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The Canadian Engineer

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TOWER STREET ARCH BRIDGE AT FERGUS

By A. W. CONNOR*

We illustrate in this article a reinforced concrete arch bridge over the Grand River, recently completed at Fergus, Ont., for the county of Wellington. The bridge proper has a length of 100 feet and clear span of 80 feet. There is a clear roadway of 16 feet and two 4-foot 6-inch sidewalks, carried on brackets at each side. It is a bridge of the open-spandrel type, carried on two ribs, resting on which are subsidiary spandrel arches, columns, floor beams and slabs. The open spandrel arches are purely ornamental. Fig. 3 shows an elevation and Fig. 4 a cross-section which indicates how the structure is built up from the supporting ribs.

The site is well adapted for this type of structure, the abutments being on a rocky ledge on the banks of the Grand River. This ledge of rock is about 16 feet above the low-water level and about 20 feet below the road level. The rock is limestone. The concrete structure is considered to be in harmony with the scenery.

The old structure was a steel deck pin-connected bridge of 75 feet span, centre to centre, resting on stone abutments, built on the same ledge. As the photograph shows, this rock has been undercut by the water. The abutments of the new bridge have been carried further back to avoid future undermining, and the arch design was favored by the engineers, as the thrust of the arch would tend to hold up the structure, even if partly undermined. The amount of the undermining was carefully determined and the faces of the abutments were set about five feet clear of the erosions. Some of the projecting portions of the rock were badly cracked, and these, together with parts necessary for getting in the foundations, were blasted off. The rock thus thrown into the stream formed a convenient means of reducing the depth of the water for setting of falseworks. The old stone east abutment, which was in poor condition, was also taken down and thrown into the river, the ends of the steel bridge being supported by a temporary wooden bent. The new west abutment was in front of the old and was carried partly below it.

The abutments were built larger than shown on the plan, being flared out to give a larger bearing on the rock.

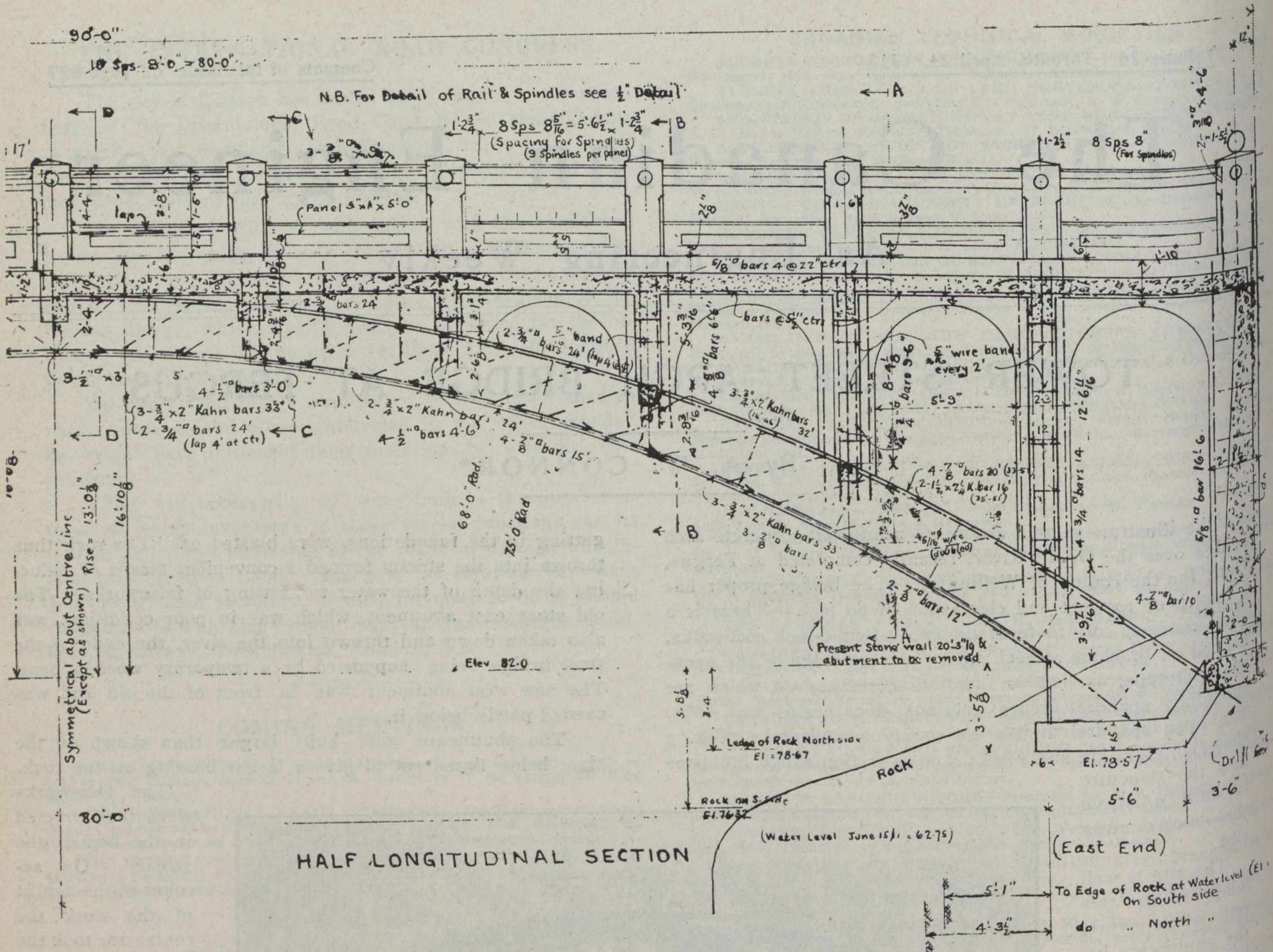
Fig. 1.—Showing Superstructure of Bridge.

The falseworks were then erected in the bed of the stream. On account of the height of the work the contractor took the precaution to build a working platform under the old bridge. The old structure was then taken down with a gin pole, and short bents on top of this carried the centering.

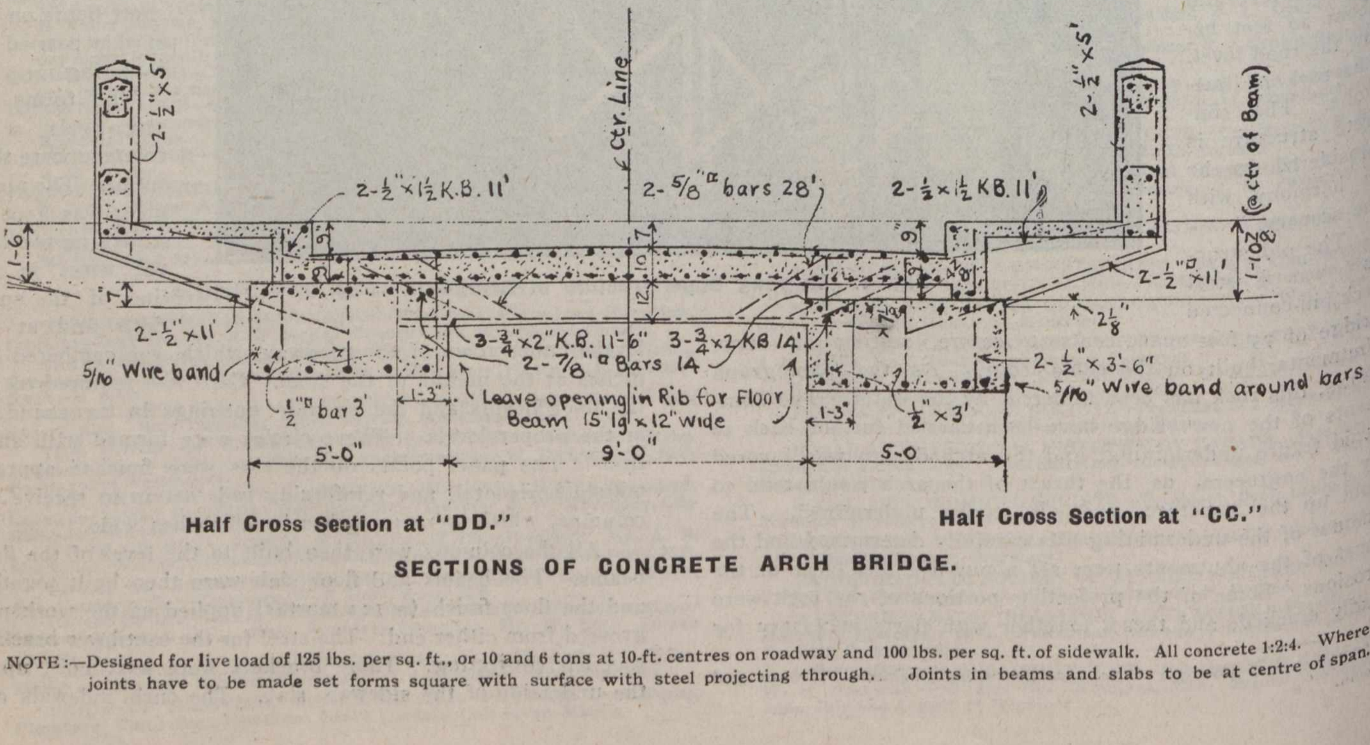
The forms for spandrels and columns were then set up. The alignment was kept by stretching two copper wires in the line of the spandrels and at the level of the crown of the roadway, which was cambered 8½ inches at the middle of the span. Care was required to get the floor beams and the circular openings in the spandrels at the proper levels. These circles were formed with sheet iron. The panel points on the ribs were finished approximately horizontal, and reinforcing rods set in to receive the columns, which were 12 inches by 48 inches wide.

All the columns were then built to the level of the floor beams. The beams and floor slab were then built together and the floor finish (a 1:2 mortar) applied as the work progressed from either end. The steel for the cantilever brackets was left projecting. There brackets were next built up to the underside of the sidewalk slab. The curb, sidewalk and

*The firm of Bowman & Connor, Consulting Engineers, Toronto and Berlin.



DESIGN FOR 80-FT. x 25-FT. CONCRETE ARCH BRIDGE OVER GRAND RIVER AT FERGUS, ONT.



Half Cross Section at "DD." Half Cross Section at "CC."

SECTIONS OF CONCRETE ARCH BRIDGE.

NOTE:—Designed for live load of 125 lbs. per sq. ft., or 10 and 6 tons at 10-ft. centres on roadway and 100 lbs. per sq. ft. of sidewalk. All concrete 1:2:4. Where joints have to be made set forms square with surface with steel projecting through. Joints in beams and slabs to be at centre of span.

bottom part of the railing, which acts as a girder for the sidewalk slab, were then built together, and the sidewalk finished before the base had set.

The forms for the hand-rail posts and upper rail were then set up, the spindles, which were cast as the work progressed from C.I. moulds furnished by the county, were set in position and the upper rail cast around the tops of them.

