.T.R.	June 21	883,825	825,675	— 58,150
T. & N.O.	June 21	16,700	16,700	.....
Mont. St. Ry.	June 20	77,271	75,024	— 2,247

ENGINEERING SOCIETIES.

CANADIAN RAILWAY CLUB.—President, L. R. Johnson; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, E. A. Evans, Quebec; secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, P.O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—96 King Street West, Toronto. Chairman, C. H. Mitchell; Secretary, T. C. Irving, Jr. Traders Bank Building.

MANITOBA BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Friday of each month, October to April, in University of Manitoba.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, J. G. Sing; secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, W. G. Miller, Toronto; secretary, H. Mortimer-Lamb, Montreal.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, TORONTO BRANCH.—W. G. Chace, Secretary, Confederation Life Building, Toronto.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, H L. Holman; secretary, Calvin W. Rice.

SOCIETY NOTES.

Institute of Architects of Canada.

The Institute of Architects of Canada are now an incorporated body acting under Dominion incorporation.

The object of the Institute, as set out in their by-laws, "shall be to facilitate the acquirement and interchange of professional knowledge among its members, and more particularly to promote the acquisition of that species of knowledge which has special reference to the profession architecture, and further to encourage investigation in connection with all branches and departments of knowledge connected with that profession."

The membership is to consist of the following persons only, who apply for admission to, and pay the entrance or admission fee and the subscription fee required by the by-laws of the Institute, may be admitted as members of the Institute:

(a) Members in good standing of the Province of Quebec Association of Architects, the Ontario Association of Architects, the Alberta Association of Architects, the Manitoba Association of Architects, the Toronto Architectural Club, and the Regina Architectural Association;

(b) Persons not members of one of the associations or of the club above named, who have practiced for two years as architects in Canada, each application being supported by an affidavit proving the qualifications of the applicant.

The annual meeting of the Institute will be held in Ottawa, September 21st to 24th. Alcide Chausse, secretary, P.O. Box 259, Montreal.

Canadian Gas Association.

The first annual meeting of the Canadian Gas Association was held at the King Edward Hotel, Toronto, Canada, on Friday and Saturday, June 26th and 27th, 1908, the President, Mr. H. H. Powell, of Brantford, Ont, presiding.

About seventy-five were in attendance, including representatives from a number of American gas companies.

During the Convention papers were read by a number of delegates, each being discussed at length. The following were the subjects and speakers:

"Producer Gas for Power Purposes," E. J. Philip, manager of the Berlin Gas & Electric Works; "Gas Appliances," Chas. Forbes, manager of the Ottawa Gas Company; "Purification and Experiences with Canadian Coal," R. A. Wallace, manager of the Quebec Gas Company; "New Method of Firing Benches by Producer Gas," W. H. Pearson, manager of the Toronto Consumers' Gas Company; "Delivery of Coal as Regards Short Weight," J. C. Hay, manager of the Listowel Gas Company; "Utilization and Further Manufacture of By-products: Coal Tar and Ammonia," J. Keillor, manager of the Hamilton Gas Company; "Commercial Appliances," L. S. Bigelow, secretary of the Commercial Gas Association, Willimantic, Conn.; "Development of the Gas Business," Mr. Cunningham, New York, editor of the Gas Journal.

The delegates were entertained at luncheon at the Royal Canadian Yacht Clubhouse on the Island by the Consumers' Gas Company, and were their guests at Scarboro' Beach. A drive around the city was taken, and a visit to the new plant of the Consumers' Gas Company.

The following were elected officers for the ensuing year: President, J. C. Hay, Listowel; Vice-Presidents, J. S. Norris, manager of the Montreal Gas Company and W. H. Pearson, general manager of the Consumers' Gas Company, Toronto; Secretary, A. W. Moore, Woodstock.

GEODETIC SURVEY STATIONS IN NORTHUMBERLAND COUNTY.

The Dominion Government is erecting a number of towers throughout Ontario and Quebec for astronomical and geodetical purposes, and J. H. Moorhouse of the Dominion Observatory, Ottawa, has leased from Dr. T. C. Lapp, of Cobourg, the highest point on his property, which has been found to be the highest point on the plains of Haldimand township. A pyramidal tower 60 feet high and 19 feet square at the base and 9 feet at the apex will be erected upon this point. The property has been leased for ten years and the work of building will be commenced at once. The Government will also erect a monument for inscriptions and observations, which will be left permanently. This is to be four feet high, one foot at base and nine inches on top. The next tower to be erected east of here is 24 miles distant and 3½ miles from Wooler, upon Mr. Murray's farm, in Murray township. The nearest one in the west is 22 miles distant, in the Township of Clarke. A fourth is about three miles from Omemee, in Emily township, away to the north of here. It is expected that it will be possible for the operators to flash light from one tower to another.

On the Canadian side of the Niagara River the Queen Victoria Niagara Falls Park had entered into leases and agreements with three companies, requiring water for power purposes. The Canadian Niagara Falls Power Company, 110,000 horse-power, requiring 8,600 cubic feet per second. Ontario Power Company, 180,000 horse-power, requiring 11,700 cubic feet per second. Electrical Development Company, 125,000 horse-power, requiring 10,750 cubic feet per second.

SMALL WATER SUPPLIES.*

By W. H. Booth.

While it is usually absolutely necessary for a large city to go outside its boundaries in order to obtain a good and safe water supply, if only because the concentration of population is too great to permit of sufficient water being obtained within the limits of the town, such is not the case with small towns, villages, or country houses. In the small country town there are often existing numerous wells. Frequently these are of no great depth, having merely been dug down to the water level, and consequently they yield water which comes from the stratum nearest the surface, and is most likely to be polluted by surface infiltration. Very usually the cesspools of the town are similarly dug down to the same depth as the wells, and their contents leak away into the same water horizon. Even where there are no such direct and wholesale sources of water contamination, it must always be the case that, on a porous soil, in an old-established town, the whole or part of the surface soil down to the water level is polluted by the surface infiltrations of centuries. The great efficiency of the surface soil as a filtering medium explains why, after the lapse of centuries, wells of shallow depth are not more polluted than they are. At the same time the wells would have been much safer had it not been that the surface of the earth had been pierced by other excavations, or had not the wells themselves formed easy inlets for surface drainage without the passing of this through the vegetable mould. It is a question whether, if the surface of the earth was nowhere broken into, and was everywhere clothed in vegetation, any real pollution of the water beneath could occur. The water supply engineer will usually find that his services are required at places where long-continued infractions of the surface have been at work, and the surface water is hopelessly polluted within the area of the town. This fact will not of necessity entirely shut out the surface water from consideration, for it may be that without the limits of the town there is an extension of the same water-bearing stratum, and the conditions may easily be such as to render it desirable to investigate this stratum with a view to utilizing it.

It by no means follows that, because water from a shallow well is polluted, there cannot be obtained pure water from the same bed, but at some deeper level. It may be here assumed, and will often be found to be the case, that the water in a shallow stratum is travelling towards some lower level, perhaps a small stream, the level of which practically governs the level in all the wells of the locality. Upon this flowing sheet of water descend all the trickles of impurity from the surface. But such surface drainage merely flows away to the drainage point as the upper layer of the whole sheet of water. Such bed of water may extend downwards 10 ft., 20 ft., 50 ft., or even 100 ft., and even if the top few feet be seriously polluted, it may be possible to draw pure water from below, just as water may be drawn from any cistern of water, the upper part of which is covered by a floating layer of oil.

The polluted infiltration will not find its way to the lower levels. But if too much water is drawn from any one point of the lower level, there may be formed a cone of depression about the locus of pumping, and towards such cone will flow the surface-polluted water from all round, and once it has arrived at the lower level there is a chance not only for it to enter the pump that has been put down, but also for it to escape laterally into the surrounding strata and cause extension of the polluted area.

Now, the same amount of water drawn from several points would only cause a very small depression about each locus of pumping, and no penetration of the surface pollution would occur. When, therefore, circumstances seem to warrant it, it may be justifiable to obtain water from the deeper levels of the surface supply (so long as the area from which the water is drawn is sufficiently extensive) to yield the required supply without drawing down of the water level to any serious extent. This system let us call system (a) when referring to the details of its carrying out.

System (b) is that of the artesian or bored-tube well. If the geological map of England be referred to it will be seen to be colored in a series of roughly-concentric bands struck from a centre not far from Dublin. These colored bands represent the surface outcrops of different strata as they slope up from below. Since the general dip is from N.W. to S.E. the oldest rocks will outcrop towards the N.W., and the surface outcrops in the S.E. are comparatively young rocks, geologically speaking. The earth's stratification consist of a long series of alternations of sand and clays and limestones, more or less pervious to water. In almost any locality, not too elevated, a borehole will reach water. If the surface is clay, this stratum must be pierced, when the water may be found in the sand rock next below. If the surface is permeable, the water may be found resting upon the clay which comes beneath. This is a crude way of putting a general fact to which there are many exceptions, and in a paper of this brevity it is hardly possible further to discuss the geological question. Sufficient to say that the geological conditions vary very quickly over England because of the high pitch of the stratification and the comparative thinness of most of the main divisions of the rocks. The subject is further complicated by faults and by unconformity, by elisions and a thousand other natural facts, and all that can be said is, that every case demands its own special investigation. Then there is system (c), the dug well.

Sometimes a dug well appears almost imperative, but as a rule a dug well is to be avoided. It affords direct access from the surface to the water-bearing stratum, and the water in a dug well is liable to pollution from many sources. Rats and mice may fall into it; workmen enter it with dirty boots. The cover of a dug well may often be seen affording a roosting-place for fowls.

The dug well has the advantage that if carried considerably below the rest level of the water it will afford a storage-room in case the yield is small, and may, in this way, enable the twenty-four hours' yield of the well to be pumped out in a few hours.

System (d) is the system of supply from a small stream, which may be collected by means of a dam or by tanks. It will occur comparatively rarely that a stream sufficiently pure will be available for direct use. Considering each of the above systems in detail, the first, or system (a), demands first a preliminary test and analysis for quantity and quality. The general disposition of the surface sand or gravel, whence the supply is to be raised, having been determined, a line of small driven tube wells can be driven down perhaps 20 ft. or 30 ft. across the line of flow of the water. Thus, each well draws from a different part of the stream. If put in the other direction they would lie, so to speak, up and down stream, and would all draw upon one streak of water and produce a considerable depression of the water surface along that line. Set across the line, each well commands all the water flowing past it.

Often such water-bearing beds are found in the alluvium alongside of rivers. Such wells are only usefully to be employed when the water level is such that they may all be coupled together upon one main and pumped by a surface pump, or by a pump only a few feet below the surface. It is customary to cap each well with an outlet piece about three feet below the surface, and connect each outlet with a common suction main. When the yield is copious each well forms its own suction pipe, but if the yield is small, and the pumped water level is liable to be drawn down below the level of the highest perforations of the well tubes, then it is advisable to connect an internal suction pipe extending down the well below the level of the perforations. This prevents the pump from drawing air at the well of least supply until all the wells have been pumped down to the same low level, which obviously cannot exceed 26 ft. to 30 ft. below the pump clack, as a rule. It is obvious that a shallow gravel supply of this nature is not feasible if the

---

* Paper read before the Municipal, Building, and Public Health Conference.

water is not within a few feet of the surface. And the fact of the water being near the surface often implies risk of surface contamination. The best areas for water supplies of this order are those far removed from human habitation and on grass lands. The author has obtained supplies both copious and excellent from small 2-inch to 6-inch wells coupled in this manner to one pump. One of the best breweries in England thus obtains its water from a number of 6-inch perforated wells with internal suction pipes. The surface of the field is left in grass and undisturbed, and there is no mounding of the surface whereby surface water can percolate unfiltered, and there is no denudation of the roots of plants which are so effective in promoting purity of the infiltering water.

Excepting in low elevations the multiple small well is usually inadmissible. Assume that the water level is down 30 ft. below the pump, can the air-lift system of pumping be applied? Let it be assumed that the delivery can be made 3 ft. below the surface, and that the pumped height is 30 ft., then the air-pipe and rising main must be extended to 75 ft. below the surface, the immersion being 45 ft. Few driven wells are so deep as 75 ft., and, therefore, the use of the air-lift pump may involve the extension of each well to a depth much exceeding that necessary to obtain water. A dozen such coupled wells may involve easily 500 ft. to 800 ft. extra boring and lining tubes, but all of them can be pumped from one air-compressor, and it is to be noted that the cost of air-lift pumping through small heights such as above does not become so comparatively extravagant as when the water level is at great depths below the surface. Still, the extra cost of a number of coupled wells may very well turn the scale in favor of a scheme (b) for a single deep borehole. The water level in a deep borehole will frequently stand as near to the surface as that in the surface gravels. Sometimes it may even be higher. If, therefore, the prospects of an artesian supply are satisfactory the bored tube well offers itself for favorable consideration in comparison with shallower-driven wells. There is less anxiety in respect of purity—in fact, practically none—and there are no serious difficulties in regard to pumping. Where the water comes reasonably near to the surface the air-lift pump may be employed. It has the advantage that it will extract from a well, if the supply is there to be extracted, very much more water than can be drawn out by the usual single-barrel pump, which can be contained in the bore pipe. But if the lift is great the efficiency of the air-lift pump falls off considerably, and the single-barrel deep-well pump must be employed. The diameter of the borehole is then to be fixed by the capacity of the pump, for single-barrel borehole pumps must not be worked fast if they are to be durable. Because of this low capacity it is often the practice to construct a dry well down to the water level simply as a container for a set of treble-barrel pumps arranged to draw the water from the closed borehole. The depth of this dry well depends very much upon the yield required. It may be dug considerably below the water level in the borehole. The bore pipe can be plugged at a point below the bottom of the well by a tube stopper; the bore pipe is then disconnected and a valve fixed on it near the dry well bottom, when the plug can be removed and the valve closed. The water is thus naturally part way up the rising main, and the range of pumping lowering is thus increased. Where dry wells are thus employed, the top of the bore pipe must never be open. The well must be close connected to the pump suction, so avoiding risk of contamination.

The dug-well system (c) with underground storage has its special risks, as already stated, and ought to be in charge of a careful man. It enables a small yield to be allowed to flow and collect during the night, but it is of little use unless carried considerably below water level, and and its capacity should be large at its greatest depth. Often one finds dug wells with capacious headings at the top water level, where the yield is at its slowest, and such are of little service.

The yield of every well varies as the square root of the amount of the lowering of the water when pumped. It is always, in the author's experience, not less than this rule will give. Often the increase of yield with lowering will be greater, as may well be anticipated, than this rule gives, for, as the level is lowered, supplies of less head become manifest that did not affect the test yield made with a few feet of lowering of head only. Obviously a fissure flow whose rest level is, say, 100 + O.D. cannot show on a pump test conducted at 105 + O.D. The rest level of water in a well is the result of the mean effect of all the supply fissures. Thus, one supply may, per se, give a rest level of 110, another may give 100. Now, the top supply will flow away into the lower level head supply fissures, and the rest level will be somewhere between 100 and 110. As the water level is lowered by pumping the lower head supplies begin to tell heavily. All supplies are sluggish at top levels, so that a dug well is of little use unless carried below water level to some distance.

For safety, a dug well should be lined with water-tight cast-iron tubing, and, unless carefully constructed, there is apt to be leakage of water down the smooth outer surface of this. The upper surface should be dug out round the well tubing and a thick wall of clay pugged in to prevent creeping of water. From the well a large circular concrete paving should extend round the well for a distance of 20 ft. or more. This compels all water to travel more than 20 ft. before it can reach the tubing, thus minimizing the risk of pollution by direct unfiltered surface water. Beyond the concrete the ground should be under grass and kept free from animals.

Small water supplies on system (d) are not common. They will usually be combined with a filter plant, and for this reason the system does not commend itself in comparison with the tube well, which rarely yields water that is not purer than any filtered surface water.

When adopted it is desirable that a storage tank should be constructed, unless an artificial pond can be made by means of a small dam. The settlement of deposit in the tank or pond greatly eases the filtration and diminishes cleaning of the filters.

All supplies, whether by well or from a stream, may be sufficiently hard to demand softening. Where the hardness is produced by sulphate of lime, or is permanent, it cannot well be reduced, for soda is necessary for this. It may be the case, in time, that the very insoluble salts of barium will be more cheaply available by the electrolytic process, in which case permanent hardness might be dealt with. As regards the temporary hardness caused by carbonates of lime or of magnesia, this is easily reducible by the Porter-Clerk process, and the amount of lime necessary to effect this is not large.

Small water supplies are usually required in towns and villages where funds are limited, and it is not advisable to be too ambitious. A pressure reservoir cannot always be constructed near the town owing to want of an elevated site. A tank or a tower must, therefore, be employed, for it will be costly to lay mains any great distance in order to reach a naturally elevated site, whereas a tower tank can be placed near the centre of demand, and the mains minimized. The safety of the artesian well, even if put down in the middle of a city, specially commends it, for it also can be placed near the centre of the demand. The well is then pumped direct to the softening plant, and from this the water is pumped direct to the tower tank, whence the distribution mains radiate to the borders of the area to be supplied. Where such arrangement is possible the mains can be kept small, for the water is divided at the tank into two, three, or more mains, whereas when the tank is beyond the town altogether the first length of main must accommodate the whole demand. A central location is also good, in that no main need be large, yet it will usually be possible, by means of the mains in cross streets, to provide alternative routes for water in event of closing of the main pipe to any quarter. The provision of a public supply to an ancient town or a hamlet that has no prospect of growth in front of it must not be undertaken on the lines one would pursue in some growing manufacturing town. We find the small town drawing from so many more or less polluted or suspicious shallow wells. It is not necessary to remedy this state of affairs by providing a high-pressure supply to throw a fire jet over the church steeple. Our first consideration is to carry pure water into every house at a price that will appeal to the inhabitants, not necessarily at a high pressure, though as high a pressure as can be reasonably given will lead to economy of water mains. But with a pumped supply every additional foot of height means expense in fuel, and is not lightly to be undertaken.

The question of the working hours of the pumping station is one of extreme importance, especially when there is no elevated site for a large-capacity reservoir, and only a tower tank can be employed.

If the pumps are worked only ten hours per day the tank must be very largely increased in capacity, and the plant generally must be larger and more costly, involving a continual extra charge on the undertaking. One man can take charge of the pumping station, but there must be a second man as a stand-by in case of illness or accident. The well and pump will need to be larger or in some way more costly.

Now, by pumping for a day of twenty hours there will still only be two men employed; the tank and the plant generally can be minimized and the expenses generally will be kept to the smallest possible figure. As regards the pumping for ten hours, however, it must not be forgotten that the power plant can be fairly small. Spare plant there must be, but with simple machinery there is no very special reason why the so-called spare plant should not be worked regularly. In event of breakdown the remaining plant can, during repairs or overhaul, be worked for twenty hours per day. With a plant set out for a long day one puts in spare plant. With a short working day the item of spare is filled by utilizing spare hours.