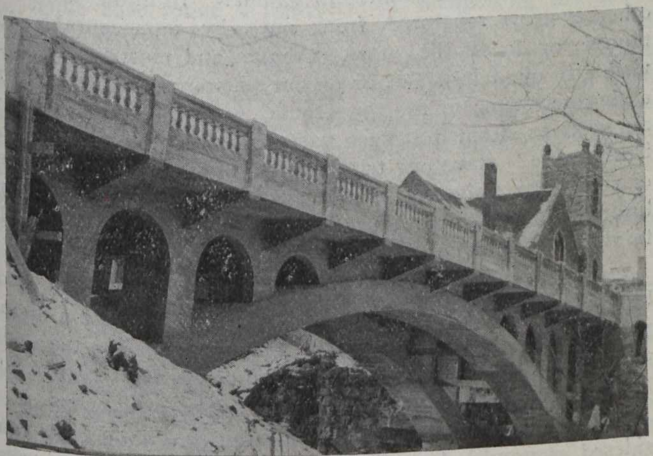


Fig. 2.—View Partially Showing Under Portion of Bridge.

A ledge in the top of the lower rail was left for these spindles and this was then grouted in.

The roadway is finished as an ordinary concrete bridge floor, with a crown of 2 inches. The curb is 9 inches high, so that at some future time asphalt blocks or other paving material may be used.

Concrete cross walls were built up at both ends of the bridge. At the east end retaining walls 85 feet on one side and 135 feet long at the other side carry the roadway down to grade level. The railing on the retaining walls is a solid one with panels and posts at 16-foot centres. It is built to harmonize with the railing on the bridge, but less striking so as not to detract from the arch itself.

The bridge was designed as a parabolic arch without hinges to carry a live load of 125 pounds per square foot of the roadway and 100 pounds on the sidewalks. The roadway is also figured to carry a concentrated load of 10 and 6

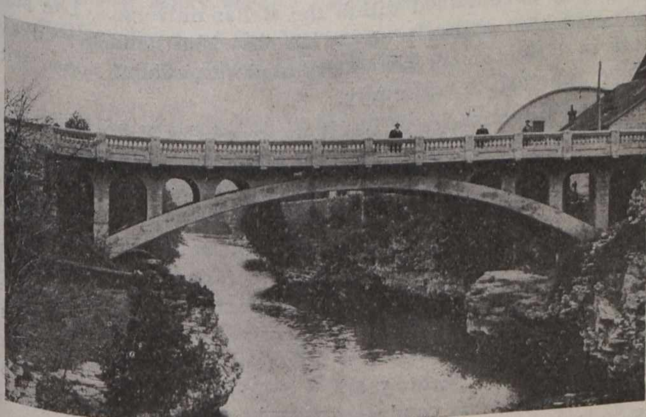


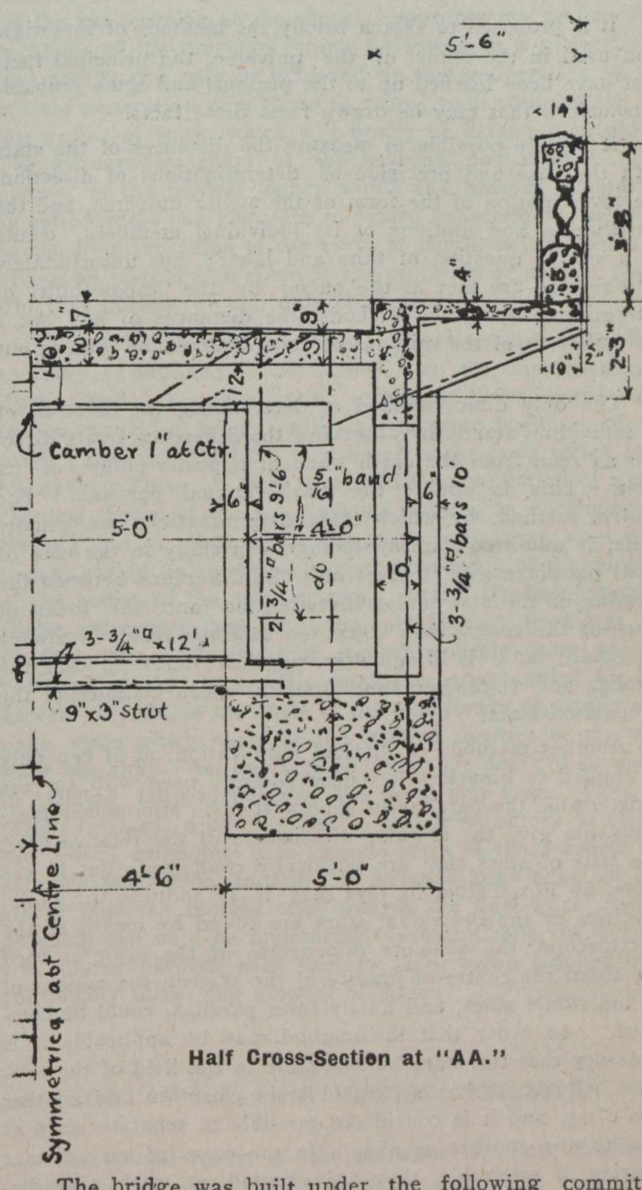
Fig. 6.—View of Bridge on Completion.

tons on two axles 10-foot centres. A temperature variation of 100 degrees Fahrenheit was also allowed for.

There are 316 cubic yards of concrete in the arch proper, with end cross walls, which are 100 feet apart. The cost of this was about $4,800. The retaining walls on the east approach contained 204 cubic yards of concrete and cost about $1,300.

All the concrete was mixed in the proportion of 1:2:4 There was no surface treatment except a wash of cement and waterproofing mixture. The finish was very good and reflects great credit on the contractor, Mr. W. M. G. Davies, of Stratford, Ont.

The bridge proper was begun in July, 1911, and finished before winter. The retaining walls were built the following spring. No crack has yet appeared in any part of the bridge.



Half Cross-Section at "AA."

The bridge was built under the following committee: G. M. Fox (warden), J. A. Wilkinson, J. M. Young, C. Steele, and G. Cassie.

The reinforcing steel was supplied by the Trussed Concrete Steel Company and by Steel and Radiation, who supplied twisted squares. The moulds for the spindles were supplied by the London Concrete Machinery Company.

The engineers were Bowman and Connor, 36 Toronto Street, Toronto, Ont.

The Newfoundland government propose to extend the telegraph system around the seaboard of the island, 500 miles having been built in the past four years, with a prospect of 250 more being constructed during the present season; also to build three more wireless stations on Labrador and to establish a telephone system for St. Johns and a number of the outlying places.

ASTRONOMICAL STUDY OF THE UNIVERSE.

At the annual meeting for 1913 of the Royal Astronomical Society of Canada the president, Mr. L. B. Stewart, professor of Astronomy at the University of Toronto, in his presidential address, spoke on "The Structure of the Universe." That portion of his address which we believe will be of most interest to our general readers we abstract and publish as follows:—

It is proposed to sketch briefly the methods of investigation used in the study of the universe, the principal facts that have been learned up to the present, and some probable conclusions that may be drawn from those facts.

If it were possible to measure the distances of the stars with the ease and precision of determinations of direction, the investigation of the form of the stellar universe, and the distribution and motions of its individual members, would be a simple question of time and labor; but unfortunately astronomers are met at the outset by the impossibility of determining by direct methods, the distances of any but a few hundreds of the millions of stars that can be seen in our telescopes.

The only direct method of determining the distance of an individual star is by observing the difference in its direction as seen from the earth when at opposite points of its orbit. This is double the star's annual parallax. The relative method, by which these determinations are usually made, is admittedly unsatisfactory, especially in the case of small parallaxes, as it gives only the difference between the parallax of the star under investigation and the mean of those of the comparison stars, so that the result is always too small, and is frequently negative, showing that the parallax star is farther away than the mean distance of the comparison stars.

Another method—of limited application, as it can only be applied to binaries—has been recently used with success to determine the parallax of such systems. Micrometer measurements give the angular dimensions of the relative orbit of a pair of stars that are physically connected; but it was shown by Fox Talbot in 1871 that if in addition the radial velocities of the individual stars are found by means of the spectroscope, the absolute dimensions of the orbit of each star about the centre of gravity of the system, the masses of the individual stars, and finally their parallax, could be computed. In order that the method may be applicable it is necessary that the stars be separable in the field of the telescope. Burnham has separated stars closer to one another than 0".25, and it is considered possible to separate stars as close to one another as 0".1. In the cases of very distant binaries, if separable, they are situated at such wide distances apart that their relative motion is so slow that centuries must elapse before their orbits can be determined.

A method depending upon a study of the proper motions of the stars of a group, which may be used to obtain the mean parallax of the group, may be thus briefly described: The observed proper motion of a star is compounded of a real motion of the star in space projected upon the celestial sphere, and an apparent motion, termed the parallactic motion, resulting from that of thee solar system. This observed proper motion may be resolved into two others, one perpendicular to the direction of the sun's way, the other parallel to it. The former is termed the *r* component and is independent of the solar motion, and the latter the apical component. This latter is composed of the resolved part of the true proper motion of the star, and the parallactic motion.

Having outlined thus briefly the principal methods of investigation that are applied to the stellar universe, let us turn next to some of the results of the investigations that have been made, and the conclusions reached by their discussion.

Before doing so, however, it will be well to place before us some of the questions to which answers are sought, in prosecuting the study of our stellar system. The following are some of these questions:

Is the universe infinite in extent? If finite, are there other systems separated from ours by immeasurable distances; or do all the stars, nebulæ and clusters, that are visible in our telescopes, or on our photographic plates, form a single system; or are the nebulæ, or some of them, separate systems situated at such vast distances from us as to be irresolvable? Have our telescopes penetrated to the confines of the stellar universe, so that the stars that are brought to light by increased power, or longer exposure, are merely fainter stars and not more distant ones?

As before stated, a full answer to these questions cannot be given at present, and possibly a complete solution of the problem will never be reached, though probably the main conclusions arrived at by a discussion of the facts now in our possession will only be modified by future discoveries.

That the universe is finite in extent has long been considered as proved, from the fact that, if infinite, the heavens would shine everywhere with a brightness equal, at least, to that of our sun. This conclusion is only valid if there is no absorption of light in its passage through space; and experimental evidence seems to be accumulating which points to a possibility that there is such absorption, though the evidence cannot be considered entirely convincing.

Prof. Newcomb's conclusions regarding the extent of the universe may be thus summarized: The universe is limited in extent, and probably extends farther in the plane of the Milky Way than in the direction of its poles, but in every direction much farther than the limit within which the proper motions of stars have yet been determined. The boundary is probably somewhat irregular, and the stars gradually thin out as it is approached. It is quite possible that far outside our universe there may be collections of stars of which we know nothing. It is not possible to decide whether the star masses of the Milky Way lie on the boundaries of the universe or not; the number of lucid stars that seem to lie within the Milky Way favor the view that that body is contained within the stellar universe. The stars lying without the galactic region show no tendency to collect in clusters, but are distributed throughout space with some approach to uniformity.

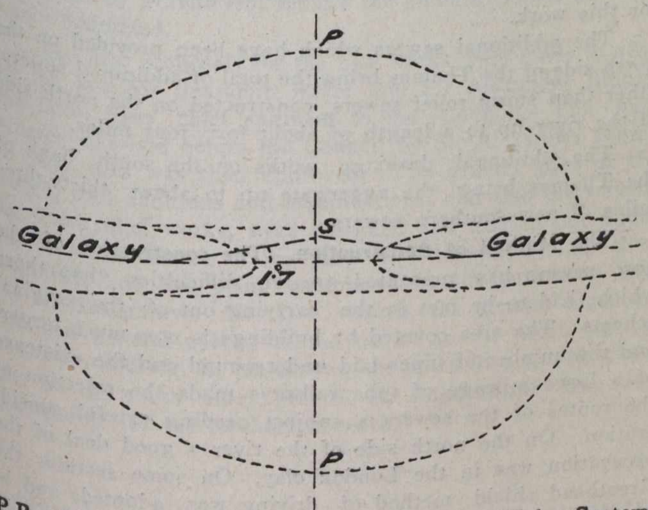
Several estimates of the distance of the Milky Way have been made, based upon different principles and assumptions, and which therefore differ widely in their numerical amounts. Professor Very makes an estimate of its distance by means of the parallax of Nova Persei. Bergstrand had found that quantity to be 0".03, but from considerations based upon the rate of expansion of the nebulosity seen to surround the star after the outburst, Professor Very concluded that his value was too small, and placed it at 0".05. This makes the distance about 60 light years. He assumed the nova to be situated within the condensed part of the spiral structure of the galaxy; and it may be remarked here that nearly all the novæ recorded during the last 300 years are situated in or very near the galaxy, and so appear to be in some way connected with it.

He then proceeds to estimate the distance of the Andromeda nebula in a similar way. A nova appeared in the centre of the nebula in 1885, and attained the 7th magnitude. By assuming its intrinsic brightness to be equal to that of a galactic star of zero magnitude, its distance is found to be

1,579, or approximately 1,600 light years. He finally expresses the opinion that the smallest and faintest of the white nebulæ may be galaxies at a distance of 1,000,000 light years, thus advocating the theory advanced by Herschel, that our stellar system is quite limited in extent, and of the form of a spiral nebula, and that the spiral nebulæ are similar systems separated from ours by vast distances.

Some have found a difficulty in reconciling the above moderate estimate of the distance of the Milky Way with the accepted fact that the stars having sensible proper motions are probably much nearer than the Milky Way, and have smaller parallaxes than that corresponding to the above estimated distance. It may also be observed that as the spiral nebulæ congregated in the neighborhood of the galactic poles, they are probably part of our stellar system; certainly that fact does not strengthen the view that these nebulæ are separate systems.

It occurred to me recently that an estimate of the distance of the galaxy may be made by a purely geometrical process, which is here given for what it is worth. It has been shown that the galaxy is not quite a great circle of the celestial sphere, but lies in about 1°.7 south galactic latitude, showing that the solar system is a little to the north of the galactic plane. This conclusion is strengthened by the observed greater star density in the direction of the south pole than in that of the north pole, Seeliger having found the densities to be 3.14 and 2.78 respectively, per square degree. If it be assumed that this difference of density is due solely to differenc of distance, the distances of the poles of the galaxy will then be to one another in the ratio of the cube roots of the above star densities, or .96. Then if the additional assumption is made that the galactic plane divides the stellar universe equally, it is found that the distance of the solar system to the north of the galactic plane is .01 of the polar diameter of the universe. The angle subtended by this distance at the centre of the galactic region being 1°.7, the distance of the galaxy in terms of the polar diameter is found to be .342. If we then assume with Newcomb that the polar diameter of the universe is about 6,000 light years, the distance of the galaxy is 2,052 light years.



P.P.—Poles of Milky Way. S.—Position of Solar System.

Hypothetical Form of the Universe. Section Through the Poles of the Galaxy.

Taking this as the distance to the central region of the galaxy, and assuming, as shown by Professor Campbell's investigation, that its nearest part is distant about 500 light years, the farthest portions will then be about 4,600 light years from the sun.

This estimate fits in well with the distance to the limits of the universe in the region just outside the Milky Way, found from its star density, and Newcomb's conclusion that the Milky Way lies partly within the space occupied by the non-galactic stars.

In a brief survey of such an extensive field it is impossible to cover the ground completely, so I have merely attempted to give a general view of that portion of it marked off for examination at the outset. Astronomers realize that problems of the universe cannot be solved in a generation; that results can only be achieved by the co-operation of the present generation with those to come; each contributing its few grains of truth, which will finally be arranged in order. The astrographic chart of the heavens, now nearing completion, is the noblest legacy which the present generation as astronomers can bequeath to future generations. In their hands, by a repetition of the work, it should be the means of giving an insight into some of the problems of nature, about which at present we can only conjecture.

This principle of co-operation, though general in science, specially exemplified in astronomy, as its history shows. Tycho Brahe, though adopting erroneous views of the solar system, provided Kepler with the accurate positions of the planets that enabled him to formulate the laws which bear his name. These, in their turn, laid the foundation of a mechanical theory of the solar system, which, as developed by Newton and his successors, has made astronomy what it is to-day, giving us an almost perfect knowledge of the motions of the bodies of the solar system. Again, the foundation of stellar astronomy may justly be said to have been laid by Bradley, who made the first accurate observations of the positions of the stars. His catalogue, re-computed by Dr. Auwers in 1882, is the basis of our knowledge of proper motions, upon which many of the modern theories of the universe are built. Astronomers of to-day are doing their share in handing down to posterity the great star map. They, in their turn may, a century hence, find it necessary to repeat the work, extending it to include stars of the smallest observable magnitude, in order to advance knowledge of the stellar universe another step towards the final goal; which probably can only be approached asymptotically, by successive approximations, each vantage point being reached by a continually increasing amount of labor.

FORT WILLIAM'S PUBLIC UTILITIES.

The annual report of the manager of Fort William's utilities for the year ended December 31st, 1912, shows that **there has been a net gain of $4,025.04 in the telephone department during the year as compared with a deficit from the operation of this utility** during the year of 1911 of $2,728.30.

The increase in the surplus of the light department is $21,085.19, as compared with a gain of $13,309.28 during the year 1911.

The revenue and expenditure in the three utilities, light, water and telephone, are as follows:—

Water Operation.—Total revenue, $75,091.74; operation, debenture interest and sinking fund, $88,015.14; deficit, $12,923.40.

Light Operation.—Total revenue, $99,310.97; operation, debenture interest and sinking fund, $78,225.79; profit, $21,-085.18.

Telephone Operation.—Total revenue, $44,684.73; operation, debenture interest and sinking fund, $40,659.69; profit, $4,025.05.

HISTORY OF THE MAIN DRAINAGE SCHEME OF LONDON, ENGLAND.

The works which have been in progress for some years past with the object of improving the London main-drainage system are now approaching completion, and, although certain additional works are to be carried out, the great schemes authorized by the London County Council in 1899 and 1903 are now in practical operation The capital expenditure on the main-drainage works of the metropolis was £6,824,877 up to March 31st, 1912, making a total expenditure of $59,264,560.

It was not until the year 1856 that steps were taken to provide for the complete interception of the sewage of the metropolis and for its discharge into the river below London instead of within the boundaries of the City. The scheme then adopted on the advice of Sir Joseph Bazalgette, the chief engineer to the Metropolitan Board of Works, required eighteen years for its completion, and consisted in the construction of intercepting sewers parallel to the course of the River Thames and connected to the old main sewers. The sewers on the north side of the river terminated at Barking, eleven miles below London Bridge, and the south side sewers at Crossness, thirteen miles below London Bridge. Three such sewers, high, middle, and low-level, were provided on the north side of the river. The high-level and middle sewers converged at Old Ford and the low-level sewer at Abbey Mills, Stratford, all three being carried side by side thence to Barking on an embankment known as the northern outfall. Four main sewers were also provided on the south side of the river, converging at Deptford, and carried as one sewer, known as the southern outfall, to Crossness. The northern high-level and middle-level sewers and two of the sewers on the south side of the river drained either to Barking or to Crossness by gravitation, but pumping plant had to be provided in the case of the low-level sewers at Pimlico, Stratford, and Deptford, and these pumping stations, to which additions have been made at different periods, are still employed in the drainage scheme of the London County Council.

The completion of the Bazalgette scheme added to the old main sewers, which had been constructed at right angles to the river, a comprehensive system of parallel and outfall sewers which were of sufficient capacity to meet the needs of that period. The population of London at that time, taking the mean of the official figures in the Census of 1851 and 1861, was 2,586,000, but the plans adopted were designed for a population of 3,450,000. The dry weather flow provided for was 108 million gallons a day and 286 million gallons of rainfall, but the discharging capacity of the sewers was made much larger than this quantity in view of the fluctuations in the rate of flow. The old sewers, which discharged directly into the Thames, were utilized as storm overflows, and their employment for this purpose had the effect of relieving the floodings which had previously taken place in times of heavy rainfall.

At the outset the sewage was discharged into the river from both the northern and the southern outfalls without any artificial treatment whatever, and, indeed, it was not until the year 1891 that the precipitation works at Crossness were completed, the works at Barking having been finished two years before. The chemical treatment of London sewage is, however, still in the experimental stage, and, of course, the question is not so urgent in the case of the metropolis, where the discharge is into a large river with great tidal capacity, as in that of inland towns discharging into small streams. To safeguard the future, however, the London County Council have acquired an additional area of 750 acres at the outfalls in anticipation of the further treatment of London sewage by bacterial or other methods. Sir Maurice Fitzmaurice, the late chief engineer to the Council, in a report made shortly before his retirement, expressed the opinion that the further purification of London sewage will not be necessary for some years, but that meanwhile experience in sewage purification elsewhere should be carefully watched.

The Metropolitan Board of Works was superseded by the London County Council in 1889, and, though the need for fresh works had been recognized, it was not until ten years later that the plans for the extension of the drainage works now completed were definitely formulated. The need for additional sewers arose not from any defects in the old scheme, but from the operation of perfectly natural causes. The population of two and a half millions on which the original drainage plans were based was mainly on the north bank of the Thames, the population of the south side at that time being only 691,761. The rapid inrease of the population during recent years, particularly on the south side of the Thames, and the substitution of houses and streets for fields and arable land, not only increased the volume of sewage, but swelled the amount of rain flowing into the sewers. Relief works, therefore, became necessary, and the construction of the additional sewers and works was put in hand in 1901, no fewer than twenty-four main contracts, exclusive of contracts for machinery, having been placed for this work.

The additional sewers which have been provided on the north side of the Thames bring the total of additional sewers, other than storm relief sewers, constructed on the north side of the river up to a length of about forty-four miles.

The additional drainage works on the south bank of the Thames bring the aggregate up to about thirty-three miles of new southern sewers.