When a short day is decided upon it would appear to be a fairly satisfactory policy to work, say, two-thirds or three-fourths of the plant, the remaining third or fourth alone being spare. This question of machinery is somewhat troublous with small supplies, because it is unwise to employ gas engines of too small a size, and when of full size or large enough to do the whole work, then the spare plant for the long day is just as big as the running plant.

An advantage of lon-day working, which comes to the front when it is necessary to soften the water, is that the softening plant may be made of smaller size, and a considerable saving of expense may, herefore, be made.

Pumps.

The kind of pumps to employ demands careful thought. With a dug well carried down to the water level there is nothing better than the treble-barrel pump, with three-throw crank, such a pump being balanced. But in many cases the water level is at a considerable depth below surface, and there will be no dug well. In this event—and such an arrangement is better from a safely sanitary aspect—there will be either an air-lift pump or a simple barrel pump put down the bore pipe and worked by machinery at the surface. These simple barrel pumps require to be so proportioned as to work slowly, for they are then durable and reliable, but unless there is a storage reservoir of considerable capacity, both the borehole and pump must be in duplicate.

In the most economically-devised scheme there should be a set of spare rods and bucket, and there should be appliances on hand for rapidly removing the working set. With the air-lift pump the power required is much greater than for the barrel pump, especially when the water level is far down. The air-lift is, therefore, most suitable where the lift to surface is low and there is a softening apparatus whence the softened water is raised to the tower tank by turbine pumps or by geared or belt-driven pumps worked by the same engine that works the well pump or air-lift. The air-lift has the very great advantage that the whole of the machinery is at the surface, and there need be no set relation between the position of the engine-house and the site of the well, it being so easy to carry the compressed-air pipe to any reasonable distance with very little loss of efficiency.

As regards tank capacity, this will depend upon the working hours of the pumps, and is best found by a diagrammatic representation of the rate of filling of the tank during the period of pumping, and of the rate of demand, which must be assumed according to conditions. Thus, a fair assumption is that the demand is divided into four parts and periods, three of two hours each, during which a quarter of the day's demand in each period is consumed, while the other fourth is divided over the remainder of the day, but chiefiy in the forenoon, afternoon and evening. By plotting supply curves for ten, twelve, sixteen and twenty hours, the depletion of the tank can be ascertained for every hour of the day, and it will be found that but little difference occurs as between a pumping day of fourteen or twenty hours, but below fourteen hours a considerably larger tank capacity will be found necessary. The height of the tank is also of importance. If too high, a perpetual extra charge for interest and high pumping is introduced, but the mains may be smaller. In small supplies the ends of the various mains are already larger than calculation demands, and too much pressure should not be expected. Every case must be considered by itself, for no anticipation can be made that will fit each case when it comes up. There are certain general rules that an engineer should follow as far as possible, but every rule may at some time be better disregarded than followed. Thus a supply main should not be made to serve as the rising main from the pump to the reservoir, but with a small supply and the necessity of a close economy cases might arise where this rule would quite properly be abrogated.

A small water supply is a matter of compromise. The people have for years had a meagre supply from more or less polluted wells. Finally, cases of typhus occur, the public conscience is roused, and a better supply is desired, but there is little money available. It is very undesirable to attempt a scheme of perfection at a cost that will merely serve to frighten the people and postpone the scheme indefinitely. Rather a moderate scheme should be undertaken, because any scheme which will deliver a fair flow of pure water from a half-inch tap into every kitchen sink is far and away better than the carrying of water from wells at a distance, and often in dirty pails. Moreover, every family using a well is at the mercy of any dirty person who may choose to carry water in a dirty pail. This is particularly the case where there is no well bucket.

The question of house cisterns is one that admits of much argument. If every house that has a cistern the mains can be smaller and cheaper, for the demand is spread over the day in comparative evenness.

But cisterns, especially in small houses, are apt to become dirty and neglected. The ideal cistern, could it be made, would be closed and expansible, like a concertina, and weighted so as practically to be in balance with the supply. But there is no material from which such a cistern could be practically constructed. Cisterns with ball valves are apt to cause great loss of water. A closed cistern with an air-snifting valve has the disadvantage that the air drawn into the cistern as this is drawn upon may be foul air, and there would be difficulty in maintaining a good filtering medium to each air pipe. Cisterns are thus not to be encouraged in small houses.

As regards power for pumping, there is to-day a wide choice between steam, oil engines, gas engines with town's gas, gas engines with producer gas, and electricity. Circumstances in each case may be such as to warrant the choice of some particular motive power, but generally for small water supplies it is likely that the gas engine with producer gas plant will prove by far the cheapest. For larger towns it may be that a steam plant will be considered more reliable than gas power, but this becomes every year less certain, and for small towns of 3,000 to 5,000 inhabitants the gas plant seems better than any other.

To sum up, it may briefly be said that the gravel and sand supplies from shallow depths must be employed with great circumspection, and that the bored-tube well is almost certainly a safe thing whereever made.

The greatest example of the safety of the bored-tube well is afforded by this city and county of London, in which there are hundreds of such wells still yielding good water, though the water level in the chalk whence most of them draw their supplies has for many years been 100 ft. more or less below sea level, thus offering every temptation to the entrance of water from the Thames. The London area is, of course, rendered particularly safe by the fact that there is so thick an impervious stratum between the surface and the water-bearing chalk.

As a matter of precaution old wells should everywhere be filled up with clean material when discarded from use, or otherwise they will but continue to act as sink holes for the further pollution of the strata to which they afford easy access for surface-water drainage.

The bored-tube well should be lined with stout, socketed special driving pipe, screwed to butt and with painted threads. It may be used with confidence, even if put down in the middle of a city.

In supplying a small town, apart from the absolute necessity of purity, the general somewhat exigeant demands made for larger schemes cannot be obeyed. The old adage, that half a loaf is better than no bread, bears strongly on the subject, and so long as the half loaf is sound and wholesome too much must not be demanded of it in respect of size.

A demand of twenty gallons per head per day is unlikely to be reached for some time by people accustomed to the limited use of pail-carried water. But a supply creates the will to use it, and while it is desirable that every house should be assessed for water rate, it does certainly seem desirable that a portion of the charge for water should be according to meter reading, so as to tend to the reduction of careless use, leaking taps, etc. So much waste only reduces the capacity of the mains to cope with the fair demand, and a wasted water supply also reduces the value of the sewage if this is turned upon a farm, and generally enhances the cost and difficulty of dealing with it.

Careful use of water is particularly to be fostered in a small town with a pumped supply to a tower tank, for the capacity of the tank is so very much a question of the demand, and first cost is so very important in most of our small country towns which have apparently arrived at a quiescent steady population. Very few of them are likely to put on serious growth, and for the few which will do so it is not justifiable in the case of the many to incur heavy expenditure on the off chance that this one town will be one selected by Fate for future great expansion. When expansion does come let it in fact be made to pay for itself.

WATER FILTRATION AT EDINBURGH, SCOTLAND.

The Edinburgh and District Water Trustees have adopted the report of a sub-committee recommending the installation of twelve of Messrs. Bell's eight-foot diameter patent pressure filters at Fairmilehead, to filter the supply of water from the Talla. The scheme originally proposed was for the erection of seven sand filters and a large storage reservoir. The twelve filters proposed to be put down at present will deal with 2,000,000 gallons per twenty-four hours, and these, with the existing filters at Alnwickhill, are expected to serve the city for a number of years to come. It will be necessary to have a balancing tank at Fairmilehead to equalize the flow of water from the Talla, but this tank will not be an expensive item. The approximate cost of the whole work is put at $100,000, while the batteries of filters could be extended so as to deal with the 10,000,000 gallons daily proposed under the original scheme at a further cost of $150,000. The present proposed instalation of filters and relevant works will take about a year or eighteen months to complete, and is regarded as completing the Talla water scheme.

CONCRETE AS A SAFEGUARD AGAINST FIRE.

In a recent discussion of the heat resistance of concrete, Mr. Leonard C. Wason, president of the Aberthaw Construction Co., Boston, showed that the great conflagrations of recent years have firmly established confidence in the fire-resisting qualities of concrete. One of the elements in the durability of concrete is the fact that a conflagration is of necessity of relatively short duration. This feature is of vital interest to manufacturers who desire strength and durability combined with the power to resist the effects of fire. Mr. Wason stated that if cement be continuously exposed to a temperature of 900 degrees it will ultimately disintegrate, but much higher temperatures may be endured for shorter periods. It will stand a temperature of 500 degrees for an indefinite period. Fire tests of five hours' duration, conducted with temperatures of 1,700 to 2,000 degrees, have shown that the temperature was not sufficient to destroy either the cement or the aggregates buried within it. Although limestone would ultimately be calcined or glass-melted, this would not occur before the cement itself was disintegrated. Nevertheless, quartz sand and broken trap rock may properly be regarded as best suited to resist fire. The use of cinder is not particularly objectionable except as regards the strength of the concrete used in connection with reinforcement. Small lumps of coal, half an inch from the surface, have been found entirely unaffected by the heat after severe tests.

Mr. Wason referred to tests which he had personally examined in which the amount of pitting did not exceed one inch, usually much less. The conductivity was so poor that he was able to bear his hand on the top surface of a floor five inches thick without burning after a fire had been raging below for five hours. It has been the practice of the Aberthaw Construction Co. to provide an extra inch of concrete, over and above the calculated amount, around the reinforcement of columns, and sometimes of beams, the strength of which is thus rendered entirely independent of the flames.

It may appear paradoxical as regards the conductivity of concrete to note that plastering on the interior of cold walls will frequently freeze when it is put on. In one of Mr. Wason's experiences solid walls were 18 inches thick, the external temperature was from 10 to 15 degrees and the internal 45 to 50 degrees; nevertheless, the plastering invariably froze. In another case plastering froze where the walls were not quite dry, 10 inches thick, with the same internal temperature, while the external was from 25 to 30 degrees. Undoubtedly the facts that the wall is continuously exposed to the outer temperature, and that the vaporizing of the water in the plaster reduces its temperature are important factors in the cooling of the inner surface.

On the other hand, the non-conductivity of concrete in the form of a steam conduit is well shown by another experience of Mr. Wason's. Such a conduit, about 500 feet long, was built between a boiler-house and a mill, just wide and deep enough to receive two six-inch and two small pipes. The large pipes, which carried live steam, were not covered in any way. After all pipes had been laid in the trench a concrete cover was constructed over them so as to render the conduit waterproof against ground water. It was carried only 2½ feet below the surface, but not below the frost line. It was open at both ends to make it easy to observe whether there was any leakage or not. The assumption was made that if any vapor escaped from either end of the conduit there must be some leakage, which would permit the water to vaporize. After the conduit was dried out, which took about two weeks, no vapor was observable. Since then the loss of heat through the concrete has been relatively small.

The warmth of the concrete building is recognized on all sides. This feature, combined with its power of resistance to fire and its durability, renders such a structure practically unapproachable in its advantages.

PRIME MOVERS.

By A. D. Le Pau, B.A.Sc.

The growth of human industry depends on nothing more than the possession of cheap and convenient power. Labor is by far the largest factor in the cost of many manufactured articles, and cheap motive power tends to displace the strength of human hands in all manufacturing processes, and so reduce the labor cost, and to set free that labor for other and less purely machine-like purposes.

The first thing to be determined in planning a power station is the proper site, which should, if steam be the motive power, be settled by convenience with respect to the supply of coal and water. In using water power, the location depends upon the hydraulic development. It should be remembered that it is strictly a utilitarian structure, and for the best results, electrically, must be dry and clear of floods, conveniently arranged for all apparatus, with an easy entrance for transmission lines, and above all it must have solid foundations, capable of further extensions, and must meet all these requirements at a minimum cost. The best watchwords in power-house design are safety, operation, simplicity and accessibility.

With regard to outside arrangement in a water power plant, the units are most conveniently placed side by side, with their shafts parallel. This tends to concentrate and simplify the whole plant and bring it clearly under the eye of the operator. The fundamental question is the proper size of units. There is at present perhaps too strong a tendency to use direct coupled units at any cost. Direct-driving is very simple and efficient when conditions are favorable, and for large units is necessary, but belt and rope drive gives little trouble when well engineered, and only wastes from 3 to 5 per cent. energy for a single drive. It is very easy to waste far more than this when using a dynamo designed for a speed unsuited for its output or with wheels under disadvantageous conditions.

(1) In deciding on the number of units to be employed several things must be taken into account. The number should not be so small that the temporary crippling of a single unit will interfere seriously with the work of the plant. This determines the maximum permissible size of the units. The nearer that one can come to this without involving difficulties in the way of proper speed or serious specialization the better. In a large plant it is seldom advisable to install less than three units, while in some cases, particularly in hydraulic plants, a larger number may have to be instaled to meet hydraulic conditions.

(2) In this case it is desirable to operate each dynamo by its own special wheels to avoid complication. Hence the consideration which determines the number of generators also determines the number of wheels in the hydraulic installation. Only on very rare occasions is it advisable to use more than a single wheel, or at most a pair of wheels, on one unit. If the plant is to feed several transmission lines it is sometimes best to assign separate generators to each line, and this may make it necessary to increase the total number. The requisite security from accident can in such cases be obtained by use of spare units or by shifting a generator from a lightly loaded line to a heavily loaded one.

(3) The first central station was put on a commercial basis about twenty years ago. Three years ago the steam power plant had settled down to a uniform arrangement, and everything seemed to indicate that it would only be necessary to buy a standard set of blue prints and make changes in size of units to have the station up to standard. From time to time gas engines were proposed, with improved economy of fuel, but, with a few exceptions, these were not generally favored. Then we have the steam turbine placed on the market after a long period of development, and during the last three years no other piece of apparatus has had such a stimulating effect upon the power plant. It has revived the superheater, which has been so developed and improved that a superheat of 200 per cent. or 300° F. can be economically obtained. With the general study of these conditions there has been brought about a general improvement of the furnace, and here there is apparently room for further improvement. It has also had a stimulating effect in the further development of condensing apparatus, so that it is now possible to obtain a vacuum within one inch of the simultaneous barometer reading.

Another change has been the adoption of high-speed generators, resulting in a decreased cost of generator and its foundations and a saving in floor space. The general high efficiency of the turbine and its claim for recognition is bound to make for a higher power plant efficiency.

In investigating the efficiency and economies of a power plant one must not confine himself to a study of prime movers, but must consider and analyze the entire plant from the coal to bus-bars; first, in regard to efficiency; secondly, in regard to the effect of load factor upon investment; and the effect of the first and second upon the total cost of producing the kilowatt-hour, which is the ultimate test.

The following table contains a complete analysis of the losses in a year's operation in one of the most difficult plants:—

Analysis of the average losses in the conversion of one pound of coal into electricity, B.t.u.:—

1. B.t.u. per pound coal	14150	100	....	....
supply	14150	100	....	....
2. Loss in ashes.........	....	....	340	2.4
3. Loss in slack.........	....	....	3212	22.7
4. Loss in boiler radiation	....	....	1131	8.0
5. Returned by feed-water	441	3.1	....	....
6. Ret'd by economizer..	960	6.8	....	....
7. Loss in pipe radiation	....	....	28	.2
8. Delivered to circulator	....	....	223	1.6
9. Delivered to feed-pump	....	....	203	1.4
10. Loss in leakage drips.	....	....	152	1.1
11. Delivered to small auxiliaries	....	....	51	.4
12. Heating	....	....	31	.2
13. Loss in engine friction	....	....	111	.8
14. Electrical losses	....	....	36	.3
15. Engine radiation losses	....	....	28	.2
16. Rejected to condenser.	....	....	8524	60.1
17. To house auxiliaries..	....	....	29	.2
	15551	109.9	14099	99.6
	14099	99.6		
Delivered to bus-bar	1452	10.3		

Coal should be bought by paying for B.t.u. only, with suitable restrictions on the maximum permissible amount of ash, etc. To test this coal a sample should be taken from each hopper so that we obtain a true average. This sample should be tested in a calorimeter. The loss in ashes mentioned above is probably as low as it is possible to bring it, and the extra cost of labor entailed in any reduction would offset any gain.

The loss to stack, we notice, is a very serious item, and recent investigation shows that this loss may be greatly reduced by the use of more scientific methods in the boiler-room. In nearly all cases it is found that the loss is due to admitting too much air into the combustion chamber, resulting in cooling the furnace. This result is usually due to carelessness and inexperience on the part of the fireman.

The loss in boiler radiation and leakage, amounting to 8 per cent., is largely due to inefficient boiler setting of brick casing, which, besides permitting radiation, admits

(1) "Electric Power Transmission." Bell. Page 427.

(2) "Electric Power Transmission." Bell. Page 430.

(3) "Power Plant Economics," by H. G Stott, A.I.E.E., January, 1906, page 1.

(4) "Power Plant Economics." Stott, A.I.E.E., January, 1906.

a large amount of cold air. This latter loss is increased by an increase of draught. The remedy for this lies in care being taken with the boiler setting and the adoption of up-to-date methods, such as an iron plate air-tight case enclosing a carbonate of magnesia lining outside the brick-work. For the tubular boiler the leakage is less than for the water-tube type, owing to the smaller number of joints in the water space. This advantage is offset by the increased difficulty of construction and the danger of using large boilers of the tubular type, especially with high-pressure steam.

The importance of getting the feed-water to the maxi mum temperature obtainable is generally recognized, and would seem to indicate that all auxiliaries should be steam-driven, so that the exhaust may be utilized in the feed-water heater. In this way the auxiliaries may operate at about 80 per cent thermal efficiency.

(5) In regard to electricity-driven versus steam-driven auxiliaries, the two considerations are economy and reliability. The economy of the steam-driven is greater than of the electricity-driven auxiliaries, and the only objection that can be raised is the extensive piping required for the steam-driven auxiliaries. This piping will have considerable radiation, which cannot be avoided, and if the steam piping to the auxiliaries becomes too great the loss from this cause may be greater than the amount of inherent economy. Pipe radiation is best taken care of by the use of two-layer pipe covering, each layer being approximately one-fifth of an inch thick, and sections put on in such a manner that all joints are broken. This covering of steam pipes reduces losses about 80 per cent. Relative values of several coverings are given here as regards reduction in losses:—

	Per cent.
Mineral wool	90
Asbestos sponge	89
Air felt	87
Magnesia	87
Asbestos navy	86
Asbestos air cell	83

(6) I do not believe that either system will prevail to the exclusion of the other. A very good arrangement seems to be direct-acting steam boiler feed pumps, and possibly centralize vacuum pumps with all the smaller and scattered auxiliaries, such as service pumps, oil pumps, etc., driven by electric motors, the power supply for the motors to be furnished by separate steam-driven exciter sets of sufficient capacity to carry the exciter, plus the motor load, and exhausting into feed-water along with the boiler feed pumps and vacuum pumps. The exciter sets should be located near the boiler and feed water heater so that there will be a maximum of steam and exhaust pipes to and from them to maintain. It is difficult to explain the expense of a piping system for a small steam plant; a steam plant when it is once installed has to be kept hot and drained all the time, so that it appears that the trouble is far greater than the expense.