The Method of Construction.—The construction of the new sewers has presented greater difficulties than those which had to be met in the carrying out of the original scheme. The area covered by buildings is now much larger, and the number of pipes laid underground and the existence of a large mileage of tube railways made the selection of the routes of the sewers a subject needing careful consideration. On the north side of the river a good deal of the excavation was in the London clay. On some sections the Greathead shield method of driving was adopted, and in places where water-bearing ballast was encountered, as in the case of the length of new low-level sewer westward from Trafalgar Square, it was necessary to work under air pressure. This sewer is carried under the Metropolitan District, and East London Railways, and over the newer "tube" lines. Different strata were met with on the south side of the river. The new southern high-level sewer is mainly in chalk and ballast. The new low-level sewer from Battersea to Deptford lies for a portion of its length in waterlogged sands and gravels, and here also it was necessary to work under pressure, and to employ, as for certain sections on the north side of the river, bolted iron ring construction. On these lengths liquid grouting applied under pressure was used to form a solid backing, and the ironwork was lined with 3 to 1 concrete and the invert faced with blue bricks.

In addition to the new lengths of sewers, about ten miles of storm relief sewers have been constructed. It is now proposed to carry out extensive works for the relief of Holloway, and North London generally, and also of the area in the valleys of the rivers Wandle and Graveney and other parts of South London. The total length of main intercepting and storm sewers taken over from the Metropolitan Board of Works was about 283 miles, and the length of the County Council additions, which are principally large main sewers, is about eighty-seven miles. The length of local sewers draining into the main system is not accurately known, but there is generally a sewer in every street, and the total length of the streets is about 2,200 miles.

Pumping Stations.—The total discharging capacity of the outfalls and storm water pumping stations is 2,171,000,000 gallons in twenty-four hours. Considerable additions have recently been made to the pumping station plant at Abbey Mills and at Crossness, and additional storm water pumping stations have been erected at Chelsea on the north side of the river, and at Battersea and Shad Thames on the south side. A new engine-house is also being provided at Crossness. Of the eleven pumping stations now in operation the five principal ones, in which the motive power is steam, are continually employed in lifting sewage, although at three of them the plant can also be used to pump storm water direct into the river. The total indicated horse-power of these five steam plants is between 5,000 and 6,000, and the gross capacity 460,000 gallons a minute. The dead lift ranges from 19 ft. to 41 ft. The duty of the other six stations, where gas-driven plant has been installed, is to pump storm water into the river at times of excessive rain. The total indicated horse-power of the plant is between 8,000 and 9,000, and the capacity 300,000 gallons a minute. The average dead lift is between 12 ft. and 20 ft. In addition, large quantities can be discharged by the storm relief sewers, which act by gravitation, though the amount cannot be accurately estimated.

The first proposals for the new works were made in 1891 by the late Sir Benjamin Baker and Sir Alexander Binnie, the latter then chief engineer to the Council. The final scheme was laid before the Council by Sir Alexander Binnie in 1899, and was then approved. The greater part of the works, with additions and modifications, and also the scheme for flood relief works, were designed and carried out under the superintendence of Sir Maurice Fitzmaurice, late chief engineer, and are being completed by his successor, Mr. G. W. Humphreys. Mr. J. E. Worth, the district engineer, has had general charge of the works on the north side of the river, and Mr. R. M. Gloyne has acted in a similar capacity on the south side. Mr. H. M. Rounthwaite has been responsible for the mechanical work.

ELECTRIC PROPULSION FOR CANADIAN SHIP.

The electrical system of ship propulsion advocated by Mr. Henry N. Mavor, of Glasgow, will be tried for the first time in a merchant vessel in the oil-engined ship Tynemouth, launched at Middlesbrough, England, last week. The only vessels of this type so far are the small experimental craft Electric Arc, with which Mr. Mavor carried out trials of his transmission gear on the Clyde, and a collier for the United States navy. The Tynemouth, which is 250 ft. long and of 2,400 tons deadweight on fresh water, has been built for the Montreal Transportation Company, and is intended for cargo service on the Canadian Lakes.

For propelling purposes she will have two Diesel engines, each developing 300 b.h.p., and between them and the propeller there will be interposed Mr. Mavor's electrical gear, which is being manufactured at the works of his firm in Glasgow. This gear is designed to allow the Diesel engines to run at a constant high speed generating electricity, and at the same time to permit the use of a slow-moving propeller of coarse pitch, reversing, stopping, and starting being carried out independently of the prime mover. For efficient service on the Canadian lakes a large propeller running at not more than 800 r.p.m. is wanted, and so far it has been found possible to meet this requirement only with reciprocating steam engines.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz.

(Continued from page 588 of last issue.)

While relief from serious electrolysis can at times be obtained by such special measures as insulating pipe coverings or insulating joints, it must be understood that all remedial measures should have for their first aim the reduction of the drop in potential in the rails to a minimum, because this removes the cause of the trouble. The first and most important step necessary to accomplish this is to maintain the rails perfectly bonded, so that the rails themselves form continuous electrical conductors. The next important step is to limit the radius from the power station to which

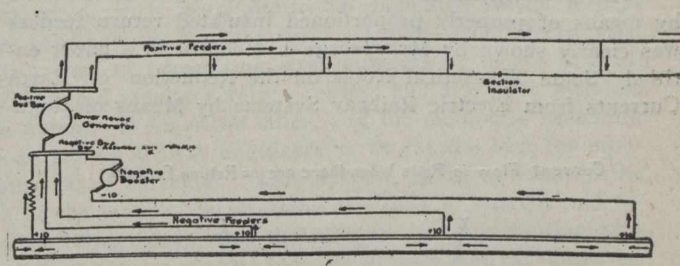


Fig. 17.—Single-Trolley Railway with Insulated Return Feeders and Negative Booster, Showing Path of Currents and Assumed Rail Potentials.

the station supplies electric power, so that current does not have to be returned from excessive lengths of rail lines to any one power station. This is usually accomplished in practice by supplying power to electric railways from distributed substations. The next step is to remove the current from the rails wherever there is concentration of current by means of insulated return feeders connecting from the rails at these points to the power station. In order that such insulated return feeders should be most efficient in reducing drop in potential in grounded rails these feeders should be proportioned for equal drop, so that the rails at all points where

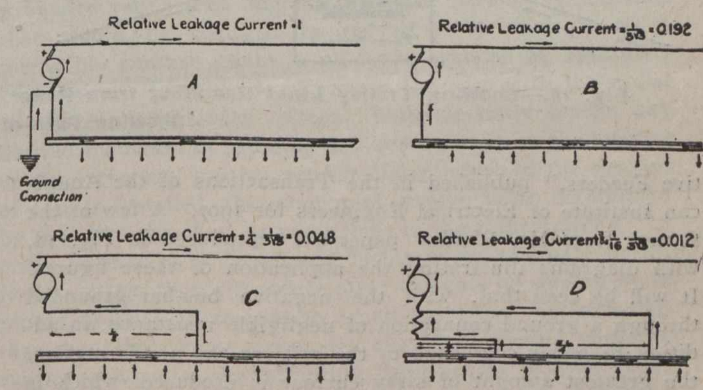


Fig. 18.—Relative Leakage Currents with Various Return Circuit Conditions.

return feeders are connected are maintained at substantially the same potential under average load conditions. This also requires that the rails immediately in front of the power station must not be connected directly to the negative bus-bar, unless a resistance corresponding to the average resistance of the return feeders is connected in this circuit. Where it is necessary to bring current back from a distant point in the rails it is sometimes more economical to employ a negative booster in series with this return feeder rather than make this feeder of such large cross-section as would be required to maintain the distant point in the rails at the same potential as the nearer connection points. With this system part of the voltage drop is actually removed from the rails and transferred to the insulated return feeders from which current cannot leak to ground.

An illustration of such an insulated return feeder system, proportioned for equal drop, is shown in Fig. 17. In this illustration it is assumed that the negative bus-bar is at zero potential and that the return feeder connection points on the rails are maintained at a potential of 10 volts with reference to the negative bus-bar. Under these circumstances there is no tendency for current to flow from the rails between points where feeders are connected to the rails. The drop of 10 volts in the return feeders has also been removed from the rails.

The possibilities in the way of reducing stray currents by means of properly proportioned insulated return feeders was clearly shown by Mr. George I. Rhodes, in a paper entitled "Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders," published in the Transactions of the American Institute of Electrical Engineers for 1907. A few of the figures from Mr. Rhodes' paper are reproduced in Fig. 18, with diagrams illustrating the application of these figures. It will be seen that, with the negative bus-bar grounded through a ground connection of negligible resistance, in addition to being connected to the rails at the power station, the greatest amount of stray current is produced, which is assumed unity for purpose of comparison. This is illustrated by Diagram A, Fig. 18. Disconnecting the negative bus-bar from ground connections at the station, but not from rails, reduces stray currents to one-fifth their former value, as illustrated by Diagram B of Fig. 18. Disconnecting the negative bus-bar from ground connections and from the rails at the power station, and returning the current by means of one insulated return feeder from the centre of the line, reduces stray currents to 5 per cent. of their former value, as illustrated by Diagram C of Fig. 18. By using two insulated return feeders with the negative bus-bar insulated, the stray currents are reduced to 1.2 per cent. of their former value, as illustrated by Diagram D of Fig. 18. It, therefore, can be seen that very great reduction of stray currents can be accomplished by insulating the negative bus-bar at the power station from ground connections and from rails, and returning the current by means of insulated return feeders.

Since power stations are usually located near the centre of load of an electric railway system, it is usual in cities to find railway lines radiating out from the power station. Where the running tracks are connected to the negative bus-bar only in the immediate neighborhood of the power station, these running tracks are depended upon alone to return current to the power station, and there is consequently always very great concentration of stray current under these circumstances in the neighborhood of the power station. Such railway lines radiating out from the power station are illustrated diagrammatically in Fig. 19. In this figure eight railway lines are assumed radiating out from the power station. In the left-hand diagram of Fig. 19 the rails of these lines are shown connected to the negative bus-bar at the power station only. It is seen that, as the result of this, all of the current used on the eight railway lines flows in the rails towards the power station. The stray currents which leak from the rails to ground also concentrate in ground and on the underground piping in the neighborhood of the railway power station, where they must return to the rails to get back to the negative bus-bar.

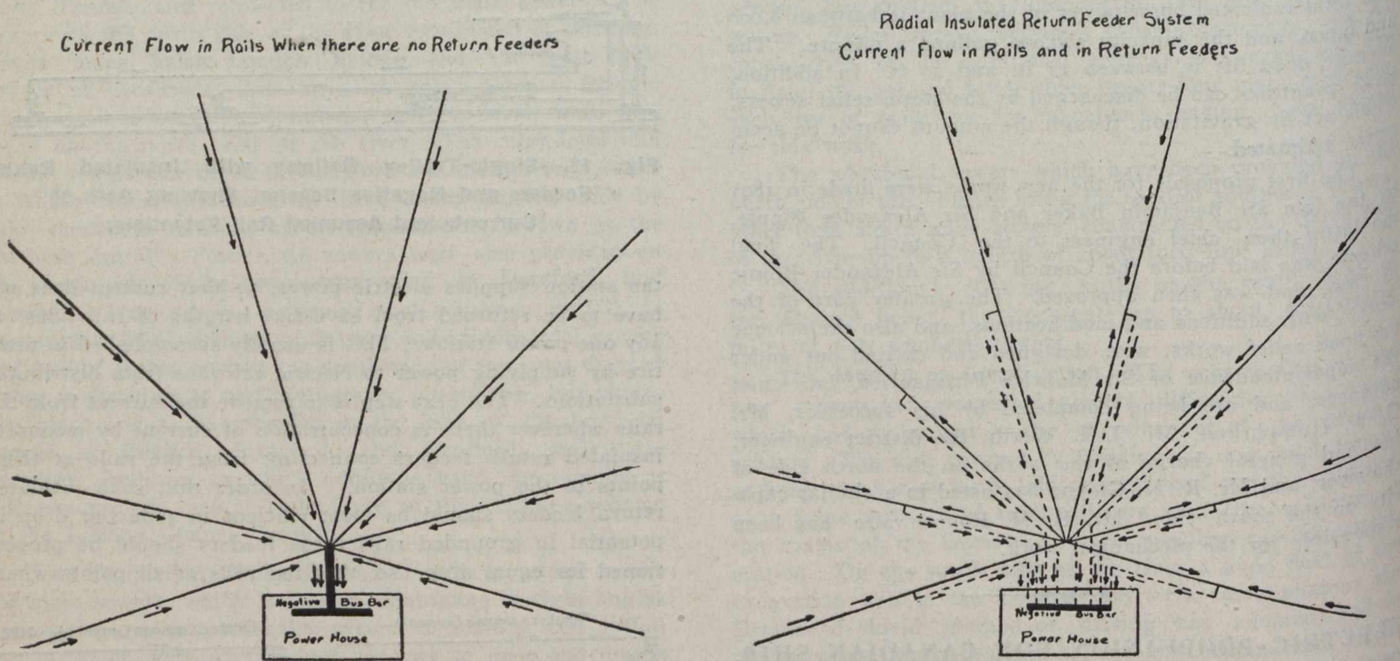


Fig. 19.—Showing Trolley Lines Radiating from Power Station With or Without Insulating Return Feeders and Showing Path of Return Currents.

If this connection between the negative bus-bar and the rails at the power station were removed, and the currents returned from the rails at points near the centre of each railway line by means of insulated return feeders, as shown in the right-hand diagram of Fig. 19, this concentration of current in the neighborhood of the power station would be entirely removed. With this arrangement, the current used by each individual line would tend to flow away from the rails at points away from the centre of each line, and towards the rails near the centre of each line. It is, therefore, seen that there is only ⅓ of the current returning from the rails at any one point than there is when the rails are connected to the negative bus-bar only at the power station. Further, the total stray current through ground with the conditions shown in the right-hand diagram will be only ¼ of the total stray current with the conditions of the left-hand diagram, assuming similar soil conditions, so that at any one point the danger from electrolysis will be 1/32 of what it is in the neighborhood of the power station with the first arrangement. As a matter of practice, however, the actual reduction is very much greater, because the return feeder connection points on the rails can be chosen so as to be located where the ground is high and dry, and consequently of high resistance, while the railway power station is generally located near water, where the ground is wet and of low resistance. Instead of connecting one insulated return feeder to the middle point of every line, as indicated in Fig. 19, a number of such feeders may be connected to a number of properly selected points in every line. In this way the drop in the rails, and consequently also the stray current produced, can be reduced to any desired value. In many cases the benefit to be derived at comparatively small cost from insulated return feeders with negative bus-bar insulated is much greater than above indicated. This is particularly true when the power house is at one side of a main network of tracks and connected to it only by a single branch line. To connect the negative bus-bar to the tracks of this single branch at the power house means concentrating the major part of the track drop within a short distance of the power station. In such case, the insulation of the negative bus-bar, and the use of insulated return feeders to the central rail network, will at once take the greater part of the drop out of contact with ground. This will eliminate the greater part of the cause of the trouble, as well as enormously reduce the concentration of the remaining stray current in the positive district. Thus the advantage gained by insulating the negative bus-bar is often very much greater than that indicated for the typical case above described.

The reduction of drop in potential in rails, for the purpose of minimizing electrolysis, is the basis for various regulations and ordinances which have been enacted for the purpose of protecting underground metallic structures from electrolysis. For example, the well-known English Board of Trade Regulations limit the maximum allowable potential difference between any two points in the rails to 7 volts. In Germany, a joint committee, representing the electric railway, gas and water interests, has adopted a regulation limiting the average allowable potential difference between any two points in the rails to 2.5 volts within a district encircling the urban district by a radial distance of 2 kilometers. Beyond this circle, the average potential drop in the rails must not exceed 1 volt per kilometer.

Where railway return circuit improvements have been made, to such an extent that there are no longer any excessive drops in the grounded rails, it is generally found that stray currents on underground pipes are reduced to small and often negligible amounts. Where, however, stray currents which are considered too large for safety are still found on such underground pipes after the railway return circuit has been thoroughly improved, then it is frequently possible and feasible to apply one or more of the other remedial measures, such as insulating joints in the pipes to take care of the small remaining stray current. Such other remedial measures, as bonding or insulating joints in pipes must, however, never be applied unless the railway return circuit has been improved sufficiently to eliminate all excessive drops in the grounded rails.

Summary and Conclusions.—Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bonding, to ground connections from the negative bus-bar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact, which is not generally appreciated, that where large stray currents exist, due to the above causes, these can always be reduced to a small fraction of their present value by removing all ground connections of the negative bus-bar and installing insulated return feeders proportioned for equal drop from radially disposed points in the track system located at some distance from the power station. By this method the rails are drained of current, and any desired part of the voltage drop can be removed from the rails and transferred to insulated conductors from which currents cannot leak. In Europe such radial insulated return feeders, for bringing current back from the rails to the power station, are made necessary by regulations limiting the allowable drop in voltage in the rails; and, in most cases, such installations of insulated return feeders have substantially removed serious trouble from electrolysis. This system of minimizing stray currents by means of radially disposed insulated return feeders has also been installed in a number of American cities, and the method is becoming recognized by railway engineers as by far the best for minimizing stray currents. This system, in fact, removes the root of the trouble, by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is, therefore, correct in principle. The railroad companies frequently object to this system, claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities to-day. The fact is that in many electric railways there is practically no installation of negative feeders, and that the railway companies are often not willing to install even a moderate amount of return feeder copper. A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Where the negative bus-bar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is only reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This, however, is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current, can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit. In order to effectively install and maintain an adequate return feeder system that will reduce stray currents on underground piping systems to reasonably small values, it is essential that the pipe-owning companies should co-operate with the railway companies by affording them access to their pipes for making necessary measurements, etc. After a railway company has installed a reasonable and fair return circuit, it sometimes also happens that it is desirable to eliminate any remaining current on pipes by the use of properly located insulating joints. Under these circumstances the pipe-owning companies should be willing to co-operate with the railway company in the installation of such joints.

It is the author's firm conviction that such remedial measures as pipe drainage or insulating pipe joints should be used (if at all) only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures.

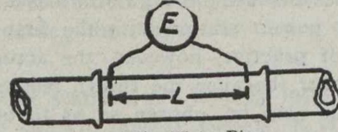
Table for Determining Current Flow on Iron Pipes from Millivolt Drop Along Continuous Length of Pipe.

Computed by Albert F. Ganz, M.E.

L = Distance between contacts, feet.
E = Instrument reading, millivolts.
K = Constant from table.

$$\text{Current flow, amperes} = \frac{KE}{L}$$

Wires must not span joint.



Cast Ifon Water Pipe.

American Water Works Association Standard—Adopted 1908. Weight 1 cubic foot = 450 pounds Resistance 1 pound foot = 0.00144 ohm.

Design.	Nominal Diam. of Pipe.	Weight per Foot Exclusive of Bell	Resistance per Foot Exclusive of Bell.	K Current for 1 Millivolt Drop per Foot of Continuous Pipe.
100 feet head, 43 pounds pressure.	ins.	lbs.	ohm.	amps.
	4	18.1	0.0000795	12.6
	6	27.9	0.0000516	19.4
	8	38.8	0.0000371	27.0
	10	52.1	0.0000276	36.2
	12	67.1	0.0000215	46.6
	14	82.5	0.0000175	57.3
	16	99.0	0 0000146	68.7
	18	118.	0.0000122	82.0
	20	138.	0.0000104	95.8
	24	187.	0.0000077	130.
	30	267.	0.00000539	185.
	36	359.	0.00000402	249.
	42	465.	0.00000310	323.
	48	609.	0.00000236	423.
	54	733.	0.00000196	509.
	60	838.	0.00000172	583.
	72	1170.	0.00000123	813.
	84	1450.	0.000000994	1010.
400 feet head, 173 lbs. pressure.	4	22.8	0.0000631	15 8
	6	35.4	0.0000407	24.6
	8	51.2	0.0000282	35.6
	10	71.6	0.0000202	49.7
	12	93.9	0.0000153	65.2
	14	119.	0.0000121	82.6
	16	148.	0.00000973	103.
	18	179.	0.00000805	124.
	20	213.	0.00000676	148.
	24	286.	0.00000503	199.
	30	422.	0.00000342	293.
	36	583.	0.00000247	405.
	42	765.	0.00000188	532.
	48	962.	0.00000150	668.
	54	1230.	0.00000117	854.
	60	1460.	0.000000987	1014.

Design.	Nominal Diam. of Pipe.	Weight per Foot Exclusive of Bell	Resistance per Foot Exclusive of Bell.	K Current for 1 Millivolt Drop per Foot of Continuous Pipe.
200 feet head, 86 pounds pressure.	ins.	lbs.	ohm.	amps.
	4	20.1	0.0000716	14.0
	6	31.2	0.0000462	21.6
	8	42.7	0.0000337	29.7
	10	59.0	0.0000244	41.0
	12	76.6	0.0000188	53.3
	14	95 0	0.0000152	66.0
	16	115.	0.0000125	79 9
	18	138.	0.0000104	95.9
	20	163.	0.00000884	113.
	24	218.	0.00000661	151.
	30	313.	0.00000460	217.
	36	419.	0.00000344	291.
	42	544.	0.00000265	379.
	48	689.	0.00000209	479.
	54	847.	0.00000170	588.
	60	1010.	0.00000143	702.
	72	1420.	0.00000101	986.
	84	1880.	0.000000767	1310.
500 feet head, 217 lbs. pressure.	6	37.8	0.0000381	26.2
	8	56.7	0.0000254	39.4
	10	78.9	0.0000182	54.7
	12	104.	0.0000138	72.2
	14	133.	0.0000108	92.4
	16	165.	0.00000873	115.
	18	203.	0.00000710	141.
	20	241.	0 00000598	167.
	24	329.	0.00000438	228.
	30	481.	0.00000300	334.
	36	668.	0.00000216	464.