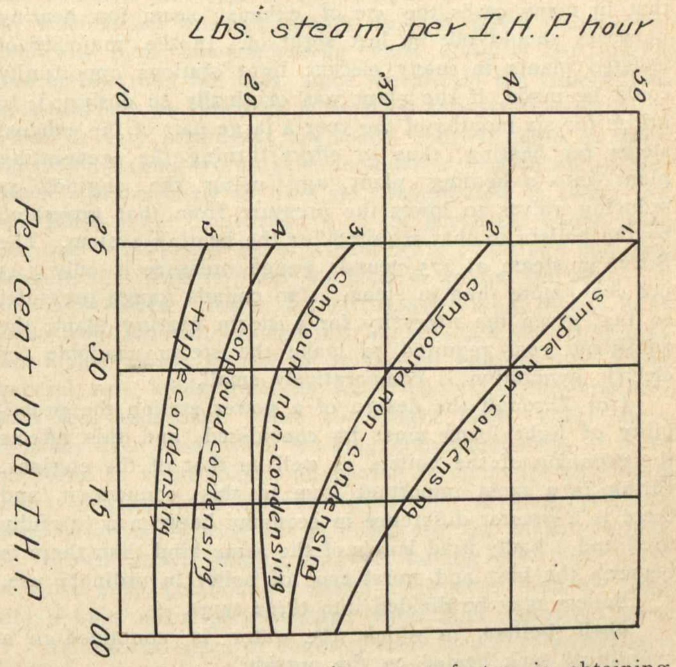
The motor drive for the other auxiliaries permits of direct connection to the centrifugal pumps making very compact, cheap, efficient and easily maintained sets, and entirely eliminates the maze of hot pipes which permeates the ordinary power plant basement, and are a continuous source of trouble and expense to keep covered. Motor-driven sets also do away with the necessity of cylinder lubrication oil cups, and greatly reduce stuffing box and packing expense. Since the exciter sets must furnish the power there is no diminution in the supply of exhausts or feed-water, and, since the power is direct current, there is every opportunity for efficient speed regulation to meet all variable load demands. From these arguments there appear to be valid reasons why steam-driven auxiliaries should not be used exclusively.

(5) P. M. Lincoln, A.I.E.E., February 13th, 1906.
(6) W. E. Moore, A.I.E.E., February 13th, 1906.

(7) Owing to the difficulty of pumping water at temperatures above 150° F., when under pressure, it becomes necessary to install economizers for the purpose of increasing the feed water temperature to 200 or 250° F. As the increase of temperature is obtained from the waste gases at no expense of fuel, it only is necessary to consider the load factor in order to determine whether economizers should be installed or not. The size of the economizer to be installed depends upon the influence of the economizer upon the available draught due to the obstruction it offers, and also due to reduced slack temperature. The second consideration is to equate the interest and depreciation changes against the saving in fuel, and thus determine the amount of investment justified in each particular case.

In regard to the loss in leakage, this should, and can be made very slight, and the high-pressure drips can be returned to the boiler, so that the actual loss from this source is very small. In considering these small losses we might also note that such losses as that delivered to small auxiliaries, heating, and to house auxiliaries are probably unavoidable, and of so small a magnitude as not to merit much consideration.

Recent tests on some reciprocating engines show a mechanical efficiency of 93.65 per cent. at full load, or an engine friction of 6.35 per cent. As this forms only .3 per cent. of the total thermal loss it is relatively unimportant.



The method of oiling is an important factor in obtaining this good result. The method used is what is called the flushing system, whereby a large quantity of oil is put through all the bearings by gravity feed from elevated oil reservoirs common to all the units. The oil, after passing through the bearings, is collected in the basement and pumped to the tanks again with a loss of only .5 per cent.

Engine radiation losses are probably as low as it is possible to bring them, due to the improved methods of heat insulation.

In considering the heat rejected to the condenser, we become involved in the thermal dynamics of the steam engine, a subject so broad that it can only be touched on here. The efficiency of any heat engine: $E = \frac{T_1 - T_2}{T_1}$ where T is the absolute temperature of the steam entering the engine and T_2 is the absolute temperature of the steam leaving the engine. If the united pressure is 175 pounds gauge and the vacuum at low pressure exhaust is 28 inches, then the maximum thermal efficiency is $\frac{837 - 560}{837} = 33$ per cent. In a particular example the point of maximum

(7) "Power Plant Economics." Stott, A.I.E.E., January, 1906.

economy shows a steam consumption of 17 pounds per kilowatt-hour, which is equivalent to 20349 B.t.u. per hour. One kilowatt-hour is equal to 3412 B.t.u. per hour, so that the actual efficiency of the steam engine and generator is equal to $\frac{3412}{20349} = 16.7$ per cent. As the generator efficiency is approximately 98 per cent. at this load, the net thermo dynamic efficiency is 17 per cent.

The difference between the theoretical efficiency and the actual is then 33 — 17 = 16 per cent., of which 6.35 per cent. is accounted for as engine friction, leaving the balance due to condensation radiation and incomplete expansion. These last three must be considered in order to obtain any improvement, and the use of superheated steam is the only remedy at hand. With its use an improvement of probably 5 or 6 per cent. may be effected by using such a degree of superheat in the boilers that dry steam will be had at the point of cut-off in the low-pressure cylinder. Any greater amount of superheat than this will result in loss to condenser, for cylinder losses increase with the difference in temperature. This would seem to point to the use of more cylinders, but this involves additional first cost and higher maintenance charges.

(9) Considering the table, we note that 60 per cent. of heat units are rejected to condenser. It is clear from this that in many cases the use of exhaust seam for heating purposes should not be lost sight of. In the majority of isolated plants in many electric light stations opportunity could be made, if the plant was originally so designed, to utilize for six months of the year a large part of the exhaust steam for heating, thus in effect turning the generating plant into a heating plant, and using the engines as reducing valves to lower the pressure from that generated by the boilers to that required for the heating system. The B.t.u. in steam at 175 pounds gauge pressure is only 5.45 per cent. more than in steam at 10 pounds gauge pressure, so that given the necessity for a steam heating plant, the additional coal required to make the steam available for electric generation is comparatively small.

(10) Through the design of a power station the probability of light loads must be considered, and this affects the economy of the boilers as well as that of the engines. Firing is a most important item in this connection, and there is a greater difference in economy between a carefully fired and a badly fired boiler of the same kind than there is between the best and worst type of boiler in ordinary use.

Boilers may be divided into three types:—

Shell boilers, in which the water is contained in a cylindrical tank heated on the outside.

Tubular boilers, in which there are tubes running lengthwise of the boiler shell, and serving as channels for the heated gases from the fire; and, lastly,

Water-tube boilers, in which the water is contained in a group of metallic tubes, around which the heat of the fire burns freely.

As to the merits of these different types opinions differ very widely, but it is clear from experience that the simple shell boiler is decidedly inferior to either of the others in economy, despite its simplicity and cheapness. Of late years it has been the fashion to employ water-tube boilers under all sorts of conditions on account of their supposed high efficiency as steam producers. Safety and compactness as tests under experiment show phenomenal efficiency, but tests under working conditions hardly give as good results.

Altogether, the subject of boiler efficiency is a very difficult one, since conditions are constantly changing, and the best guides are found from long practical tests than from the theory of combustion. Boiler tests, with the condition of economy in view, are of great importance, and are likely to pay for themselves many times over in a few months of operation. Forcing a boiler usually injures its efficiency, as it increases the consumption of coal for grate area.

(8) "Power Plant Economics." Stott, A.I.E.E., Jan., 1906.
(9) Calvert Townley, A.I.E.E.
(10) "Electric Power Transmission." Bell. Page 326.

Therefore, it follows that a boiler is more efficient at moderate loads than high ones. It may occur in central station practice that despite these facts it is better to force the boilers at hours of heavy load than to keep a relay of boilers banked ready for use.

The best fuel is not always that of the highest thermal value, for, in fact, a grade of coal only moderately good is often the most economical. Good boilers should with careful firing utilize from 70 per cent. of the thermal value of the coal. In regard to actual tests under boilers, examples show from 8 to 13 pounds of water evaporated from and at 212° F. per pound of combustible. As average good steam coal contains from 8 to 13 per cent. of ash and moisture, these results correspond to from 7 to 11¾ pounds of water per pound of coal. Generally speaking, from 10 to 15 pounds of coal are consumed per hour per square foot of grate surface.

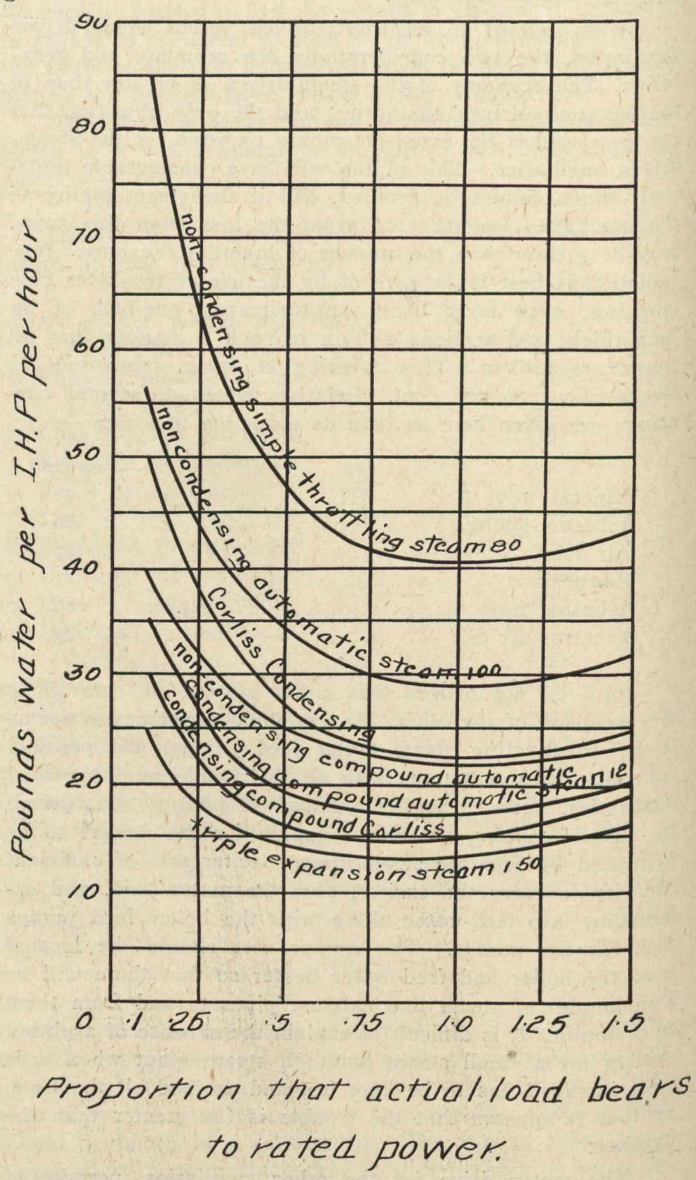


Fig. 2.

(11) The following table gives a general idea of the results of several boiler tests, good, bad and indifferent:—

Kind of Boiler.	Kind of Coal.	Evaporation.
Return tubular	Welsh steam	13.12
Water-tube	Bituminous	13.01
Return tubular	Cumberland	12.47
Verticular tubular	Cumberland	12.29
Marine	Newcastle	11.44
Water-tube	Anthracite	11.31
Plain tubular	Cumberland	10.98
Marine	Anthracite	10.88
Locomotive	Welsh steam	10.44
Cylinder	Coke	10.39
Cylinder	Anthracite	9.22
	Cumberland	8.74

(11) "Electric Power Transmission." Bell. Page 330.

In the above table the evaporation is per pound of combustible. We might notice the small difference in efficiency between the different kinds of boiler. Economy depends vastly more on careful firing and proper proportioning of the grate and heating surface than on the kind of boiler used. Shell boilers, of course, fall below all others in matters of economy; and of the other two classes the water-tube are generally more compact and stand forcing better, but, on the other hand, are more expensive and perhaps harder to keep in condition, more particularly if the water supply is of inferior quality. In the statement of evaporation we were, of course, dealing with firing under tests, which is usually more carefully handled, and were not allowing for ash and banking and general waste, so that, considering these last, we see that actual evaporation is from 15 to 20 per cent. lower, running about 9 or 10 pounds, or even as low as 8 pounds, in cases of varying load, such as we might expect in electrical plants of moderate size.

Most furnaces are constructed to meet the requirements of high-grade fuel, and serious losses result with the use of inferior grades, unless allowances are made for this in grate surfaces, draught, etc.

(12) At the present time there is a demand for larger boiler units, caused by the introduction of the steam turbine, whose relatively small floor space makes a compact boiler of great desirability. It must not be forgotten that the smaller the number of boiler units the less attention they require, and the cheaper their cost of installation, piping and maintenance becomes.

To-day, mechanical stokers are in very extensive use in some parts of the country, and the reports from these, though varying in their nature, would seem to indicate that they are advantageous in the handling of medium and low-grade coals only. Firing large quantities at a fairly uniform rate, they are found to work satisfactorily, while with irregular loads and high-grade coal careful hand-firing is, perhaps, more economical. It must also be noted that automatic stoking saves no labor in small plants. A saving of from 20 to 30 per cent. in labor can be effected by their use in plants using from one hundred to one hundred and fifty tons per week, and this can be increased to 30 or 40 per cent. in plants burning over two hundred tons per week. Coal-handling machinery is not, as a rule, an economical investment in plants of less than one thousand b.h.p.

Primarily, the condition of firing must be taken into account. This is very often overlooked, and any laborer who can handle a shovel is accepted. A poor fireman is dear at any price, and quite as disadvantageous to the station as a poor engineer. Very often poor firing is evidenced by a poor and non-uniform spreading of the coal, and by not admitting just the correct amount of air. With not enough air combustion is incomplete and gases are smoky, while with too much air gases are cooled, and we have a serious loss in efficiency. As boilers are ordinarily set the temperature of the flue gases is greater than is conducive to best economy, and for this reason economisers are introduced.

We have noted the several consumptions for different engines, but the amount of coal consumed per horse-power hour is an indication of the economy of the plant. The cost of fuel varies considerably, and its price on the market is by no means proportionate to its thermal value. As a rule, the coals giving the best economic results are not those of the greatest intrinsic heating power, as the best results are frequently from cheap coal, or a mixture of the two. Here the boilers of a model plant may show an evaporation of only seven or eight pounds of water per pound of coal. For electric power stations operated by steam power the vital, economical question is the cost of fuel per kw. hour rather than the performance of engines or boilers alone. The final result involves the performance under varying loads and the skill of the operator in keeping his apparatus running as near its point of maximum efficiency as possible in spite of changes in the electrical output. This personal element forbids a reduction of the facts to generalities.

(12) W. E. Moore, A.I.E.E., February, 1906.

Steam.

An electric light plant run by steam of a capacity of one hundred to one hundred and fifty horse-power will use from five pounds of coal per horse-power hour to six pounds of coal per electrical horse-power hour.

(13) Steam should be admitted at the highest pressure feasible and exhausted at the lowest pressure possible. This indicates that high boiler pressure should be used, and that it is better to condense the steam than to expel it into the air, as by condensing most of the atmospheric pressure can be added to the working range of the pressure in an engine.

Waste of heat in the engine should be stopped as much as possible. This means checking losses from the cylinder by radiation and conduction and internal losses from cylinder condensation. The first principle laid down has for its object the increase of the possible efficiency, while the second principle bears on the recurring of as large a proportion as possible of this possible efficiency. The work of an engine should be maximum practically for its dimensions and use. To fulfil this condition high pressure and high piston speed are necessary. Compound engines involve the principle of lessening thermal losses in a cylinder by avoiding extremes of temperature between initial and final temperatures. The simple engine may be used where the size is small and coal is very cheap.

Condensing engines always furnish power more economically than non-condensing ones. This is particularly true at less than full load, since the loss at the atmospheric pressure may be taken as a constant source of inefficiency, which is very serious at low loads. For example, a triple expansion engine working at one-quarter load in one horse-power will be likely to have its consumption of steam per one horse-power increased 15 to 25 per cent. above that per one horse-power at full load, while working non-condensing the increase would be from 50 to 100 per cent. per one horsepower. Hence, for elctrical working, where light loads are frequent, condensing engines are an enormous advantage. With simple or compound engines the same general rule holds good as for triple expansion engines, with the additional point that light loads effect their economy even more when working non-condensing. It must be borne in mind that if an engine is to do its best work under varying loads its valve gear and working pressure must be arranged with this in mind, else the advantage may be thrown away. Among engines having the same class of valve gear, compound engines give better economy than simple ones and triple-expansion better than compound ones.

As regards speed of engines, there is always advantages in high piston speed, both as respects first cost and mechanical efficiency. So far as economical use of steam goes, speed makes little difference, except that it sometimes involves a change in valve gear. Most high-speed engines have valve gear of the dependent sort, which puts them at a disadvantage, except in so far as lessened cylinder condensation may offset the losses due to less efficient distribution of the steam, but the best dependent valve engine is less economical than the best independent valve engine of the same class.

With respect to actual economy in the steam consumption, the size of the engine has a powerful, though somewhat indeterminate influence. Even at full load, non-condensing dependent valve engines of moderate size require 30 to 40 pounds of steam per indicated horse-power hour, and only in very large engines does this steam consumption fall below 30. Working condensing, the same machines used from 20 pounds in very favorable cases to 25 to 30 pounds more commonly.

Passing to compound non-condensing engines, the effect of compounding on the efficiency is about the same as that of condensing. Independent valve compound engines, which are seldom worked non-condensing, perhaps use from 18 to 20 pounds of steam per horse-power hour.

When condensation is employed the dependent valve engines are in rather infrequent use. The steam consumption

(13) "Electric Power Transmission." Bell. Page 311.

of dependent valve compound condensing engines is well known to be 16 to 24 pounds per one horse-power hour, with the first-mentioned figure rarely reached. Tests on compound condensing engines with independent valves give 14 to 20 pounds of steam per one horse-power hour, while some tests have run as low as 12 pounds. We may notice from these results that the difference between dependent and independent valve gear is less in compound engines than with simple engines. Compound and triple-expansion engines permit greater expansion of the steam without loss of economy; hence, they allow higher steam pressure and a greater temperature range, thus giving higher thermal efficiency. Good practice indicates that for simple engines the boiler pressure should not be less than 90 to 100 pounds per square inch, for compound engines not less than 120 to 150 pounds, and for triple expansion not less than 140 to 150 pounds, and hence up to 200 pounds.