Design.	Nominal Diam. of Pipe.	Weight per Foot Exclusive of Bell.	Resistance per Foot Exclusive of Bell.	K Current for 1 Millivolt Drop per Foot of Continuous Pipe.
300 feet head, 130 pounds pressure.	ins.	lbs.	ohm.	amps.
	4	21.3	0.0000676	14.8
	6	33.0	0.0000436	22.9
	8	48.1	0.0000300	33.4
	10	65.6	0.0000219	45.5
	12	85.6	0.0000168	59.5
	14	108.	0.0000133	75.0
	16	134.	0.0000107	93.1
	18	163.	0.00000884	113.
	20	191.	0.00000754	133.
	24	258.	0.00000558	179.
	30	368.	0.00000392	256.
	36	498.	0.00000239	346.
	42	659.	0.00000218	458.
	48	834.	0.00000173	579.
	54	1040.	0.00000138	723.
	60	1220.	0.00000118	847.
	72	1750.	0.000000823	1220.
600 feet head, 260 lbs. pressure.	6	39.6	0.0000364	27.5
	8	60.7	0.0000237	42.2
	10	84.7	0.0000170	58.9
	12	113.	0.0000127	78.5
	14	146.	0.00000987	101.
	16	181.	0.00000795	126.
	18	220.	0.00000654	153.
	20	266.	0.00000541	185.
	24	362.	0.00000398	251.
	30	539.	0.00000267	375.
	36	754.	0.00000191	523.

Table for Determining Current Flow on Piping from Millivolt Drop Along Continuous Length of Pipe.—Continued.

Cast Iron Gas Pipe.
American Gas Institute Standard—Adopted 1911.
Weight 1 Cubic foot = 450 Pounds.
Resistance 1 Pound-foot = 0.00144 ohm.

Nominal Diam. of Pipe.	Weight Per Foot, Exclusive of Bell.	Resistance Per Foot, Exclusive of Bell.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	Pounds.	Ohm.	Amperes
4	17.3	0.0000833	12.0
6	27.3	0.0000528	19.0
8	38.0	0.0000379	26.4
10	51.1	0.0000282	35.5
12	67.1	0.0000215	46.6
16	102.	0.0000141	70.9
20	140.	0.0000102	97.1
24	187.	0.00000770	130.
30	258.	0 00000559	179.
36	346.	0.00000416	240.
42	453.	0.00000318	314.
48	609.	0.00000237	423.

Standard Wreught Iron Pipe.
Resistance 1 Pound foot = 0.00181 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	Pounds.	Ohm.	Amperes.
1/8	0.24	0.000754	1.33
1/4	0.42	0.000431	2 32
3/8	0.56	0.000324	3.09
1/2	0.84	0.000216	4.64
3/4	1.12	0.000162	6.18
1	1.67	0.000108	9.23
1¼	2.24	0.0000808	12.4
1½	2.68	0.0000676	14.8
2	3.61	0.0000501	20.0
2½	5.74	0.0000316	31.7
3	7.54	0.0000240	41.7
4	10.66	0.0000170	58.8
6	18.76	0.00000965	104.
8	28.18	0.00000643	156.
10	40.00	0.00000452	222.
12	49.00	0.00000370	271.

Standard Steel Pipe.
Resistance 1 Pound-foot = 0.0021 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	Pounds.	Ohm.	Amperes.
1/8	0.24	0.000873	1.14
1/4	0.42	0.000500	2.00
3/8	0.56	0.000376	2.66
1/2	0.84	0.000250	4.00
3/4	1.12	0.000188	5 33
1	1.67	0.000126	7.95
1¼	2.24	0.0000937	10.7
1½	2.68	0.0000784	12.8
2	3.61	0.0000582	17.2
2½	5.74	0.0000366	27.4
3	7.54	0.0000278	35.9
4	10.67	0.0000197	50.8
6	18.76	0.0000112	89.4
8	28.18	0.00000745	134.
10	40.07	0.00000524	191.
12	49.00	0.00000428	234.

Discussion.

The President—Gentlemen, you have listened to a splendid lecture on an important scientific subject, delivered in a manner that has made it simple and comprehensible, and by a master mind. I will ask Mr. Gould to open the discussion.

Mr. Gould—Mr. President, our troubles in Boston from electrolysis seem to be disappearing. Looking over our records for the last four years, I find we have only had an average of one case of electrolysis on mains and three on services, 1909 to 1912. That means the cases that have been brought to our attention as distinct ones. Of course, we may have had damages to our pipes through corrosion, which did not have the other electrical indications. If you had asked me a month ago whether we had had any trouble, I should have said, "Practically none"; but last month in one of our suburban districts where the electric railroad is not a part of the Boston Elevated System, a service pipe was destroyed. It had been laid about 8 or 9 years. Tests showed that our pipe was an indefinite number of degrees negative to the rails; our voltmeter only registered 10 volts, and the hand came up with a thump on that side of the voltmeter. I have heard since that the engineers from the Metropolitan Water Department four or five years ago found a maximum of 90 volts in that district, but their pipes being negative to the rail, they did not worry very much about it. This service pipe was within 50 feet of the point where we tested, and was opposite the terminus of the electric road. I found afterwards that a telephone conduit passed under the service pipe at the point where it was destroyed. Undoubtedly the current went from the rails to the main, passed through the service pipe and from it to the telephone conduit, and was one of the best illustrations of that process of destroying pipes. The railroad people are investigating this, and I hope something will be done about it. One of Prof. Ganz's diagrams illustrates a trouble which we were investigating late last fall or early this winter. One of our holders, a steel tank holder, located above the surface of the ground, had a slight leakage through the bottom plates. There is a creek from the river in back of it, formerly salt water, now more or less fresh, on account of the dam of the Charles River Basin. The ground is saturated with marsh water, and, of course, there is salt in it. The power station is perhaps three-quarters of a mile above the river. We found that there was a light current passing from the pipes in the governor house to this creek. The quantity of the current we did not know. We simply made a voltmeter test in connection with the railroad officials, and up to the present time nothing else has been done to remedy the trouble. The inserting of insulating joints would be rather difficult at this point. The connecting of the pipes in governor house to plates sunk in the creek by copper wires may do some good.

Mr. C. J. R. Humphreys—I am inclined to think that after Prof. Ganz has finished a lecture on "Electrolysis" there is not very much that the rest of us can add that will be of any very great value. It is true that we did have considerable trouble in Lawrence from electrolysis four or five years ago, trouble on the sheaths of our underground electric cables and on certain of the gas services, particularly near the power plant. I called Prof. Ganz in to our aid, and he made a very thorough survey and very thorough study of all the conditions surrounding us. Some of the slides which have been thrown on the screen here to-day remind me very much of the incidents that we ran against in Lawrence; as, for instance, a current on a water main leading to a building by the water service pipe and then coming in contact with the lead sheath of an electric service, thus getting on our cables in the conduit. Such a case as that takes a good deal of time in tracing out, and I know in one of those cases the Professor had to put in a good deal of time before he found just where the current was getting out to our cable. I do not wish to speak of each particular instance, because I think they are all covered by what the Professor has said. There are certain principles, however, that seem worthy of consideration. When we first took up this matter and we were having considerable trouble with our underground electric cables, the suggestion was made to us by the trolley people that we should connect our sheaths to their return wires to their power house. The Professor and I discussed the matter thoroughly. It seemed as if that were the only remedy, but, after considering the matter, we both agreed on the proposition that we were not going to enter into partnership with the trolley company for the return of their stray currents. They had to take care of their own current; we were not going to enter into any partnership on these lines, and we held to that. Our troubles were lessened a good deal about that time by the fact that the trolley company was relaying its rails in a part of the city where we were having trouble, and we had this matter up with them. We notified them that we expected them to take care of their currents, that we were not going to do it, and in relaying their rails and trackage, they rebuilt on very substantial lines. They lessened our troubles quite a little, and then, of course, the Professor found, as I have just indicated, several cases where the current was coming on to our system, and where it could be done away with entirely or at least reduced. Now, I would like to call attention to the importance of the charts that have been shown or reproduced here, giving the record of the recording instruments, particularly the one which showed the load current for different days in the week and for different hours in the day, where you could see in the evening, as the peak load came on, it was reproduced on the coart, and in the morning and on Sundays. Now, I think that those charts are very important. The Professor has used them in Lawrence. Their importance is this, that it establishes without any doubt that it is trolley current. I do not see how you can get away from that. If you study the peculiarities of the trolley system, when the peak comes on and when it goes off, and you find those conditions reproduced on those charts, there is no use of the trolley road coming back and saying it is not its current. That is what they told us, of course, that it was our own current, not theirs, but with the system of those registering charts, and the study of the peak loads of the trolley system, you can establish that, of course, without a doubt. The only other point I wish to mention, is this: We do not seem to have now very much trouble from stray currents, but we have not stopped and said, "Well, stray currents cannot do us any harm." We have not stopped our investigations. On the contrary, all the work that we have been doing in the past in the way of survey is kept up, and the Professor visits us at least twice a year on a special trip, and during his absence, in the meanwhile, we test our electrical system along the lines which he suggests, the idea being this, and I think an important idea, to catch on to trouble just as soon as it occurs. At times we will, in this way, detect incipient trouble, and while it may not call for immediate action, we know something is going wrong. It cannot do any harm now, but it is something that has to be watched. Now, having that in mind, detecting what you might call these minor flows of current, we have points that we know will stand watching, and we do watch them, and we hope to catch the source of trouble before any serious damage is done. Electrolysis, I think, is one of those cases where "a stitch in time saves nine" by the systematic survey work carried on practically all the time.

Prof. Ganz—I would like to supplement what Mr. Humphreys has said by a few words. Electrolysis surveys do not always give a direct return for the money spent for them. Mr. Humphreys has brought out exceedingly well how they do serve to keep track of the situation. There is one other very important use of such surveys; namely, when damage results in the future they may be useful as a proof that the damage was caused by electrolysis. Very often after a pipe has been destroyed by electrolysis and has been replaced it is impossible to prove that electrolysis was the cause. Further, if a pipe owning company finds from an electrolysis survey that its piping system is endangered by electrolysis, it can notify the railway company of this fact; if then damage results in the future, the railway company cannot plead that they were not aware of the danger produced by their currents. It has also been my experience that when a railway company knows that the pipe-owning company is making electrolysis surveys, and is keeping watch on the situation, it will do at least some work towards improving the return circuit, thus reducing the danger from electrolysis.

The Secretary—I would like to ask Prof. Ganz or anyone else, if in a condition similar to this Charlestown exhibit the chemical composition of the material after it has not been destroyed but changed, can be used as a test to show whether or not the damage has been done by electrolysis or by some other corrosive agency? Most of the cases which I personally have had have been on old lines where there was a possibility of other corrosive agents, and I have asked that question several times without receiving thus far much satisfaction from the answers.

Prof. Ganz—I believe I can give a satisfactory answer, namely, that you cannot tell from the appearance of a corroded wrought iron or steel pipe whether the corrosion and destruction were caused by electrolysis. In the case of cast iron a graphitic material left as the result of the corrosion usually, but not always, indicates electrolysis. If corrosion from electrolysis is going on, it is perfectly possible, however, to make a suitable electrical test which will show conclusively whether or not stray electric current is leaving the pipe and is causing the corrosion. For this purpose we use an instrument known as an earth ammeter; we place this next to the pipe and connect it to a recording instrument, and obtain a 24-hour record of the current flowing from the pipe to the surrounding soil. This record will not only show the presence of current but will also indicate whether it has railway characteristics. If such current is found leaving the pipe it is certain proof that it must produce a corresponding amount of electrolysis. A test of this kind, together with the corroded pipe affords, in my opinion, the best possible evidence that we can have a corrosion by electrolysis. The corroded pipe by itself without any connecting electrical measurements will not ordinarily serve as complete evidence.

Mr. Shattuck—I was interested to hear the Professor say that there was no way of knowing whether a pipe was absolutely damaged by electricity or from some other source. Perhaps in contradiction to that I have heard recently that a professor in, I think, Swarthmore College, had made examinations under a microscope, and he claimed that in the case of a pipe that was destroyed by electrolysis the particles of iron were magnetic or stood out just as they do around a magnet. I was wondering if the Professor had made any experiments along that line, or if that was more theoretical than it was practical. Has the legal question been touched on?

The President—No, it has not.

Mr. Shattuck—I did not hear the paper. I have been advised quite recently that the proper action to take in cases of electrolysis if your electric company is not willing to go ahead and do something, is to file a bill in equity against a continuing trespass, and you will have a pretty good chance of sustaining an action under such bill. It brings it to a head quicker than anything else, and I believe it is the best legal practice to-day. It may be of interest to some of the smaller companies.

Prof. Ganz—I agree absolutely with the suggestion of Mr. Shattuck. An attempt to secure an injunction would rarely be granted because an electric railway is a public utility, and the courts will hesitate a long while before issuing an injunction restraining them from operating. Regarding the tests suggested by the Swarthmore professor for determining whether a given corrosion was caused by electrolysis or by natural causes, I would like to say that local galvanic action can produce currents which would produce electrolysis in which case the corrosion is not due to external stray currents, and yet the corroded iron must have the same appearance as if it had been produced by stray electric current. I, therefore, do not think that much can be hoped for from this test.

SASKATCHEWAN'S BRIDGE CONSTRUCTION.

Methods that are followed in the construction of bridges by the province of Saskatchewan may not be generally known, but it is the policy of the Government to endeavor to build all small timber bridges, reinforced cement bridges and cement bridge abutments during the summer months, as this class of work can be better performed during the warmer part of the year, while the erection of the steel bridges, which vary in length from 40 to 250 feet each single span, is usually undertaken during the winter months; such arrangement gives continuity to the work, so that in no part of the year is there any cessation of the work of bridge construction.

It is almost unnecessary to remark that the bridging of streams, especially in those portions of the province which only very recently were thrown open to settlement, but which are now rapidly becoming the centres of agricultural enterprise, is of even greater importance than the construction of graded roads, because, as a rule, the average prairie trails can be travelled without difficulty with average loads, and it is to such districts that a considerable amount of the attention of the department is devoted, in order to enable the farmers in the outlying districts to market their produce. This might be described as pioneer bridge work.

Another class of bridge is that which is constructed in order to complete the links in a main road selected for improvement either by the rural municipal councils or by the board of highway commissioners, and wherever the location warrants, especially on the main roads directly leading to a market town, such structures are of a permanent or semi-permanent type.

The third class consists of those bridges built to replace older structures, which have passed their age of usefulness. Generally the bridges which replace these latter are of a permanent type, that is, of steel and concrete, and last year saw fifteen of these bridges handled in this manner. At the time of writing a few of these works are still in progress, and it is satisfactory to note that the work of construction has not been delayed at any time during the severe weather of the early part of February.

At present there are seven bridge crews on the day labor basis in the field, working continuously, which is about half the number of crews usually employed during the summer months; in addition to these are the contractors who are constructing bridges under direct contract.

HIGH-POWER GAS ENGINES FOR JAPAN.*

By Frank C. Perkins.

The arrangement of the four gas engines in the Kamata gas operated power plant in Japan is noted in the accompanying drawings of the 2,130 h.p. gas engines in the English shops of the Lilleshall Company, Limited, at Oakengates, Shropshire. From these drawings may be noted the details of construction of the cylinders and valves of these high power engines of the Nuernberg design built in English shops for the Japanese government.

The Japanese officials recently determined to electrify the line of railway between Tokio and Yokohama and it was decided to generate the energy necessary by means of gas power, a power house being erected for this undertaking at Kamara near Yokohama.

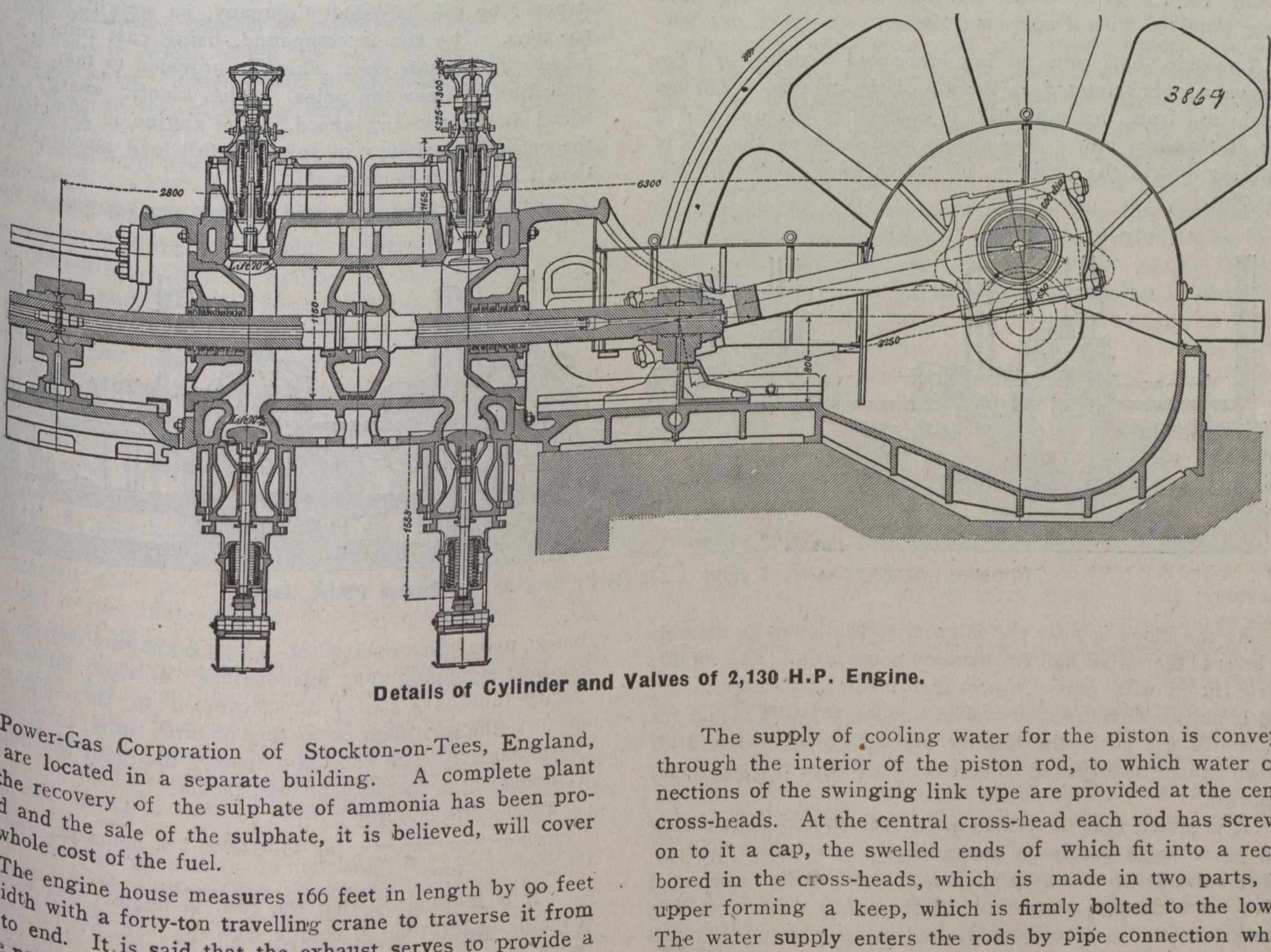
It will be noted that the station was designed to accommodate four gas engines each rated at 2,130 b.h.p. when running at 95 r.p.m. The gas producers were supplied by the Power-Gas Corporation of Stockton-on-Tees, England, and are located in a separate building. A complete plant for the recovery of the sulphate of ammonia has been provided and the sale of the sulphate, it is believed, will cover the whole cost of the fuel.

The engine house measures 166 feet in length by 90 feet in width with a forty-ton travelling crane to traverse it from end to end. It is said that the exhaust serves to provide a large part of the steam required for operating the Mond producers, into which it is necessary to pass about two tons of steam for each ton of coal gasified. There is an electric motor-driven centrifugal pumping plant provided for cooling the pistons and cylinders arranged in a pit to one side of the last engine on the right.

For starting there is a supply of compressed air under a pressure of 300 pounds per square inch provided, the two compressors being motor-driven and located near the water pumps for the piston. The compressors are cooled by a supply of water from the cylinder cooling main and deliver the air by a 2½-inch air main into receivers 48¾ inches in diameter by about 12 feet long, there being four located under the engine platforms.

On this gas engine it will be seen that the cold water enters near the hottest part of the cylinder, and is withdrawn at the coolest, and the inlet valves are nearly flush with the cylinder barrel. Each individual cylinder weighs 25 tons, and these cylinders are 1,200 mm. (47¼ in.) in diameter by 1,300 mm. (51⅛ in.) stroke. The engine was designed for a speed of 100 r.p.m. at which its output would be 2,600 to 2,500 b.h.p., but at Kamata it is to run at 94 revolutions and generate 1,500 kilowatts current, this being equivalent to 2,130 b.h.p.

It will be noted that the whole of the weight of the pistons is carried by the cross-heads, thus reducing wear in the cylinder and at the blands. To this end the rods have a slight upward chamber, so that they are straight when loaded with the weight of the piston. The piston is bolted down to a conical seat by a fine threaded nut, the nut beds into the piston, and by means of a rubber joint makes a perfectly water-tight connection when screwed home.



Details of Cylinder and Valves of 2,130 H.P. Engine.

The supply of cooling water for the piston is conveyed through the interior of the piston rod, to which water connections of the swinging link type are provided at the centre cross-heads. At the central cross-head each rod has screwed on to it a cap, the swelled ends of which fit into a recess bored in the cross-heads, which is made in two parts, the upper forming a keep, which is firmly bolted to the lower. The water supply enters the rods by pipe connection which straddle the cross-head proper.

It will be observed that the junction piece between the cylinder is open at one side, so as to give ready access to the central cross-head and its water connections; and symmetry is secured by reinforcing this open side by a stout steel tie. The forward bed is made in two portions in order to facilitate the transport of the bed over the Japanese railways. The two portions are coupled together by link, shrunk into place, and the weight of the whole complete is 55 tons. The total engine weight, including the fly wheel, is 400 tons. The connecting rod is of the marine type. Forced lubrica-

*Abstract from The Gas Engine.

tion is provided for the crank pin which is 600 mm. (23⅝ in.) in diameter.

The shaft at the fly wheel seating has a diameter of 820 mm. (32¼ in.). The front cross-head is of nickel steel with the small end pins forged solid with it. There is secured to it a cast iron slipper lined with white metal and this is secured in such a way that the cross-head proper can readily be lifted clear and the piston withdrawn for examination or repair.