Kind of Engine.	Steam per 1 h.p. General Range.	Steam per 1 h.p. Working Range.
Simple, non-condensing, dependent valve	30 to 40	33
Simple, non-condensing, independent valve	25 to 30	28
Simple, condensing, dependent valve	20 to 30	25
Simple, condensing, independent valve	18 to 25	21
Compound, non-condensing, dependent valve	20 to 28	24
Compound, non-condensing, independent valve	18 to 25	22
(1) Compound, condensing, dependent valve	10 to 24	20
Compound, condensing, independent valve	14 to 20	17
Triple, condensing, dependent valve	14 to 20	17
Triple, condensing, independent valve	12 to 18	14
Triple, large, condensing, independent valve	12 to 14	13

Unfortunately, engines employed for electrical work are comparatively seldom kept at uniform full load. On railway service there are sudden changes from light loads to very heavy loads, while in lighting service the change in load is usually graduated. These variations affect the economy of the engines unfavorably—at certain loads there is not enough expansion, while at others there is decidedly too much. The variations in economy are largely controlled by the suitability of the engine to its work. For uniformity it is better to rate an engine at the horse-power of maximum economy, whatever the real load may be.

In Fig. 1 curves 1, 2, 4 and 5 are of engines so rated as to have their maximum economy near full load, while the curve 3 is from an engine intended to give highest economy at about three-quarter load. This is generally preferable for variable loads, but for large central station work, where the number of units is large enough to permit loading fully all that are running it is better to have each unit give its best economy near full load, and to vary the number of units instead of the load on each.

For electric railway service under ordinary conditions, it is best to employ an engine which at full load is worked to a high capacity, and hence somewhat uneconomically while at lesser loads, which more nearly correspond to average conditions, its economy will be a maximum. For electric lighting service it is preferable to have the point of maximum economy of all more nearly at full load. For power service, which is on the one hand more uniform than railway service, and on the other hand less uniform than electric lighting work, it is probably best to employ an engine having characteristics between the two mentioned. In cases where variations in the load are very sudden, great mechanical strength of all moving points is necessary, and an attempt should be made in planning the power station to arrange for its best economy at average load.

(1) "Electric Power Transmission." Bell. Page 310.

The curves on Fig. 2 show plainly the advantages to be gained by using compound and triple expansion condensing engines, and disabuse the common fallacy that simple engines are more efficient for varying loads. Their advantage is so great that under any ordinary condition the use of the simple engine is a wilful waste of money. If the saving in first cost was great, their use might be excused, but the extra steam required means addition of outlay in boiler capacity. The curves show that twice the B.h.p. is required for non-condensing engines as is required for triple expansion engines. This same ratio of original cost holds true of the capacity of stack feed pumps, steam piping, water piping, and in the building, so it is poor economy to buy a cheap type of engine.

The greatest economy in recent years has been in superheating introduction, whereby steam on its way to the engine is often raised to 600 to 700° F. This largely increases the working ranges of the engine, and hence the efficiency at a small extra expense of fuel. This high range of temperature has somewhat complicated matters of lubrication, but has been satisfactorily solved, more particularly abroad, where the very efficient result of ten pounds of steam per one horse-power hour has been obtained. Superheaters have been introduced in this country chiefly as auxiliaries to steam turbines, with very good effect, but we do not appear to be getting the very best out of them.

For large railway or power service it is best to direct connect the units for the sake of compactness and economy, and if the station is of the magnitude of 4,000 or 5,000 horse-power, engines direct connecting are advisable in nearly every case. In cases of this kind it is best to work the units at a fairly high speed. It is better to have small units and less weight running at 900 to 1,200 r.p.m. than to exaggerate to size of both engine and generator and run it from 50 to 70 r.p.m. Direct connected units of moderate size give much better efficiency than do the enormously large ones with a heavy piston and enormous flywheel.

We can now refer to engine performances in regard to coal consumption per horse-power hour. The table given below shows the consumption for various engines based on the burning of one pound of coal for every nine pounds of feed-water used, and which may be considered slightly better than is found in practical experience:—

(14) Kind of Engine.	Coal per 1 h.p. hour. Condensing.	Non-condensing.
Simple, dependent valve	2.77	3.66
Simple, independent valve	2.33	3.11
Compound, dependent valve	2.22	2.66
Compound, independent valve	2.00	2.44
Triple, dependent valve	1.88	....
Triple, independent valve	1.66	....
Triple, independent valve (large)	1.44	....

These figures only apply to engines of several hundred horse-power. From this we see that a combination of great efficiency at the boilers and a small steam consumption in the engines gives remarkable results. The best triple expansion engines can be counted upon to do a little better than one and a half pounds of coal per one horse-power hour, but this is under very favorable conditions.

Steam Turbines.

A strong factor in the raising efficiencies of power plants has been the introduction of the steam turbine. Primarily, its first cost is, perhaps, thirty per cent. less than for a steam motor and generator, and it is more economical than the reciprocating engine. With it superheat to the extent of 200° F. reduces the steam consumption about 15 per cent., and its economy is about 20 per cent. better than that of reciprocating engines. It has also been

(14) "Power Plant Economics." Stott, A.I.E.E., January, 1906.

instrumental in bringing the size of prime movers up to about ten thousand horse-power.

(15) The inherent principles involved in the design of the steam turbine show that it can be expected to give an almost perfect adiabatic expansion, as there are no thermal cycles of heating and cooling at every stroke as in the reciprocating engine. Since it is evident that the expansion will be more nearly adiabatic in the low-pressure stage of the turbine than in the low-pressure cylinder of the engine, it has been proposed that the turbine should be used for the low-pressure part of the cycle.

The following calculations show approximately what might be expected from such a combination. Assuming that the 5,000 kw. reciprocating unit would take 50 per cent. more steam when operating non-condensing than condensing, there would be, from experimental results, a con-

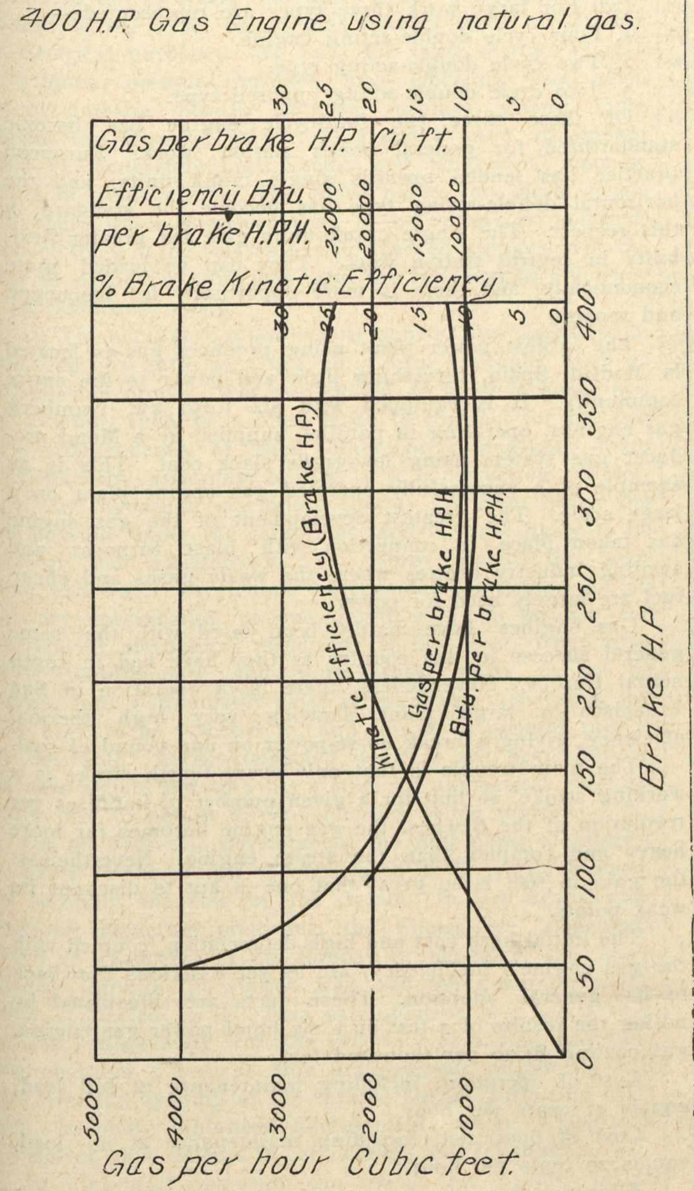


Fig. 3.

sumption of 25.5 pounds steam expanding between the absolute pressure of 190 pounds and 14.7 pounds would give up 165.3 B.t.u. per pound, a total of 4,125 B.t.u. per kw. hour. The total heat in the steam at 190 pounds absolute is 1,197, so that the heat units left for the turbine would be $(1{,}197 \times 25.5 - 4{,}125) \times 5{,}000 = 131{,}542{,}500$ B.t.u. The B.t.u. for turbine, per kw. hour, operating on dry, saturated steam, may be taken as 20,349, but owing to wetness of steam the efficiency would probably be lowered to about 70 per cent., so that the steam consumption would be increased to about 29,070 B.t.u. The total power available for the turbo generator would then be 4,807 kw. Thus, we obtain 5,000 kw. from the reciprocating unit and 4,807 kw. from the turbo unit, or a total of 9,807 kw. at a cost of 15,562 B.t.u. per kw. hour.

(16) In this case the turbine performs exactly the function of a vast third cylinder on the engine, a cylinder of size and shape suited to the load; it receives its load without cylinder condensation; in fact, it has all the characteristics of an ideal cylinder. It is just another expansion working in the field which the reciprocating engine is incapable of filling, and in that field can give as good an efficiency as in any other field, and that efficiency closely approximates to that of a high-pressure cylinder. There has been obtained experimentally on the lower stages of pressure in a single process, corresponding to the work in one cylinder in a steam engine, an efficiency as high as 77 per cent. with saturated steam in a very simple kind of steam engine. This is as well as the engine does, even in the higher ranges of pressure, and about four times as well as it does at the lower ranges.

Suppose that an engine station is operated with engines limited in the matter of overload by congestion in the low-pressure cylinders. Instaling a low-pressure turbine between a low-pressure exhaust and the condenser, and assuming that the engine exhausts at a pressure of 20 inches vacuum, then 20 per cent. is added to the maximum output formerly obtained from the station. The capacity of the turbine is one-fifth of the capacity of the engine. It has no govenor, it has only half the wheels and processes of a high-pressure turbine—altogether it is a very simple device. The turbine would cost probably $35 to $45 per kw., and the additional power produced, if rated on the increase of capacity of the station on an engine basis, would amount to something like five times the cost of the turbine. Consequently, enlargement by the addition of low-pressure turbines may cost only one-fifth as much as the enlargement along the original line, and the results are also better.

In operation a much higher rotative speed and uniformity of angular velocity can be obtained with the turbine. This high speed conduces to a smaller size of rotating member in the generator, while uniform angular velocity is a feature of special importance with reference to the operation of alternators in parallel. These features are, of course, inherent in the construction of the turbine.

Many engineers claim that as regards thermal economy that there is really very little difference between the best steam turbines and the best reciprocating engines. Some actual tests would seem to indicate this, and the guarantees of some engine builders even go farther than those of turbine builders.

It is generally conceded, though, that the most striking innovation in recent years is the introduction of the turbine. The strongest points of steam turbines are cheapness for a given output, economy of floor spact, freedom from vibration, uniform efficiency at varying loads and light friction. Of these, the first is the result of high speed, and it may be said that the turbine goes to the extreme in this respect for the most economical construction, and still it can be built at a cost probably much below that of any other direct-connected unit. Economy of floor space is very marked, more particularly in the vertical type, but this is actually less than at first appears, since the boiler location generally determines the area of the plant, and turbines cannot be huddled into the space which their dimensions would suggest.

Some authorities give that, at equal pressure, superheat and vacuum, the steam turbine in its present stage is about as efficient per break horse-power as a first-class compound (17) condensing engine. With reference to the use of superheated steam, it should be said that superheat causes no additional lubrication expense on the turbine such as is necessary with high superheat in engines. The use of superheated steam is especially adaptable to turbines, and all the economies incidental to its use are easily obtained. Average results for a 400 kw. Westinghouse-Parsons unit show an increase in economy of 5 per cent. for 50° superheat and 10 per cent. for 100° superheat, 15 per cent. due to 150° superheat.

---

(15) "Power Plant Economics." Stott, A.I.E.E., January, 1906.

(16) W. L. R. Bennett, A.I.E.E., March, 1906.

(17) W. E. Moore, A.I.E.E., February 13th, 1906.

The increase in economy due to increased vacuum is also greater than in the steam engine. For every inch increase in vacuum between 23 inches and 28 inches the increase is 3 per cent. for 100 kw. units, 4 per cent. for 400 kw. units, and 5 per cent. for 1,000 kw. units.

(18) Obviously, the use of a high vacuum is important in turbine work, and efforts for obtaining this vacuum have met with every success. Only by using a vacuum of 28 inches and 100 to 150° F. superheat can the best results be obtained from turbines. Sometimes a reciprocating engine can be run non-condensing economically, but the advantage of condensation is so much greater with the turbine that the only reason for running non-condensing is the need of steam for other purposes. By instaling cooling towers in a non-condensing plant the output can practically be double without adding to the operating cost.

Recently turbines carrying expansion to as many as five stages have been introduced, and from large units of this construction it is possible to secure economy equal at least to that of a first-class triple expansion engine.

Gas Engines.

The gas engine has probably developed more slowly than any other piece of apparatus, and it is only within the last ten years that the larger type of engine, from 500 to 2,000 h.p. in size, has appeared. For highly intermittent service gas engines are undoubtedly cheaper than steam, and in ordinary units the cost of operating is very low, but against this we have a high first cost and much depreciation. The delay in the success of the gas engine may be said to have been due to the difficulty experienced in bringing forward an efficient and inexpensive method of making gas.

The chief objections to this prime mover are lack of uniform angular velocity, uncertainty of action, high cost of maintenance and inability to carry heavy overloads. Of late years the first two of these have been removed, and vigorous development has placed the gas engine in the front rank. The cost has been so reduced that to-day it is very little more than a high-class reciprocating engine, and with natural gas has, perhaps, outdistanced all competitors. The most economical load is at between 50 to 90 per cent. full load, and this is a serious defect. It has been found that a combination of the gas engine and the steam turbine gives good results, and the water from the gas engine may be used for boiler feed, as it is above 100° F.

Curve No. 3.

(19) The jacket water necessary for an internal combustion engine is about 40 pounds per kw hour, and, assuming that jacket water enters at 50° F., then the discharge temperature will be $50 + \frac{19 \times 12,500}{40 \times 100} = 109.4°$ F. from special example considered. As the steam turbine will only require about 15 pounds per kw. hour, including auxiliaries, it is evident that only 37.5 per cent. of this heat or 7.1 per cent. of the jacket water loss can be utilized. The other loss in the exhaust gases of 30 per cent. can be utilized either in economizers or directly in boilers or superheaters.

Considering the combination of gas engine and turbine, we may say that it is reasonable to expect a maximum thermal efficiency in the turbines of 15 per cent. Referring to Table No. 1, we note a loss of 2.4 per cent. due to ash, which is now evident does not exist, and that loss of 22.7 per cent. in slack can be reduced to about 5 per cent. as the process of combustion is complete in the gas engine. The total efficiency of conversion of this 30 per cent. of heat from the waste gases when used in turbine plants will then be $15 + 2.4 + (22.7 - 5) = 35.1$ per cent.

The heat recoverable from the jacket water was shown to be 7.1 per cent. of the total heat in the coal, so that there is 30 per cent. plus 7.1 per cent. = 37.1 per cent. of the original heat of the fuel returned from the gas engine, and this can be converted into electrical energy at an efficiency of 35.1 per cent.

For each kw. delivered by the gas engine plant 3,918 B.t.u will be turned over to the steam plant, and this in turn will give 403 watts to the steam engine free of cost. The steam plant will then have only to furnish 1,000 — 403 or 597 watts per kw. at a thermal efficiency of 15 per cent.; in other words, the economy of the steam part of the plant will be raised to $\frac{15}{0.597} = 24.5$ per cent.

Gas engines on this continent run with pea anthracite as fuel. Anthracite screenings, coke, charcoal, sawdust, and many waste products may be used to advantage. Gas engines from 20 to 150 h.p. use about 1¼ pounds of coal per break horse-power, or 1½ pounds per e.h.p.

(20) For large work three types are represented:—

1. Four cycle double-acting engine.
2. Two cycle double-acting type.
3. Two cycle double-acting opposed type.

Of these three, the four-cycle engine has become standardized for general power station work. European practice has tended towards single crank units, and the horizontal double-acting type has become the standard in this respect. The single crank units give far greater flexibility in central station work. They can be loaded more economically, and there is more opportunity for inspection and repairs.

The largest power plant using producer gas is located in Madrid, Spain, furnishing light and power to the entire community. It is equipped with six 1,250 kw. Numberg gas engines, operating in parallel, supplied by a Mond producer gas system using low-grade slack coal. This is an example of a successfully operated gas engine plant on a large scale. The greatest development of the gas engine has taken place in connection with blast furnaces and availing industry centres where the waste gases and cheap fuel are largely used for power.

Gas engines have hardly been used with the same general success in this country as they have had in continental Europe. Nevertheless, there is in operation in San Francisco a large plant showing very high thermal efficiency, giving a break horse-power on one pound of coal.

The main trouble is that only every fourth stroke is a working stroke, so that for a given number of impulses per revolution of the flywheel the gas engine becomes far more heavy and complex than the steam engine. Nevertheless, the gain in fuel is so great that one is apt to discount its weak points.

The initial high cost and high depreciation, coupled with the gas engine's inefficiency, are as yet a serious drawback to its general adoption. These facts are illustrated by noting the results of a test on a six horse-power gas engine, gas costing $1.70 per thousand feet:—

Cost of operation, including maintenance at full load, equals 41 cents per hour.

Cost of operation, including maintenance at no load, equals 20 cents per hour.

Allowing $10 per horse-power year for interest and depreciation, we can easily estimate for a 3,080-hour year at full load:—

3,080 hours at 41 cents....................	$1,262 80
Interest and depreciation..................	60 00
Total	$1,322 80

Cost per horse-power hour equals $7.15, of which interest and depreciation amount to 31 cents per horse-power hour.

Secondly, suppose engine in use three hours a day and running idle rest of the time:—

924 hours at 41 cents....................	$378 81
2,156 hours at 20 cents..................	431 20
Interest and depreciation..................	60 00
Total	$870 00

(18) W. L. R. Emmett, A.I.E.E., March, 1906.

(19) "Power Plant Economics." Stott, A.I.E.E., January, 1906.

(20) Rudolph Wintzer, A.I.E.E , February, 1906.

This is $12.08 per horse-power hour actually used, and is a very fair type of present practice, as gas engines are more commonly used for engines under 100 horse-power. This, of course, does not apply to producer gas plants.

Water Wheels I.

The importance of the development of water powers for electrical purposes is just becoming to be realized, and to-day we have the very largest plants operated entirely by this prime mover. The lessons of the last few years have been exceedingly valuable, and it is safe to say that the utilization of water power for electrical development will be kept up until every one which is capable of successful development commercially is worked to its utmost capacity. In spite of the length of time that water wheels of various sorts have been used, it is only quite lately, with the introduction of the turbines, that these prime movers have been brought to the development that renders them satisfactory for electrical purposes. We have the three distinct classes of turbines: pressure turbines, most efficiently used when low or uniform heads; impulse turbines, giving more efficient use of water at part load and a more convenient speed at moderately high heads, and tangentical impulse wheels do relatively the best work under very high heads and where water does not have to be rigidly economized. Each of these three classes has decided advantages over the other in particular situations, and the full load of efficiency is approximately equal.

(22) The success of a power development and transmission plant depends quite as much on careful hydraulic work as transmission proper. The two should go hand in hand, and any attempt, such as is often made to contract for the two parts independently of each other, or to engineer them independently, generally results in a construction of electrical and hydraulic machinery that is far from being the best possible under the conditions, and is quite likely to be anything but satisfactory. As before stated, the generator and water wheel must be considered together, for an arbitrary specification of one might well be beyond the electrical or mechanical possibility of the other. When generator requirements and water wheel limits cannot be brought into a reasonably close relationship, then gears and belts have to be resorted to, and this as a general rule is not desirable. Direct-connected work is the best, but an engineer should not ruin his station by unpractical arrangements just to obtain direct-connected prime movers.

On all hydraulic development the first point of interest in regard to the design of wheel used is the available head, and secondly, the flow of the stream. In low heads, and, therefore, moderate pressures, the wheels are sometimes placed in chambers in the forebay or headrace, the shaft running through the station wall and the generator being direct connected to it. This arrangement is a good one, because it does away with the necessity of having hydraulic valve-operated gates, as this arrangement of wheels will start with the opening of the turbine bucket gates and draft tube. In many high-head developments where a penstock is required this scheme is, of course, impracticable.

In high-head operation the wheels are usually inside the power station, and are incased in a large initial chamber, used as a water jacket. This arrangement calls for gate valves, and these are, perhaps, better operated hydraulically. A by-pass round the gate is essential in this type of wheel in order to fill the water jacket of the wheel before attempting to raise the gate, thus helping to equalize the pressure on each side of the gate and greatly relieving the gate-raising equipment. This by-pass arrangement may be very simple in construction and operation, and does not need to be controlled by a hand-valve, as with a plant running nearly continuously it need not be often used. If it is not desirable to have these wheel-gates operated hydraulically, an electrically-driven device from the exciters may be used, thus putting the operation in the hands of the general operator and centralizing control—a desirable thing in case of accident.

(22) F. Osgood, A.I.E.E., April, 1907.

One of the most common difficulties in laying out a hydro-electric plant is due to the variability of heads. The methods taken to get over this are various. A common one is to arrange the wheels to operate normally at a partial gate and to open at lower heads, while at higher heads the wheel is throttled still more. Such an arrangement works the dynamo in a fairly efficient manner. Another method of overcoming the difficulties due to variation in head is the installation of two wheels on the same shaft, one intended to give normal power and speed at ordinary head, the other at the emergency head. This practice is carried out in various forms. Sometimes two wheels may be mounted on the same horizontal shaft, and one of them is disconnected and runs idle unless needed. Another modification of the same general idea is the use of the duplex wheel with the runner and guides, arranged in one or two concentric sets of sockets, which can be used singly or together, according to the available head. This can be made a very effective way of maintaining uniform speed, and, although its first cost is high, it is decidedly economical of water at normal head.

MODERN GERMAN RAILWAY CAR TILTER.

Recently there has been erected in Germany a tower for tilting railway cars which contains several novel features. In Cosel-Oderhafen, an inland harbour, great quantities of coal arrive which are to be sent off from there by ships. The main object was to perform this large unloading business in a minimum of time and without many human hands. The ordinary types of car tilters could not be used on account of the considerably changing water-level and of the brittleness of the material to be shipped—coal.

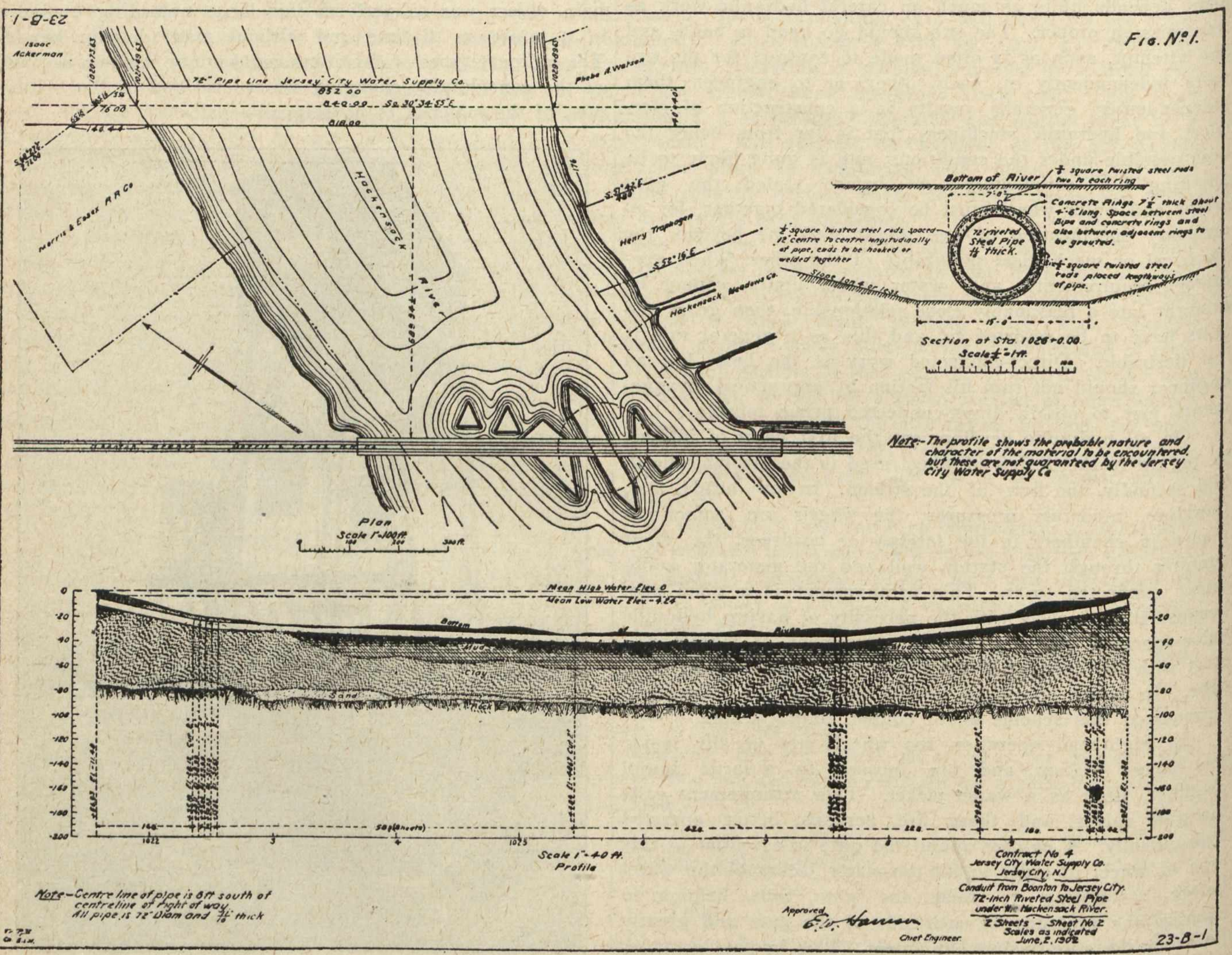
Car Tilter.

A special apparatus therefore was designed, the principal feature of which is that it prevents crushing of the coal, as this falls always from the same height, irrespective of the water level, which varies between 165.25 and 169.7, that is 5, 4 meters. The platform is made vertically movable, by lowering that portion near the water, or raising the other part of shifting both accordingly, also it is turned to an angle of 45 degrees. The dead loads are counterbalanced by heavy weights. In the horizontal position the platform is locked by automatic stop-devices in such a way that the ropes are relieved from the pull when a car is drawn upon the platform. The process is as follows: A loaded car arrives on the track and is pulled on the platform. At high water-level an electric hoist lifts the landside portion and tilts it to 45 degrees; at low level the other side is let down and so on. For this purpose a second electromotor is installed. An additional novel feature is also the way of moving the cars from and to the tilting apparatus. Here again electricity is employed, and this increases the economy of the process considerably, compared with the difficult, tiresome way of pushing the cars by hand, which always requires several men and is expensive and slow. An electric spill pulls first the cars upon a turntable, turns it at 90 degrees and then draws it on the platform. Here it is locked automatically by clamps fastened to the front axle. The platform is tilted and the material falls into a box with a funnel-shaped end. The latter is closed by a trap-door, which is also electrically operated. It can be opened more or less by the engineer from his place according to the quantity of coal. After the car is emptied the car is tilted back to horizontal position and pushed by the spill over the turntable to a side track to make room for another car. It can be seen that extensive use is made of electric energy. During the short time this fine apparatus is in service it has worked very satisfactorily.

REPAIRS TO A 72-INCH STEEL MAIN UNDER THIRTY FEET OF WATER.*

By A. W. Cuddeback,
Engineer Jersey City Water Supply Co.

The pipe to which these repairs were made is a part of the plant of the Jersey City Water Supply Company furnishing Jersey City, N.J., with water. This line is about 21 miles long, and runs from a large storage reservoir at Boonton, N.J., across country to Jersey City, and consists of concrete conduits, tunnel and steel pipe. The portion of this line in question under the Hackensack River was laid in 1902, and consists of 11-16-inch riveted steel pipe, six feet lengths, made up of four sheets. These were connected upon the west bank of the Hackensack River on staging suitable for the purpose, carried out across the river and supported on floats. As the pipe was connected, it was enclosed in reinforced concrete rings, which were made in forms and slipped over the pipe and afterwards grouted, making eventually a continuous concrete covering. The weight of the pipe and concrete covering being just sufficient to sink it. After



in diameter. Figure 1 shows the general plan of the Hackensack River at the point where the line crosses; a cross section of the pipe in place in the river bottom; and a longitudinal cross section showing the general character of the supporting soil.

The method employed in laying the pipe was as follows: The pipe was furnished on the ground in about 28 foot pipe composing the river crossing was completed and entirely supported by barges, it was lowered to its final position in a trench that had been prepared for it by dredging, as shown on Figure 2 accompanying the paper.

At the time the pipe was lowered into place and just as it was filled with water, a break occurred in a field joint at approximately the centre of the river. The exact point of this break is noted on Figure 2. This break was first noticed December 15th, 1902, shortly after the pipe was lowered

* Paper read before American Waterworks Convention, Washington.

into place and filled with water, and before the ends of the pipe were connected to the balance of the line. After discussing the possible character of the break and the method to be employed in repairing it, it was decided to build bulkheads in each end of the pipe, force the water out by air pressure, go in and make an examination. After considerable trouble the contractor who laid the pipe, and who was making the repairs, succeeded in getting the water out on about January 10th, 1903. It was then discovered that the pipe had opened up. In other words, a plate had parted about ⅞ of the way around the pipe, the widest opening, 2½ inches, being on the bottom. It was repaired by putting a complete ring of steel plate inside the pipe over the break and fastening with stud bolts. The ring was put on in five pieces and the repairs finally completed about February 16th, 1903, two months after the break was first discovered.

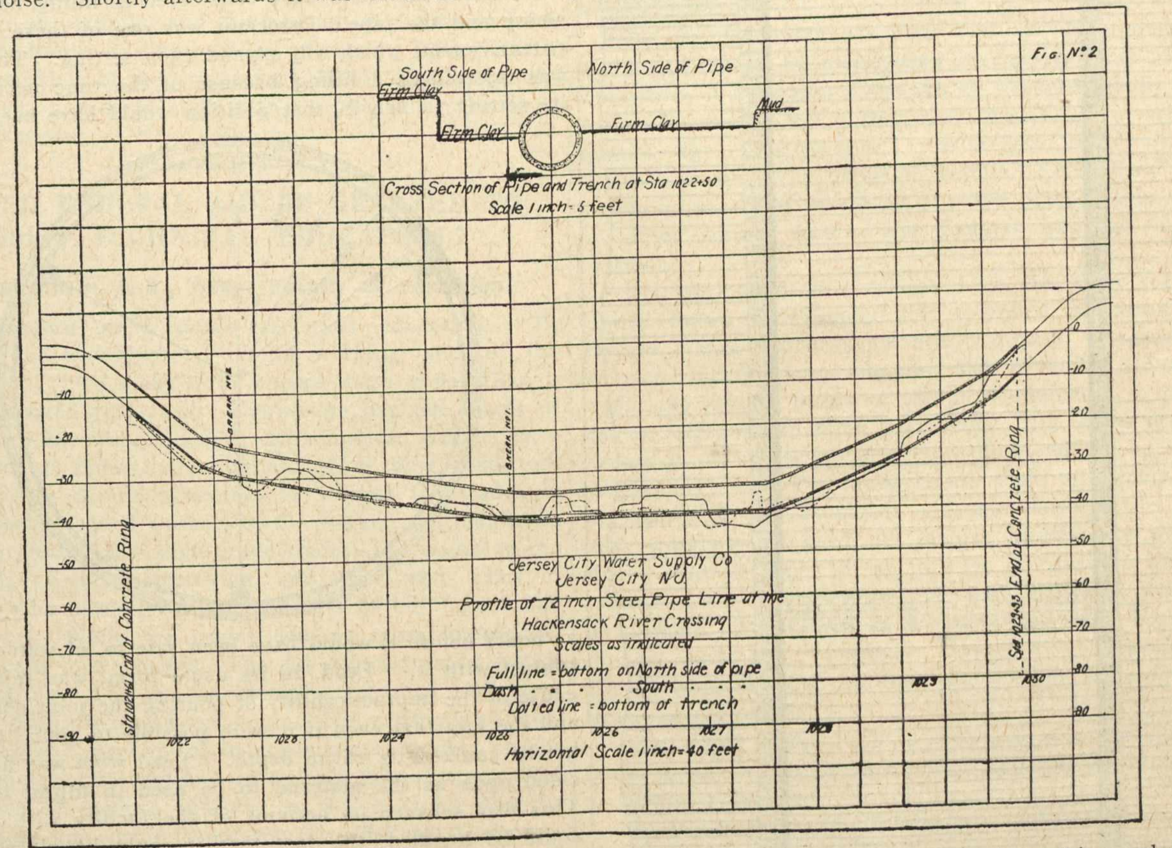
No further trouble was experienced with this pipe until some time in 1904, when an examination of the river crossing developed the fact that there was a small leak. This was discovered by the sound which was plainly audible when passing over the pipe in the river in a boat. In November, 1904, a diver was employed to make an external examination of the pipe, but he could discover no evidence of a leak, except the noise. Shortly afterwards it was observed that considerable water was being lost between Boonton and Jersey City. The measurement of the water flowing into the pipe was made through sluice gates at the intake at Boonton, and at Jersey City through a 72-inch Venturi meter. The noise at the river crossing made by the leak continued to increase, and the difference in the quantities, as measured at Boonton and Jersey City also increased, until the loss was between five and six million gallons daily.

In the fall of 1907, we again employed a diver to examine this pipe from the outside, and this examination made October 7th, 1907, showed that there was a substantial stream of water coming out of the pipe at about Station 1022 + 50, shown on Figure 2. The diver reported that the stream coming from the pipe was of sufficient velocity and volume to force his body to one side when he passed in front of it, and that there was a hole in the concrete covering on the side of the pipe about ten inches square, and that the velocity was so great that he could not feel of the pipe to determine the character of the injury to the steel plates. The diver's description of the leak and the quantity of water being lost, convinced us that we should make repairs at once.

It was at first decided that repairs might be made more economically without the aid of air pressure, and plans were made to get at the leak by pumping out the water. This pipe crossing the Hackensack River is in the middle of the Hackensack Meadows, and about two miles from the nearest point that could be reached by wagon road, and at least two miles from the nearest point where power could be obtained. After considering the feasibility of getting electric power to operate the pumps, which would of necessity have to be placed inside the pipe in order to handle the water, it was decided that the cost of getting electric power would be excessive, and the difficulty of getting a steam plant there and handling the exhaust pipes within the main pipe, led us to decide to abandon this method and make the repairs by means of compressed air.

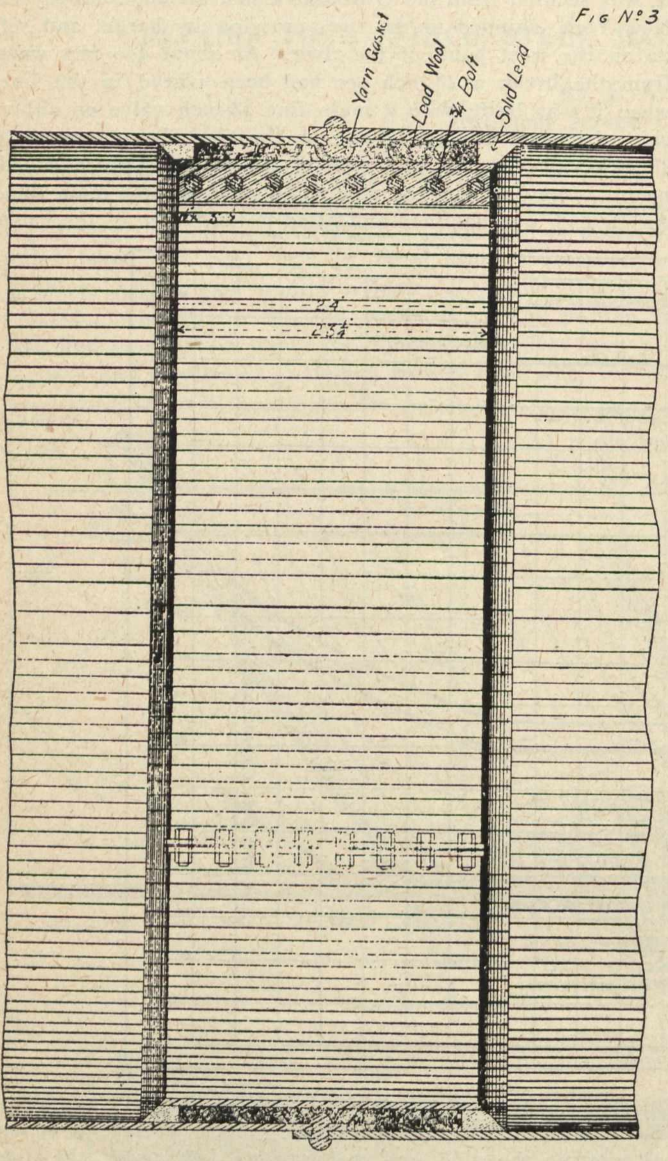
A compressed air plant of sufficient capacity to handle the job, together with the necessary boiler power to operate it, was secured from the O'Rourke Construction Company of New York, shipped to the river crossing by barge, and set up on the west bank of the river. At about 400 feet west from the break a 48-inch tee had been placed in the line when it was built, with a main line 48-inch valve on either side of it, and a 48-inch valve on the tee; also a main line 48-inch valve on the east side of the river. This afforded means of getting into the pipe without cutting the main line. An air lock was obtained and fitted to the flange of the valve in the tee, the plant set up and got in working order. About 200 feet east of the 48-inch branch which afforded a means of entering the pipe, and therefore 200 feet nearer the river and the break, was a manhole. As soon as the pressure was off the main line, the cover was removed from this manhole, and another cover which had been previously fitted with a 3-inch tapped opening through which a 3-inch nipple was screwed, was put on in its place. From this manhole we then connected a line of 3-inch screw wrought iron pipe, which had been previously prepared in suitable lengths and carried this 3-inch pipe down the 72-inch pipe toward the break as the water was forced out of the 72-inch pipe through the break by the pressure of the air. This 3-inch pipe acted as a discharge for the water after the break had been stopped up and no more water could be forced out that way, and proved of sufficient capacity.

On December 1st, 1907, we made the first move towards getting into the pipe to determine the nature of the break. We shut down the main line valve on either side of the river, thus isolating the river crossing, which is about 1,000 feet in length. These valves were finally closed at about 2 p.m. After these valves were closed the 48-in. valve on the branch was opened and as much water allowed to run out this



section of pipe through the airlock as would do so. Then the airlock was closed and the air compressor was started. No difficulty was met in forcing out the water until it got to such a level in the pipe that the air would escape through the top of the break. As soon as this point was reached the air escaped with such rapidity that no further progress could be made towards forcing out the water. Several schemes were tried before we finally succeeded in plugging up the crack sufficiently to hold the air and force out the rest of the water. It being in the winter time it was exceedingly unpleasant to wade in water up to ones neck and by hand plug up the crack with clay. Large quantities of waste and gasket yarn were floated out on boards in the pipe and the crack partially plugged in this way, but this method was found to be slow and unsatisfactory. Finally the foreman

Fig No 3

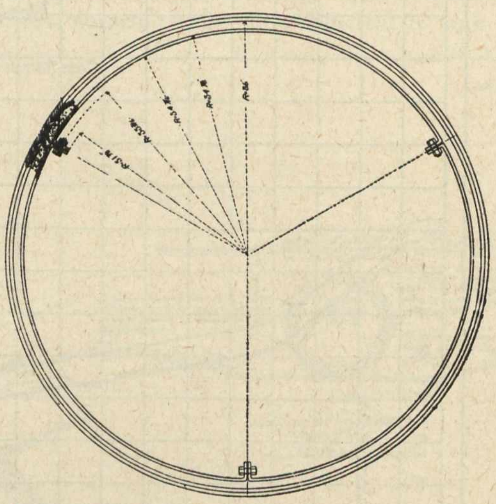


Longitudinal Sectional Elevation

in charge of the work waded out in the water in a diver's suit and succeeded in plugging up the crack with clay, after which there was no further difficulty in forcing out the water sufficiently to allow men to enter and examine the pipe thoroughly. It was discovered that the pipe had cracked about 3-5 of the way around, the crack being on top, and open at its widest part from ⅜-inch to ½-inch. This work took all Sunday afternoon, December 1st, all day Monday, the 2nd, and up to 2.30 p.m. on the 3rd, when we finally got down so could make an examination and determine the nature of the rupture in the pipe. At this time we were notified by Jersey City that they were getting short of water, and that we would have to turn the water through this 72-inch pipe again in order to maintain their supply. The water was again sent through the pipe at 6 p.m., December 3rd.

Owing to the difficulty of maintaining the supply to Jersey City without this 72-inch main being in service, and therefore, the time for making repairs being limited, to practically a 48-hour period, it was seen that it would be utterly impracticable to repair this break in the manner that the first break had been fixed. It had been our intention before examining the break to make repairs as before, i.e., to rivet on patches with stud bolts, but we now decided that this could not be done without delay and that repairs must be made in the shortest possible time, and the question was, how repairs could be made so that they might be completed in the least possible time. After considerable discussion of various plans proposed, it was decided to put an internal ring in the pipe, and our first thought was to make this ring of cast iron. After considering the subject in all its phases, especially the difficulty of handling the heavy weight of iron that would be necessary, it was finally decided to make the internal sleeve of steel plate. This sleeve was made up of three steel plates, two feet wide by six feet long, as shown on Figure 3 accompanying the paper. It was thought that these plates could be bent to form an angle for bolting together, as shown on the drawing, but it was discovered that this could not be done without cracking the plates, and angles were riveted to the plates to form flanges. Set screws were put in the plates to assist in adjusting and holding the sleeve in position in the pipe.

Several materials were considered as filling between the sleeve and the pipe. Pyrocenit was one of these; this is a patent cement which will expand upon setting. This cement was rejected as a filling because of the time necessary for its setting, which in that position would have been at least



24 hours before it would have been safe to let water come in contact with it. Lead, in its usual form, was rejected because of the impracticability of pouring the joint completely, and the fact that even if it were possible to pour it, it could not be caulked its entire depth. Lead wool was finally decided upon as the material to be used in filling the joint. This was selected on account of the facility with which it could be handled, the fact that it could be placed in the presence of water, and that it could be caulked in the entire depth of the joint.

After the first examination of the pipe was made, the actual starting of repairs was delayed for several days until arrangements to supply Jersey City with water, while the conduit was out of service, were made, and the repairs proper were begun on December 19, 1907. The water was turned off at 8.45 a.m. on this date, and the pipe finally emptied below the position of the break the necessary tools, sleeve, materials, etc., gotten in the pipe by 6 p.m. During the night the sleeve was placed in position ready for the filling material.

After the sleeve was placed in position, the centre of the joint around the row of circumferential rivets of the pipe and where the crack was located, was thoroughly caulked with ordinary gasket yarn smeared with clay, in order to prevent the water working in and getting in around the layers of lead wool which were to follow, and to act as backing for the first layer of lead. Then the filling was continued from either side with lead wool and thoroughly caulked to within about two inches of the outside edge of the sleeve. This outside space was filled with strips of solid lead, three or four feet long, which had been poured in moulds the thickness of the joint, thoroughly caulked, and leaving the sleeve finished in position as shown in detail on the longitudinal sectional elevation, Figure 3. The work of caulking in the lead wool was begun at 6 a.m., December 20th, and carried on continuously until finished, and the water again turned on about 7 p.m. of the same day, making the total time that the conduit was out of service approximately 36 hours. The pipe was tested for leakage when the water was turned on and found to be tight.

Special home-made caulking tools were used in placing the lead wool in the joint. The men who actually made the repairs worked in two shifts of five men and foreman for each; two hours in and two hours out of the conduit, the same men working in this was from start to finish of the job. The men were all from the regular working force of the company, and were selected for their known qualities of endurance, and to their faithfulness is due very largely the successful completion of the job in so short a time.

To Chris McGarry, the general foreman in charge of the work, great credit is due for the careful and complete manner in which he carried out the plans, and provided for all emergencies likely to arise in such an undertaking.

Acknowledgment is hereby made of the assistance and advice given in planning and carrying out this work to John H. Cook, hydraulic engineer of the company; Edlow Harrison, chief engineer of the company; J. Waldo Smith, consulting engineer, and Fred Gubelman, of the O'Rourke Construction Company of New York.

SHOULD FEDERAL AID BE GRANTED TO ASSIST TECHNICAL EDUCATION?

W. Packenham, B.A., Dean, Faculty of Education.

The modern world needs technical education. "To make well and to sell cheap" is the working creed of the great nations. "To make well" means more to-day than it meant a hundred years ago. Knowledge has put forces of nature into subjection. Science, mathematics, and art have transformed all industrial activities. They have made old trades more exact and scientific, as witness the trades of the woodworker, metal worker, textile worker, and engineer. They have created new high-grade trades—the trades of the art worker, chemist, electrician, and that vast army of tradesmen who minister to the comforts of our homes and leisure hours. While the trades demand more knowledge, the shop tends to teach less. The old apprenticeship system is disappearing. The machine replaces the man. All work becomes standardized and automatic. The workman, limited in functions and mechanical in attainments, quickly attains his full industrial stature and as quickly degenerates. Over every phase of modern industry is written large the demand, "More knowledge," and side by side with it appears the response, "Less opportunity." Here lies the need of technical education.

What is the world's need is in a special sense Canada's need, and what is the need of the man at the bench or counter is in a special sense the need of the captain of industry or the consulting engineer. Canada's raw materials are widely distributed and difficult of access. Her motive power is unlimited, but remote from urban centres. Her problems of transportation are greater than those ever yet solved by six million people. And she is exposed to the competition of the greatest industrial nation of modern times. Here lies Canada's special need of the highly-trained expert.

But technical education is expensive. No two nations and no two educationists agree as to its form and content: it is still in the realm of experiment. Experiments are proverbially expensive. They consume material under conditions that are not commercial. They have to do with hordes of students whose fee-paying powers are limited, and with teaching plants as varied as the trades and as unstable as machine shops.

Who will bear the expense? In Europe the burden rests with varying stress upon the trade guilds, the manufacturers, the municipalities, and the State. Everywhere the State's proportion of the burden steadily appreciates. In America, next to the municipalities and the State, the philanthropists are the fairy god-mothers of technical education. Here, too, the State assumes a steadily increasing proportion of the cost of maintenance.

It would be far from generous to belittle the splendid benefactions of such men as Sir William McDonald, but Canada's needs in this matter of technical education cannot be met by her philanthropists. Nor should the municipalities be expected to meet them. These needs are national, not local. In any case. the burden would be too great for the municipalities. It remains, then, for the State to take up the burden.

Now, the State may mean the Province or the Dominion. The Province, let it be confessed, cannot do much. Its revenues are limited, and they are strained to the breaking point by recent subventions to elementary education and to instruction in agriculture. The Dominion, on the other hand, has buoyant revenues collected from the people of all the Provinces. It has a splendid asset in Crown lands purchased at the expense of all the Provinces. Finally, it has a dominant interest in such national issues as commerce and industry.

But the Dominion has been cautious, not unreasonably cautious, perhaps, in recognizing its duty in these premises. Education, it has pointed out, is, in the term of the B.N.A. Act, a Provincial, not a Dominion interest. It is unwise to disturb the Constitution. Interferences with Provincial rights have not been happy in results. Federal aid to education in one form would be a grave precedent as regards all other forms. And so the Federal publicist has been cautious!

Let us look at this caution from the other side. The United States Government aids technical education in the various States, and does not find it difficult to separate one form of education from another. The Dominion Government itself aids certain forms of technical education in the Provinces, and has not found grave difficulties in the precedent. Grants in aid of technical instruction would not be unhappy interferences with Provincial rights when all Provinces and all classes in the Provinces welcome those grants. Moreover, grants-in-aid need not involve interference with Provincial control. They do not involve interference with State control in the United States, or with Cantonal control in Switzerland. The Constitution should be sacred, but it must change with the centuries. Canada's Constitution has already been changed for interests scarcely as important as technical education.

But would Federal aid to technical education be a violation to the British North America Act, and would it require a change in that Act?

In the terms of the B.N.A. Act trade and industry are Federal interests. Technical instruction belongs to trade and industry. Is it not, therefore, a Federal interest? The Dominion maintains a splendid type of instruction in engineering in the Military College at Kingston, and defends such technical instruction as attaching naturally to militia and defence, which is a Federal interest in the terms of the Constitution. It maintains experimental farms, dairy stations, and cold storage centres, with bulletins to instruct the people in the operations of these agencies, and defends this technical instruction as attaching naturally to agriculture, which in its larger phases is a Federal interest in the terms of the Constitution. It goes even further. In commercial agencies in the world's great trade centres, and in national expositions and world expositions, it aids or organizes magnificent agencies in the development of industrial intelligence—a form of technical education which attaches logically to trade and industry, and is a Federal interest. Surely it would not be altogether unnatural, or illogical, or illegal, to recognize all instruction in the arts and crafts as within the sphere of trade and industry, and to that extent a Federal interest.

Even if technical instruction were a thing apart, attaching itself to education proper and not to trade and industry, the Federal Government could still aid it and be consistent with its own practices. It assists the Canadian Mining Institute, the Royal Society, the National Art Gallery, and the National Museum. It maintains several biological stations, schools of navigation on the inland lakes, and to some extent the Department of Railway Engineering of McGill University. It organizes a Bureau of Standards, instructs the commercial classes in the metric system, and experiments in the electric treatment of Canadian ores. Through its grants to the Royal Canadian Academy it aids the art schools of the Provinces. Would it be wholly inconsistent to subsidize the science and art of the technical schools?

Federal grants to technical education would find precedents in the practices of other lands. The authority of the Federal Government in Germany is singularly circumscribed. The German States are practically autonomous, and jealously so. Education attaches to each State. And yet out of its large ambitions for commercial supremacy the Federal Government maintains an Imperial Physical and Technical Institute for standardization and research in the industries, and organizes navigation schools, shipbuilding schools and schools of naval engineering on the Baltic.

Decentralization of authority is the keynote of the Swiss Constitution. Differences in race, language, and creed have secured permanence for that keynote. In the terms of the Constitution education is transferred formally to the Cantonal Governments, and the Cantons are peculiarly sensitive as to the maintenance of their prerogatives. But they welcome Federal interest in industrial education, and Federal grants in aid of the trade and industry of the country. Thus it comes about that the Federal Government maintains at Zurich one of the world's foremost colleges of Technology. It subsidizes the higher commercial colleges of the Cantons, and even many of the primary commercial schools. Quite recently, indeed, it has organized a schedule of grants for agricultural and industrial education of an elementary type, for schools of domestic economy, and for schools for the professional training of women.

But more interesting to us and more pertinent is the precedent set by the United States. State rights mean more to the average American than Provincial rights mean to us. Education is a State right, and yet in the Morrill Act of 1862 the United States Congress granted the equivalent of 13,000,000 acres of land, valued at $10,000,000, to the various States in aid of State colleges for instruction in agriculture and the mechanical arts. In the Morrill Act of 1890 Congress added to this an annual grant to each State of $15,000 (which increased to $25,000 in ten years). Going even further, Congress makes a special grant to each State of $15,000 in behalf of an experimental and scientific station in agriculture. From all sources the Federal grant to the State in behalf of technical education now amounts to 41 per cent. of the total revenues of the technical colleges of the United States. In the presence of such examples need the Dominion hesitate?

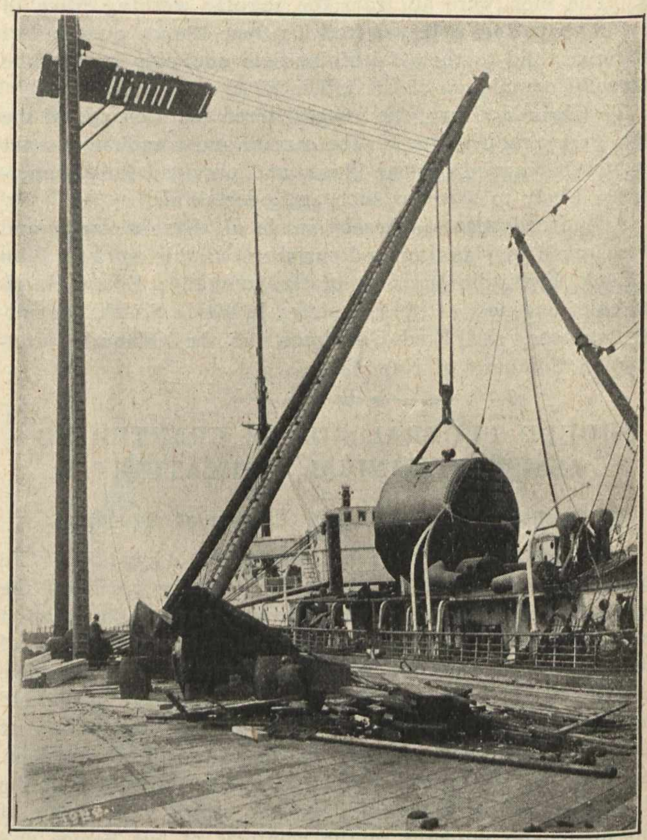
Finally, above and beyond all statutes and precedents stands the great truth that the Federal Government is sponsor for the commercial and industrial welfare of this country. In the performance of its duties in this regard it arbitrates trade disputes, organizes trade agencies, negotiates commercial treaties, or establishes national tariffs, But arbitrations, agencies, treaties, and tariffs are altogether vain things if the Canadian workman or the Canadian engineer lacks industrial intelligence. To give industrial intelligence, then, is here the first and great duty of the Federal Government Can it perform this duty without cost?

ELECTRIC DOCK HOIST.

A striking example of time-saving through the use of a modern electric hoist comes from the Pacific coast, where in the yards of the Commercial Boiler Works, Seattle, a 65-ton boiler was raised from the dock and placed in position in the hold of the steamship "Pennsylvania" in the short space of twenty minutes. The illustrations show the boiler about to be placed in the hold.

The plant of the Commercial Boiler Works, engaged in the manufacture of marine boilers and in handling ship repairs, has its machines equipped with individual motor drive, and to facilitate the loading of heavy materials it was found necessary to install electricity in the yards as well. The hoist used was supplied by the Lambert Hoisting Engine Co., and is driven by a 40 horse-power type "K" Westinghouse D.C. motor, controlled by a drum type controller, affording nine forward and nine reverse speeds. From the drums of the hoist a ¾-inch steel cable runs to the top of the shear legs, where it reeves through a set of blocks capable of lifting from 75 to 90 tons.

The boiler, which was lifted and placed in position in twenty minutes, was one of the largest ever built in Seattle.



The worm-gear hoist, which was previously used, would have required three hours' time to raise the same load. A 15-ton boiler was recently loaded by the Lambert hoist in 4½ minutes.

The power which drives the hoist and the motors in the shop as well is purchased from the Seattle-Tacoma Power Co., being transmitted by a two-phase line at 2,300 volts. It is utilized on the dock as a direct current and in the shops as alternating current for two 50 horse-power motors, driving heavy rolls, one 50 horse-power motor driving an air compressor and various small motors, all of standard Westinghouse manufacture. A motor generator set is instaled in the shop to supply the necessary direct current for the hoist.

LAKE LEVELS FOR MAY.

The United States Lake Survey reports the stages of the Great Lakes for the month of May as follows:—

Lakes.	Feet above tide water, New York.
Superior	602.07
Michigan-Huron	581.36
Erie	573.51
Ontario	248.46

Since last month Lake Superior has risen 4¾ in., Lakes Michigan and Huron have risen 6½ in., Lake Erie has risen 3½ in., and Lake Ontario 5¼ in.

During the present month all the lakes should rise about as follows: Lake Superior 3½ in., Lakes Michigan and Huron 3 in., Lake Erie 2½ in., and Lake Ontario 1 in.

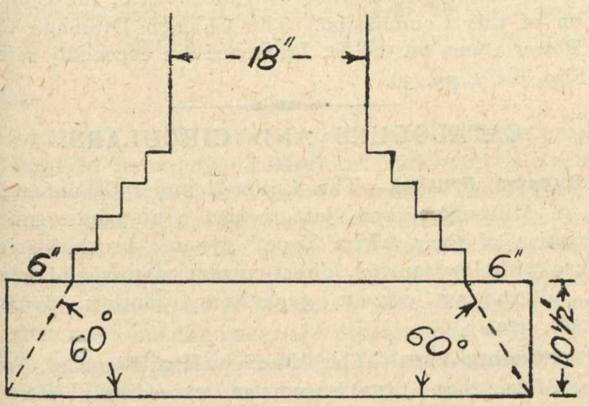
ENGINEER'S LIBRARY

CONCRETE FOR FOUNDATIONS OF BUILDINGS AND MACHINERY.*

Spread foundations of concrete are necessary only when the soil is deficient in bearing power, and where a saving would be effected by using it rather than offsetting the base of the brick wall to the required width for safe bearing.

The composition of the concrete depends upon the conditions of the work. For heavy walls and foundations the cement used should be heavy and slow-setting; that is, having a setting period of from two to five hours. A suitable mixture would be 1:3:6, employing as aggregate broken stone, brick, clinker or gravel up to 1½-inch mesh.

Considerable care in placing the concrete is necessary for the best results. If the trench is to be deep, the mass should be deposited through a chute, since dumping from a height of ten feet or more causes the aggregate to settle to the bottom, or gives rise to possible disintegration of the mass already placed, if it be in the process of setting. It is preferable to place the concrete in layers of about one foot thickness, lightly ramming each layer, but for long foundations a step of a foot may be made at intervals of ten or fifteen yards, so that the filling may go on in two or more places at the same time.



The dimensions of the foundations are governed by the character of the soil built upon. They generally extend laterally a distance of about six inches on each side beyond the lowest course of brick footings, because this is the allowance made in excavations for the bricklayer to get at his work properly. The depth of the concrete should be such that its projection is just sufficient as a cantilever to withstand the bending moment produced by the upward pressure of the soil. This is obtained by proportioning it as in Fig. 1, where the width having been previously determined, an angle of 60 degrees from the horizontal is drawn from the outer edge of the brick footings to cut the width. A rule which is generally sufficiently accurate is to make the depth 1½ times the projection.

In the concrete foundations of machinery subject to vibration or shock, it is necessary to provide a large mass in order to absorb the energy thus liberated with diminished movement. Where there is any grinding effect accompanying the revolutions of the machine, as, for example, in the case of emery grinders, the foundation requires to be divided into two parts: the lower or true foundation will be an ordinary bed of concrete; then a layer of cork, india rubber or felt may be interposed to deaden the transmission of sound, and upon that the mass of concrete is placed that may be necessary to absorb the vibrations and give stability to the machine. C. R. Y.

---

*Abstract of article in April-June number of "Public Works," by Henry Adams, M.Inst.C.E.

BOOK REVIEWS.

Books reviewed in these columns may be secured from Vannevar & Company, 438 Yonge Street, Toronto, Ont.

Modern Machine Shop Construction, Equipment, and Management.—By Oscar E. Perrigo, M.E. New York: The Norman W. Henley Publishing Co. Cloth; size, 7 x 10; pp. 328; over 200 illustrations. Price, $5.

To quote from the preface: "The aim and object of the author in publishing this book is to produce a work suitable for the practical and every-day use of the architects who design, the manufacturers who build, the engineers who plan and equip, the superintendents who organize and direct; and for the information of every stockholder, director, officer, accountant, clerk, superintendent, foreman, and workman of the modern machine shop and manufacturing plant of industrial America." The first part of this book takes up the design and construction of manufacturing plants in general, and the author lays stress on one point that is often neglected, viz., the great question of future extension. We have seen too many plants started without consideration of their future needs, and as a result we find them in a few years struggling with their shops and yards crowded and no possible chance of extending their plants. To illustrate the contentions of the author, the general discussion is followed with a detail design of a model plant suitable for the manufacture of machine tools. These works include machine shop, foundry, forge shop, power plant, and pattern shop, besides the necessary adjuncts, such as works office, draughting-room, tool-room, store-room, etc. The only criticisms that can be made of the general layout are that the foundry is put to one side of the machine shop instead of being directly in line with it so as to decrease the cost of transportation of castings, and that the offices and draughting-room are directly connected with the shops, and are thus subject to all the noise and vibration due to the travelling cranes, etc. Except for these defects the plant is compact and at the same time capable of considerable extension, though at a sacrifice of valuable yard storage. The arrangements of the tools and the methods of shop transportation are such as to insure low costs of operation. For the design of the individual buildings two types are discussed, viz., steel frame and wooden mill construction. No mention is made of the use of reinforced concrete, although this type of construction is often used for buildings of this class. While the general design is good, the same cannot be said of some of the details. This, however, may be excused, as detail design is a study in itself, and cannot be expected in a book treating the subject of shop construction in a broad and general sense. The subject of lighting, heating, and ventilation is discussed, and attention called to the importance of placing the windows so as to give a uniform light to all parts of the shop. Power and power transmission is taken up, and the relative merits of the system of transmission by line shafts and those by driving by individual motors are compared, though the question is not discussed as fully as we think its importance would warrant. The second part of this book is devoted to machine shop equipment, and contains some very good diagrams, showing floor plans and layout of machinery in all the branches of the model plant. Each department is considered in detail, and, although very few illustrations of actual machines are given, the general plans show the method of grouping each set of tools so that they may be used to the best advantage. One chapter is devoted to cars and trackwork for shop and yard transportation, and contains some very useful hints. The arrangement of offices, draughting-room, and tool-room is also shown, and attention is called to the importance of having a place for everything and everything in its place. The third part is on shop management, and starts with a general discussion of the organization of a manufacturing establishment, and the responsibilities that should be borne by each man, from the president down to the shop foreman. The author advocates a general system for all routine work by which every order is given in writing and repeated in the same way as it passes through each department. The various forms and cards used in carrying this out are illustrated and described. The question of cost-keeping and the division of the fixed charges is discussed, and the merits of the various systems in use pointed out and compared. Following the general consideration of organization and management is a discussion of the system of carrying on the work in the draughting-room, pattern shop, and storage-room. For the latter a simple and efficient system of issuing tools to the shop is proposed. The remaining chapter is devoted to such parts of the organization as reading-rooms, dining-rooms, etc., for the employees. The formation of mutual aid associations for benefit in cases of accident and illness is brought up in this chapter. In conclusion, we would say that this book is one that could be read by anyone connected with a manufacturing establishment, and being quite general is free from technical expressions. It would be very useful both to the man in the shop and to the clerk in the office. Both could read it intelligently, and the former would learn something of the business in general, while the latter would get a good idea of the practical side of the work on which he is engaged. For the experienced manager or superintendent there is nothing to be learned by reading a book of this kind, as they will have picked up all the general information about shop management during the years of training that fitted them for their responsible positions. R. E. C.

The Design of Typical Steel Railway Bridges.—An elementary course for engineering students and draughtsmen. By W. Chase Thomson, M. Can. Soc. C.E., assistant engineer, Dominion Bridge Co., Montreal. New York: The Engineering News Publishing Co.; London, England: Archibald & Co. Cloth; size, 6¼ x 9¼; pp. 178; 21 plates and text illustrations. Price $2.

Mr. Thomson's new book is a sequel to his former work, "Bridge and Structural Design," and like it is an eminently useful volume for those wishing to familiarize themselves with the problems arising in a bridge office. The division into chapters and the use of much clearer illustrations have effected a considerable improvement over the former work. The matter presented consists principally of detailed designs of six typical steel railway bridges, closing with a theoretical discussion of the latticing of compression members. But little theory has been developed in the text, the necessary equations being assumed and references made to standard works on theory. Loopholes affording opportunity for much adverse criticism do not readily present themselves. On page 21 the statemnet that when the flanges of plate girders are composed of two angles with cover plates, the effecive depth is approximately equal to "the depth back to back of angles," might well be modified to read, "the depth of web plate," thus making it an even number of inches. The author has done this on page 6 in deriving an expression for the section modulus of a plate girder. Some liberty is taken with conventional conceptions by styling the sum of the squares of the distances of the rivets in a plate girder web splice from the neutral axis of the girder the "moment of inertia of the rivets." In the detail of the 100-foot deck Warren girder span no provision is made for equalizing the pressure on the rollers, although the best practice requires the use of a pin or disc bearing for all spans over 75 or 80 feet in length. Though one disposed to do so might offer further criticism, no other book has presented complete designs in such a concise and helpful way for those for whom this work is intended. C. R. Y.

PUBLICATIONS REVIEWED.

Peat and Lignite.—A report by E. Nystrom, M.E., of the Department of Mines, Canada. Mr. Nystrom went to Europe and investigated the peat and lignite industries there. The report deals with the peat beds, processes of preparing, machinery used in preparing peat for fuel. Size, 6 x 9, pp. 245. Illustrated.

T and N.O. Railway Report.—The sixth annual Report of Temiskaming and Northern Ontario Railway Commission, containing financial statements, report of superintendent, chief engineer, general roadmaster, etc. Size, 6 x 9, pp. 213. Illustrated.

Report of Minister of Public Works, Ontario.—The report for 1907 gives in some detail the various public works carried on by the Provincial Government, their necessity and cost. Hon. J. O. Reaume, Minister of Public Works, Toronto, Ont. Size, 6 x 9, pp. 126.

Report of Minister of Mines, British Columbia.—Annual Report of the Minister of Mines of British Columbia for the year ending 31st December, 1907, being an account of mining operations for gold, coal, etc., in the Province. William Fleet Robertson, Provincial Mineralogist. (British Columbia, Bureau of Mines.) Pp. 237, plates, maps, 1907. Victoria: Government Printing Office, 1908.

Report of the Superintendent of Highways.—Report of A. J. McPherson, Superintendent of Highways for the Province of Saskatchewan for 1907. Besides a description of work accomplished during the year it also contains a manual for road overseers. Size, 6 x 9, pp. 45. Illustrated.

Nova Scotia Mining Society Report.—Volume XI., being the transactions of the Society during 1906-7. Gives a list of officers and members. It also contains eight papers on subjects of interest to mining engineers. Edited by H. Piers, and may be secured at the rooms of the Society, Halifax, N.S.

International Waterways Commission.—A supplement of the report of 1907, dealing with the work of the Canadian section of this Commission. The Chicago Drainage Canal and Power Dams on the St. Lawrence are especially referred to. Size, 6 x 9, pp. 36.

CATALOGUES AND CIRCULARS.

Dynamo Brushes.—The Cutler-Hammer Manufacturing Co., of Milwaukee, has just issued a 16-page pamphlet descriptive of their "Wirt Type" dynamo brush, designed for use with low tension, direct-current motors and generators, alternating current generators, plating dynamos, exciters, etc.

Ventilating Fans.—The Massachusetts Fan Co., Watertown, Mass., has just issued an exceedingly attractive booklet, entitled "Davidson Ventilating Fans." The illustrations show both pulley fans and many types of electric fans driven by standard motors of various makes. These are applicable for economical movement of large volumes of air at moderate pressures.

Blaw Collapsible Forms.—We are in receipt of a 58-page catalogue describing the Blaw system of steel centering, for which Messrs. the Stinson-Reeb Builders' Supply, 188 William Street, Montreal, are the Canadian sales agents. The Blaw system is in use in all parts of the United States in the construction of conduits of all shapes and sizes, of concrete and brick sewers, drains, manholes, water supply conduits, railroad and road culverts, subway roofings, tunnel linings, mine shaft linings, electric wire and cable conduits, arches and similar work. Those interested in similar construction work will find these catalogues helpful and interesting. It contains a large number of full-page illustrations of work under construction and other news of interest. Size, 6 x 9.

Boilers.—The Jenckes Machine Co., of Sherbrooke, Que., have ready for distribution a new boiler catalogue. The catalogue describes the various styles of boilers, and also gives tables of weights and dimensions useful to those planning for boiler instalation.

Concrete Construction.—The Aberthaw Construction Co., 8 Beacon Street, Boston, Mass., have issued a 30-page booklet descriptive of the uses reinforced concrete may be put to in construction work. Dwellings, factories, bridges, standpipes, and chimneys built by this Company are illustrated.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

RAILWAYS—STEAM AND ELECTRIC.

Ontario.

PORT ARTHUR.—Port Arthur is now in the Western division of the C.P.R., and is now under the supervision of Superintendent Graham, of Fort William.

PORT ARTHUR.—The extension of the electric railway is being considered here, to Kakabeka Falls, and a committee has been appointed to look into the question.

SARNIA.—That the Canadian Pacific Railway will build a line from Sarnia to Komoka, next spring, is the announcement now made. The line has been surveyed and will run north of the present tunnel branch of the Grand Trunk. Trains will be ferried across the St. Clair River between Port Huron and Sarnia, unless arrangements can be made with the Fort Huron Tunnel Company, which is under Grand Trunk control. This line will enable the Canadian Pacific to enter Chicago over the Pere Marquette, and will reduce the mileage from Montreal to that city.

TORONTO.—Three new lines are being operated on the C.P.R. for the first time to-day. They are from Linewood on the Guelph and Goderich line to Listowel, 16 miles; from Saugeen Junction on the Owen Sound section, through Priceville, Durham and Allen Park to Hanover, 27 miles, and from Embro to St. Mary's, 18 miles. The total is 61 miles of track.

Quebec.

LACHINE.—It is authoritatively stated that the proposed new Imperial Locomotive & Machine Works will be erected at Lachine without any unnecessary delay. The Trust and Loan Company of Canada has just received the engineers' plans for the construction of the series of buildings required for this great undertaking, and have handed them over to Mr. H. C. Stone, architect of Montreal, who has been commissioned to carry out the necessary preparations with a view to tenders being secured for the work during the month of July.

MONTREAL.—An order for twenty new freight engines has been placed with the Locomotive & Machine Company by the C.P.R. The contract calls for delivery by September 15th next, and it is promised that all will be ready well within that time. The engines are for the Western division of the road.

New Brunswick.

MONCTON.—The Grand Trunk Pacific has entered Moncton. The rails of the new Transcontinental Railway were run into Moncton to-day, and now within a few hundred yards of the I.C.R. depot. Several surveys have recently been made by the G.T.P. engineers, but no one except the railway officials knew exactly where the new line was to be located. In a single day the rails were laid, and now a steam shovel has been installed and is rapidly throwing up the grade. The rails run almost up to the I.C.R. track, and from there will parallel the I.C.R. depot.

Saskatchewan.

REGINA.—The C.P.R. will install its own lighting plant in the local station and yards, the electrical plant having arrived. For the present it is the intention to only replace the old lamps in the roundhouse with electric lights, but later the station will be cut off from the city system and attached to the private system of the company. The work of installing the plant in the roundhouse will commence at once.

CONTRACTS AWARDED.

Ontario.

JORDAN.—The contract has been awarded to Messrs. Newman Bros., St. Catharines, for the erection, at a cost of $16,000, of the new Administration Building and superintendent's house, at the Jordan Harbor Experimental Farm.

GUELPH.—The contract for the new boiler house and fruit house at the Agricultural College has been awarded by the Minister of Public Works to the Clemens Company, Guelph.

GUELPH.—The contract for building the water conduit here was awarded to Corm & Company, of Windsor, Ont., for approximately $30,000.

Quebec.

ST. PIERRE.—At a meeting of the council of Ville St. Pierre last night, better known as Blue Bonnets, it was resolved to accept the tender for street and residential lighting as submitted by the Montreal Light, Heat & Power Company. The residential lighting is to be the same in price as exists in Montreal, and a clause has been inserted in the agreement giving to St. Pierre the right of any reductions that may be made in Montreal. A tender was sent in by the Saraguay Company, and both tenders were found to be the same in street lighting, but that of the Heat & Power Company was considered more favorable for residential lighting.

Manitoba.

WINNIPEG.—The controllers are recommending to council that the tender of the J. J. Gartshore Company, of Toronto, be accepted for 800 tons of rails for the power tramway at $36.50 per gross ton. The Montreal Rolling Mills' tender for bolts at $3.50 per 100 pounds and for spikes at $2.50 per 100 pounds is to be accepted.

WINNIPEG.—The School Board awarded the contract for the construction of the new Cecil Rhodes school to Davidson Brothers of the city, whose tender was $64,781. Work will be started immediately.

Saskatchewan.

REGINA.—The contract for the grading of the spur track to be built south of the city in connection with the Legislative buildings has been awarded to Wright and Richardson at 18 cents a yard.

Alberta.

LETHBRIDGE.—The Council has awarded the contract for street grading to Janz Bros. & MacDonell, and for cement sidewalk to Marshall, Batcheller & Skairin, of Calgary. The total contracts are about $75,000.

TENDERS.

Ontario.

HAMILTON.—Tender for wiring Armory, Hamilton, Ont., will be received at this office until 4.30 p.m. on Thursday, July 9th, 1908, for electric wiring at the Armory, Hamilton, Ont. Fred. Gelinas, secretary, Department of Public Works.

PORT COLBORNE.—Tenders will be received until July 13th for widening and deepening water channel along the west pier, Port Colborne. L. K. Jones, secretary, Department of Railways and Canals. (Advertised in The Canadian Engineer.)

OTTAWA.—Tenders for Trent Canal will be received at this office until 16 o'clock on Wednesday, the 15th July, 1908, for deepening and improving of a channel way from a point in Cook's Bay, Lake Simcoe, Ontario, to the mouth of and up the Holland River, and the east branch thereof to the Bradford road at Holland Landing. By order. L. K. Jones, secretary. Department of Railways and Canals. (Advertised in the Canadian Engineer.)

Quebec.

LACHINE.—It is quite probable that tenders will be received during July for the work of erecting the buildings in connection with the Imperial Locomotive & Machine Works here.

BALCARRES.—Tenders marked for Indian Agency Buildings, will be received at the office of the undersigned, File Hills Indian Agency, Balcarres P.O., up to Saturday, July 18th, 1908, for the erection of two frame dwelling houses to be built on Pasqua Reserve. W. M. Graham, Inspector of Indian Agencies, Balcarres P.O.

Manitoba—

WINNIPEG.—Tender for St. Andrew's Rapids Works will be received until Wednesday, July 8, 1908, for the construction of movable dam, steel service and highway bridge, repair shop, etc., at St. Andrew's Rapids, Red River, Province of Manitoba. Fred. Gelinas, Secretary Department of Public Works, Ottawa.

Saskatchewan.

MOOSE JAW.—Sealed tenders will be received by the undersigned, up to, and including, Wednesday, 15th July, 1908, for the erection of the new collegiate building in the city of Moose Jaw. H. Jagger, secretary-treasurer Moose Jaw Board, Moose Jaw, Sask.

Alberta.

CALGARY.—Tenders will be received until July 3rd for a continuous wooden stave pipe for the supply and conctruction of same. J. G. Watson, chairman, Waterworks Committee; J. T. Child, chief engineer, Calgary. (Advertised in The Canadian Engineer.)

British Columbia.

VICTORIA.—Tenders will be received up to Monday, the 20th July, 1908, for the supplying and erecting of one horizontal cross-compound pumping engine, one steel tank and tower, one concrete and steel water tower. The lowest or any tender not necessarily accepted. W. H. Northcott, purchasing agent, city hall.

VICTORIA.—Tenders will be received up to Monday, the 20th July, 1908, for the supplying and erecting of 1 Horizontal Cross-Compound Pumping Engine; 1 Steel Tank and Tower; 1 Concrete and Steel Water Tower. The lowest or any tender not necessarily accepted. W. H. Northcott, purchasing agent, City Hall.

New Brunswick.

FREDERICTON.—Tenders for Fredericton bridge superstructure will be received at the Department of Public Works, Fredericton, until Monday, 20th day of July, 1908, for constructing three metal superstructure spans of the Fredericton highway bridge, between the city and the south end of the already revised work. John Morrissy, Chief Commissioner. Department of Public Works, Fredericton, N.B.

RECENT FIRES.

Ontario.

TORONTO.—A fire causing damage to the extent of $16,000 to the C. Wilson & Son Scale Works, 67 Esplanade Street East, broke out on June 28th. The company, who own as well as occupy the building, report a loss of $3,000 to the three-storey frame and ironclad buildings and $13,000 to contents.

SEWERAGE AND WATERWORKS.

Ontario.

CHESLEY.—By a vote of 282 to 9 the by-law granting free water and exemption from taxation for the ten years to the William Smith Company, manufacturers of church and lodge furniture, was adopted yesterday. A waterworks system to cost $38,000 will be installed as soon as possible in order to provide better fire protection.

TORONTO.—Both debenture by-laws were carried by the ratepayers of the city on June 27th, and in due time Toronto will have a trunk sewer and a water filtration plant, the combined cost of which will be $3,200,000. The cost of the trunk sewer is estimated at $2,450,000, and the cost of the filtration plant, $750,000. The annual interest will be $128,000, and the annual sinking fund, $80,000, a total annual cost of $208,000. For this expenditure of money Toronto will have a bay free from contamination by sewage.

LIGHT, HEAT, AND POWER.

Ontario.

TORONTO.—The city of Toronto requires an electrical engineer to prepare plans and specifications and supervise the construction of a plant for distributing electric power throughout the city of Toronto, including a plant for lighting the city. Applications to be in before Monday, July 13th, 1908. Joseph Oliver, mayor, Toronto.

MISCELLANEOUS

New Brunswick.

ST. JOHN.—The City Harbor Committee, after hearing a report from the delegation which went to Ottawa recently, have decided to recommend to the common council that the west side of the harbor be placed in commission, the commission to consist of three members. It was also decided in favor of sharing in the expenses of making borings in Courtenay Bay to ascertain the nature of the bottom in view of the possibility of the G.T.P. terminals being there, and to ask the Federal and New Brunswick Governments to bear part of the expense. The sum of $10,000 is mentioned as the cost.

Quebec.

SHERBROOKE.—The Sherbrooke Machinery Company has been organized for the manufacture of pulp mill machinery and general pulp and paper mill work. For the present the purchasing will be done from their office at Nashua, N.H. They now require bar iron, steel bolts, screws, belting, etc.

MONTREAL.—As a sign of returning good times the C.P.R. Angus shops are increasing the number of employees. Their freight and passenger car shops, the former of which last summer turned out box cars at an average of twenty-six each day, will, it is expected, reopen on July 2nd.

Ontario.

BRANTFORD.—For some time past there has been a persistent movement in Brant county for the abolition of toll roads, of which there are three. The only plan by which this can be accomplished is the purchase of the roads from their owners by the county. In this connection the County Council received an offer from Mr. Clarke, owner of the Paris-Ayr toll road, in which he stated that he was willing to sell the six miles of the road in the county for

$5,000. The road extends into Waterloo County, and will also be purchased there by that county. The Brant councillors are inclined to view the matter with favor, as the abolition of tolls would be very popular with the farmers generally.

OWEN SOUND.—A by-law has been introduced by the council to authorize the borrowing of the $11,000 authorized by By-law 1302, for the erection of the Boyd Street School extension from the sinking fund account, and another to authorize the raising by debenture $12,000 for the construction of a cement concrete arch bridge at Union Street.

TORONTO.—Acting City Engineer Fellowes has reported to the Board of Control that it will cost $20,000 to construct two ferry slips 65 feet long and 35 feet wide on each side of the western channel, to provide for a depth of ten feet of water at zero level of the lake.

WELLAND.—The announcement re a new and greater Welland Canal has not only excited much interest but meets with universal approval. Great interest is taken as to where the Lake Ontario terminus will be located. In all probabiity the new channel will leave the present one between Welland and Thorold, or at Thorold. The most probable routes thence to the lake are: 1. Immediately west of Thorold to Port Dalhousie, or the Fifteen. 2. From a point on the canal near Welland to Jordan Harbor. 3. From some point on the Welland river or canal below Port Robinson to the Niagara River near Old Niagara. This would give a deep harbor seven miles long.

SAULT STE. MARIE.—The rolling plant of the steel mills here have opened up, and will be kept in operation, it is thought, for some time. It is expected that the blast furnaces will blow in again in about two weeks.

Manitoba.

WINNIPEG.—Carter, Halls, Aldinger & Co., contractors and engineers, have just completed a fine hotel at Winnipeg Beach. This and the station at Melville, Sask., a G.T.P. divisional point, were two of the rush jobs of the season, and reflect great credit on the contractors.

Alberta.

STRATHCONA.—The Dominion Bridge Co. have just completed the structural steel work on the Canadian Bank of Commerce building at Strathcona, Alta. This steel was all shopped in the Winnipeg premises of the Company.

PERSONAL.

MR. H. H. VAUGHAN, assistant to the vice-president of the C.P.R., has been appointed president of the American Association of Master Mechanics, which met last week in Convention in Atlantic City.

DR. BOVEY, who recently resigned as Dean of the Faculty of Applied Science at McGill, to become rector of the new Imperial College of Science, London, has just been honored with a dinner tendered by the graduates of the Faculty.

Mr. WILLIAM F. KING, who has just been made a Commander of St. Michael and St. George, was born in Stowmarket, Suffolk, Eng., in 1854, and came to Canada in 1862. He was educated at the Port Hope Grammar School and the University of Toronto, where he won many honors in mathematics and natural science. He was assistant astronomer on the International Boundary Commission in 1872 and for a number of years was employed on the Dominion land surveys in the North-West. He entered the Permanent Civil Service as inspector of surveys in 1881. In 1886 was made chief inspector and became chief astronomer in 1890.

MR. GEO. L. GRIFFITH, city engineer, has tendered his resignation. He has been carrying on work for the city and Perth County both and has found the work too heavy. He will continue the latter work. A temporary appointment has been made.

MR. J. A. WERNER, for many years locomotive coaling engineer for the Link Belt Company, has recently severed his connection with that company and assumed charge of the coaling station department of the Jeffrey Manufacturing Company, of Columbus, Ohio. Mr. Werner, who is one of the most extensively known and best qualified coaling station engineers in this country, will make that work one of the most important features of the Jeffrey Manufacturing Company's business.

MARKET CONDITIONS.

Montreal, June 30th, 1908.

The pig-iron markets of the United States seem to have reached the point where the little that is being done is at previous figures, and where practically nothing new is going on or looked for. Some buying is in progress, but the market is featureless. Recent expressions made public show that prominent men well acquainted with the general situation, hold opinions on the situation diametrically opposed to each other. For instance, President Millen, of the Ontario and Western Railway, said:—"The month of May was the worst we have seen since the depression set in. June is a little better but I think only a fluctuation. As for the future, no man can state. I myself see nothing upon which to forecast a return of sustained business activity. There is a prospect of fair crops which will start things up for a while, but this may result in a mere puff, unless the fundamentals of the situation are cleared up."

J. P. Morgan, on the other hand, said:—"You may say that I am very optimistic about the financial situation. There have been many improvements in the period since my departure some months ago, and the future looks very bright."

The situation in England is firm, with apparently a fair business being done. It had been expected that pig-iron prices would show a decided decline, but this decline has not yet materialized, and, owing to the lessened production and low stocks, may not develop, particularly should demand show any improvement. The resumption of shipbuilding improves the situation somewhat, but steel making irons continue to be a weak feature, hematite metal being at a low basis. Good Scotch brands are not any too plentiful and prices continue at about the same level as for several weeks past. Reports from Germany indicate that stocks are accumulating and that there is uncertainty as to the future. This, however, seems to have been discounted in England. The lessening demand from Germany has not changed producers' views as to prices.

Matters are improving locally, from the standpoint of enquiry. Several good lots have been placed during the past week and the tonnage now open to quotation is heavier than it has been at any time during the present season. In fact, things look as if the bulk of producers are now going into the market for their summer and fall supplies. Local furnaces continue to take the bulk of the business, but several good lots of import metal have been purchased for delivery here before the close of St. Lawrence navigation.

Prices have held steady, all round, during the past week and dealers are not even anticipating alterations for some time to come.

Antimony.—The market is steady, and sales are being made at 10 to 10½c. per pound.

Bar Iron and Steel.—Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $1.95; sleigh shoe steel, $1.95 for 1 x ⅜-base; tire steel, $2 for 1 x ⅜-base; toe calk steel, $2.45; machine steel, iron finish, $2.20; mild steel, $2.05.

Boiler Tubes.—The market is rather lower, quotations being as follows:—2-inch tubes, 8c.; 2½-inch, 10½c.; 3-inch, 11½c.; 3½-inch, 15c.; 4-inch, 19¼c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $2 per 100 pounds; felt paper, $2.75 per 100 pounds; tar sheathing, No. 1, 60c. per roll of 400 square feet; No. 2, 40c.; dry sheatning, No. 1, 50c. per roll of 400 square feet, No. 2, 32c. (See also Roofing).

Cement—Canadian and American.—Canadian cement, $1.70 to $1.75 per barrel, in cotton bags, and $1.95 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

Cement—English and European.—English cement is steady at $1.85 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $2.20 to $2.30 in wood, per 350 pounds, gross Belgian cement is quoted at $1.75 to $1.85 per barrel in bags, and $2.05 to $2.20 per barrel, in wood.

Copper.—The market is steady at 14 to 14½c. per pound. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb cases, 40 per cent. proof, 18c. in single case lots, Montreal. Blasting powder, 25-lb kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder. Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, $1 extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Iron.—Prices continue steady, pig-iron now arriving being:— No. 1 Summerleee, on cars, Montreal, $20 to $20.50 per ton; No. 2 selected Summerlee, $19.50 to $20; No. 3, soft, $19 to $19.50; Cleveland, $18.50, and No. 3 Clarence, $18; Carron, special, $20.25 to $20.75; Carron, soft, $20 to $20.50.

Lead.—Trail lead is weak and prices are steady at $3.80 to $3.90 per 100 pounds, ex-store.

Nails.—Demand for nails is moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

Pipe—Cast Iron.—The market shows but little change and prices are as follows: $33 for 8-inch pipe and larger; $33 for 6-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

Pipe—Wrought.—The market is quiet and steady at last week's range:— ¼-inch, $5.50, with forty-eight per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36, and 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Roofing.—Ready roofing, two-ply, 90c. per roll; three-ply, $1.15 per roll, or $1.50 complete, including one pound, each, of caps and roofing nails, and two gallons of cement.

Spikes.—Railway spikes are in fair demand, $2.60 per 100 pounds, base of 5½ x 9-16. Ship spikes are steady at $3.15 per 100 pounds, base of ⅝ x 10-inch and ⅝ x 12-inch.

Steel Shafting.—Prices are steady at the list, less 25 per cent. Demand is on the dull side.

Steel Plates.—Demand is good, and the market lower. Quotations are:—\$2.25 for 3-16, \$2.20 for ⅛, and \$2.15 for ¼ and thicker, in smaller lots.

Tar and Pitch.—Coal tar, \$3.50 per barrel of 40 gallons, weighing about 500 pounds; coal tar pitch, No. 1, 75c. per 100 pounds, No. 2, 55c. per 100 pounds; pine tar, \$4.35 to \$4.50 per barrel of about 280 pounds; pine pitch, \$4.25 per barrel of 180 to 200 pounds.

Tin.—The market is steady, and is now quoted at 32½ to 33c. per pound.

Tool Steel.—Demand is light, but the market is firm. Base prices are as follows:—Jessop's best unannealed, 14½c. per pound, annealed being 15½c.; second grade, 8c., and high-speed, "Ark," 60c., and "Novo," 65c.; "Conqueror," 55 to 60c.; Sanderson Bros. and Newbould's "Sabeh," high-speed, 60c.; extra cast tool steel, 14c., and "Colorado" cast tool steel, 8c., base prices. Sanderson's "Rex A" is quoted at 75c. and upward; Self-Hardening, 45c.; Extra, 15c.; Superior, 12c.; and Crucible, 8c.; "Edgar Allan's Air-Hardening," 55 to 65c. per pound.

Zinc.—The market is unchanged, at 5¼ to 5½c. per pound.

* * * *

Toronto, July 2nd, 1908.

A marked variation in experience of business is reported to us by men in different lines, and even by different firms in the same line. For example, the Don Valley brick people tell us that they are actively employed and well satisfied; while cement firms complain of dulness, and the Paterson Roofing Company say, "business is rotten." The wood market is distinctly weak, and in some articles prices have given way. Iron pipe is slow of movement, even at reduced quotations. Metals, such as tin, copper, and zinc are on the weak side, but there is a better feeling in lead.

The effect of the American Steel Company's reductions has been to destroy or very greatly to lessen the budding intentions of builders and contractors, and to cancel, in some cases temporarily, in some permanently, the orders ready to be given in May. A very similar effect appears to have been produced in Canada, which helps to account for the very inactive condition of the building trade in various parts of Ontario, where people seem frightened to undertake anything. In the Far West, this is not by any means the case. They are looking forward very hopefully to December.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

American Bessemer Sheet Steel.—Fourteen-gauge, \$2.45; 17, 18 and 20-gauge, \$2.60; 22 and 24-gauge, \$2.65; 26-gauge, \$2.80; 28-gauge, \$3.

Antimony.—Business continues quiet, price for Cookson's, 9c.

Bar Iron.—\$2 base, from stock to the wholesale dealer.

Boiler Plates.—¼-inch and heavier, \$2.40. Fair supply, prices steady. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Demand limited. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, \$8.50; 2¼-inch, \$10; 2½-inch, \$10.60; 3-inch, \$12.10; 3½-inch, \$15.30; 4-inch, \$19.45 per 100 feet.

Building Paper.—Plain, 32c. per roll; tarred, 40c. per roll. Orders are of a limited character.

Bricks.—Common structural, \$9 to \$10 per thousand, wholesale, and the demand is still active. Red and buff pressed are worth, delivered, \$18; at works, \$17.

Cement.—Price of Canadian makes to the dealer in 1,000 barrel lots and up in \$1.80, in cotton bags, on car, Toronto. In lesser quantities, \$1.90 per barrel.

Copper, Ingot.—Quotations here are as before; say 13¾c. for large purchases, and 14¼c. for small.

Detonator Caps,—75c. to \$1 per 100; case lots, 75c. per 100; broken quantities, \$1.

Dynamite, per pound, 21 to 25c., as to quantity.

Felt Paper—Roofing Tarred.—Market cannot go lower, dealers say there is no profit at present rates. and not much doing.

Fire Bricks.—English and Scotch, \$32.50 to \$35; American, \$25 to \$35 per 1,000. Demand continues fair.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, \$4.50; 6 feet, \$5; 8 feet, \$5.50; 10 feet, \$6. Single strength, 4 feet, \$3.50; 6 feet, \$4; 8 feet, \$4.50; 10 feet, \$5. Bennett's double tape fuse, \$6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, \$3.25; 12-14-gauge, \$3.35; 16, 18, 20, \$3.50; 22-24, \$3.70, 26, \$3.95; 28, \$4.40; 29 or 10¾, \$4.70 per 100 pounds. Demand very active.

Iron Pipe.—Black, ¼-inch, \$2.03; ⅜-inch, \$2.25; ¼-inch, \$2.63; ¾-inch, \$3.56; 1-inch, \$5.11; 1¼-inch, \$6.97; 1½-inch, \$8.37; 2-inch, \$11.16; 2½-inch, \$17.82; 3-inch, \$23.40; 3½-inch, \$29.45; 4-inch, \$33.48; 4½-inch, \$38, 5-inch, \$43.50; 6-inch, \$56. Galvanized, ¼-inch, \$2.85; ⅜-inch, \$3.08; ½-inch, \$3.48; ¾-inch, \$4.71; 1-inch, \$6.76; 1¼-inch, \$9.22; 1½-inch, \$11.07; 2-inch, \$14.76. These downward changes indicate the decline spoken of last week.

Lead.—More active here at about previous prices, feeling is, however, a little firmer.

Lime.—In plentiful supply and moderate movement. Price for large lots at kilns outside city 21c. per 100 lbs. f.o.b. cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—The whole market is weak, and the demand slow; superior pine suffers less in price however than other lines. Dressing, we quote, \$32.00 to \$35.00 per thousand for usual lengths (12, 14, and 16 ft.), and stock sizes of boards, and \$38 to for usual lengths (12, 14, and 16 ft.) and stock sizes of boards, and \$38 to \$40 for special lengths, common stock boards, as to grade, \$24 to \$28; culls, \$20. Southern pine and Norway pine are somewhat easier. Hemlock moves more freely and quotes at \$18 to \$20, according to size. Much spruce comes from the East and is in better demand; the price asked for flooring is \$25 wholesale and \$28 retail. Shingles, B.C., are off again, having been offered at \$3 wholesale, per thousand. Laths are quiet, No. 1 quote at \$4 on track, No. 2 at \$3.50.

Nails.—Wire, \$2.55 base; cut, \$2.70; spikes, \$3.15.