In the construction of this gas engine Siemens-Martin steel is used for the crank shaft, the main bearings for which have four part brasses of steel lined with white metal, and these are also arranged with forced lubrication. The glands are packed with cast iron rings turned slightly smaller than the rod, and split. Each is backed by a floating metallic packing kept tight by springs and the glands are lubricated by oil, supplied by forced feed lubricators.

It will be seen that the valves are operated by eccentrics mounted on the side shaft, and which is made in two parts coupled together by gearing, and in the gear box provision is made for the gears which drive the governor. The latter being provided with a speed regulator.

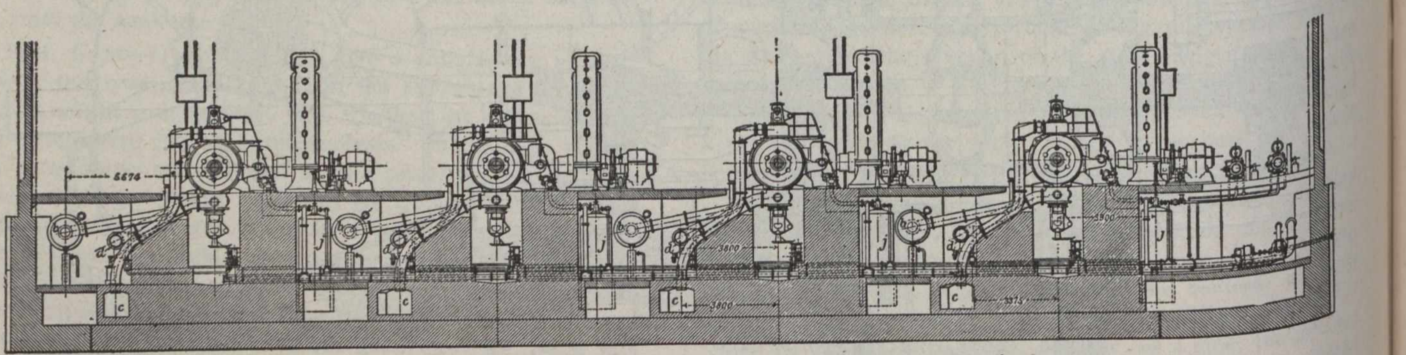
The side shaft runs in ring lubricated bearings and the inlet valves are mounted on the top of the cylinder. The eccentric rod from the side shaft is coupled to the upper of a pair of "rolling" levers, as shown, and between the two is a sliding block, the position of which is regulated by the governor.

the supply going to these. Each water outlet is fitted with a regulating cock and a thermometer, so that the supply to each part can be adjusted with great nicety, and water economized. A single large cock is provided on the supply pipe, by which the water can be shut off when the engine is stopped and the regulating cocks do not, therefore, require to be touched.

It is said that the supply of water is at the rate of about 8 gallons per b.h.p. hour, and the temperature rises from 60 degrees to 105 degrees Fahr. Cooling towers are provided by the use of which the actual loss of water is reduced to 2 pounds per b.h.p. hour. The ignition system is unique, as each cylinder is provided with three low-tension ignition plugs, operated by small electromagnets and the current supply is taken from storage batteries.

It is of interest to note that the engine is started by compressed air, admitted through independent ports, with valves which are operated by the side shafts. To each engine is coupled a 1,500-kw. alternator having its pole pieces mounted direct on the rim of the fly wheel, which was constructed by the Lilleshall Company, its weight being about 100 tons. The rim is compound, being cast round a dovetailed strip of soft steel, which is provided to take the magnetic flux between the poles. The kinetic energy of the wheel at the running speed of the engine is sufficient that the cyclical variation in speed at full load amounts to less than 1 in 250, it is claimed.

As to operation, it is said the cost per kilowatt is $0.046,



Showing Arrangement of Four 2,130 H.P. Engines in Power Plant, Japan.

As the block is near the fulcrum of the lower of the pair of levers, the valve has its maximum opening. A rotable sleeve fitted with ports is provided inside the valve casing and it moves with the main valve, and by twisting round the spindle of the latter the relative proportions of gas and air drawn in can be adjusted to suit the quality of the gas being supplied.

It is stated that the whole of the valves and their casing can be removed bodily on unscrewing a few nuts. The exhaust valve is operated by the same eccentric as the inlet valve immediately above it. As before, a pair of rolling levers are used to secure the desired rapidity of opening and closing, but no adjustment is required for varying the amount and time of opening, as is necessary at the inlet valve.

The valve is mounted complete in a casing independent of, and merely bolted to the cylinder. The casing is thoroughly water-cooled but the valves themselves are not, since it is found that with efficient cooling of the seats this complication is unnecessary. There are oil catchers which retain all the oil which escapes, and conduct it to a filter below the engine, and from this filter it is pumped back to the tank.

The cooling water is supplied at a pressure of about 16 pounds per square inch, but the accelerating forces to which the pistons are subject make a higher pressure necessary for

based upon the working of a 4,500-kilowatt central power station, supplying four gas engines, of 1,500 kilowatts capacity (one as a spare) direct coupled to three-phase generators, the gas plant consisting of three units, of 2,500 kilowatts capacity each (one as a spare); the plant working continuously at a 60 per cent load factor:

$$\frac{4,500 \times 60 \times 24 \times 365}{100} = 23,652,000 \text{ kw. hours per annum.}$$

It is maintained that the two generator sets would be capable at full load of coping with the load, but for the purpose of the estimate, and to get a fairer idea of the running cost, three engines have been assumed to be working. The consumption of gas per b.h.p. is taken at 106 cubic feet or 156 cubic feet per kilowatt hour (half load consumption).

It is held that the total cost of about ½ cent per kilowatt hour includes interest and depreciation, and is based upon the engine running at about half load. The cost of sulphuric acid has been taken at double what it can be bought in England to allow for the freight in Japan. Ammonium sulphate plays an important part as a manure in agriculture, and this was one of the main reasons in deciding the Japanese government to install a gas plant, and thus support their farmers without having recourse to foreign manures.

WATER TREATED WITH CHLORITE OF LIME AGAINST TYPHOID FEVER AND ITS EFFECT UPON VEGETATION.

During typhoid epidemics the water supply of cities is temporarily treated with hypochlorite of lime in order to destroy the active typhoid bacilli in the water and thus prevent the spreading of this disease by means of impure water.

Coincidentally with this practice, nurserymen and others using this treated water for their greenhouse and other plants, stated that they noticed a peculiar failing in the vigor of their plants, and thus were anxious to obtain advice whether this water may be injurious to plant life. Considering the great germicidal properties of this preparation, it was thought probable that injury might also result to higher plants from its use.

For this purpose the Dominion Chemist, Mr. F. T. Shutt, M.A., and Mr. H. T. Gussow, Dominion Botanist, began a series of experiments in February, 1911, which were continued with a view of disclosing any facts bearing on the subject.

They obtained a number of plants which were suspected to be failing in health owing to their being treated with chlorinated water. Three plants of carnations and three of Hybrid roses of this kind were subjected to the following treatment:—

1. Potted into new soil, watered as required with snow water only.

2. Potted into new soil, watered as required with chlorinated water (0.26 p.p.m. available chlorine).

3. Potted into new soil, watered as required with chlorinated water, but boiled for fifteen minutes.

4. Potted into new soil, watered as required with chlorinated water plus 1 lb. of soot per 3 gallons of water.

5. Roses grown on the farm used as check plants treated in the same manner with chlorinated water.

The plants were very carefully watched and kept under the same condition of temperature and culture. After three months had elapsed no difference whatever could be noticed in any of the plants. The roses blossomed freely throughout, the carnations, however, hardly recovered, having been transplanted while practically in flower. The check plants subjected to the different modes of treatment showed not the slightest signs of any injury.

Another experiment was conducted to test the effect of chlorinated water on the germination of seeds. Various strengths ranging from 0.05 to 10 parts per million of available chlorine were used. Six varieties of wheat were employed, the seed being soaked in the freshly made-up solutions, and an equal number in distilled water. (Time 12 hours).

All samples were sown on the same day. Germination was found to be uniform throughout; no influence could be observed on the energy of generation or in the development of the young plants. Later on, a series of experiments was started with barley and oats without any sign of injury, or even retardation. The plants were grown until in flower, when the earth was washed away and the plants, root and all, were carefully dried in the air and then weighed. Although slight differences in weight between plants of the same series occurred, such did not indicate that there had been any injurious influence exerted by the chlorinated water.

Without going into further detail, Mr. Shutt and Mr. Gussow, as a result of this investigation, conclude that the water supplies, as ordinarily treated with hypochlorite of lime, have no injurious effect, direct or indirect, upon cultivated plant.

A NOTABLE OVERLOAD BOILER TEST.

A recent test of the No. 12 boiler in the plant of the Narragansett Electric Lighting Company, Providence, R.I., produced for eight hours very nearly 250 per cent. of boiler rated horse-power at an over-all efficiency of boiler and grate of 73 per cent. This test, which was witnessed by James D. Andrew and Fred B. Freeman, of the Boston Elevated; Charles W. Clarke, of Stone & Webster Engineering Corporation; Messrs Arnold and Sarckey, of the Westinghouse Machine Company; M. Alpern, of the American Engineering Company; H. O. Breaker, of the B. F. Sturtevant Company; B. F. Allen, of Westinghouse-Church-Kerr & Company; Mr. Brown, of the Foster Superheater Company; Wm. Pastell, superintendent of the power station of the Rhode Island Company, and M. W. Kern, of the Narragansett Electric Lighting Company, was for the purpose of determining the capacity of a Riley self-dumping, underfeed stoker of five retorts, which had been placed under the boiler.

The boiler, which was twelve years old, is a B. & W., 12 tubes high, 18 tubes wide, and 16 tubes long. No special effort was made to prepare it for this test. As a matter of fact, its companion boiler in the group of two was cold. The boiler was of such a size that a stoker of 7 retorts could have been installed under it, which would have resulted in the burning of more fuel and a considerable increase in the capacity obtained. As the stoker is of the self-dumping type, working automatically, there was not a periodic dumping which is a necessary feature of the other types, hence the steadiness of the steam pressure (174.1 lbs. average) and other operating conditions. The fire appeared to be in the same condition from one end of the test to the other, all clinker being broken up automatically during its process of formation, and the boiler was kept on the regular line for some hours after the test.

The total amount of coal consumed was 25,450 pounds, or an average of 3,181 pounds per hour. The water fed amounted to 251,170 pounds, or an average of 31,396 pounds per hour, thus giving an evaporation of 9.87 pounds of water for each pound of coal. The water was fed at a temperature of 196 deg. F., and the equivalent water evaporated per hour from and at 212 deg. F. was 33,437 pounds per hour, or a total of 969.2 boiler horse-power developed, which was 248.5 per cent. of builder's rating. The equivalent evaporation per pound of coal as fired thus figures out at 10.51 pounds of water, and the factor of evaporation is 1.055.

The coal analysis showed 74.13 per cent. fixed carbon; 14.95 per cent. volatile matter; 6.52 per cent. ash, and 4.40 per cent moisture. The calorimeter test showed the heating value to be 14,600 B.t.u. when dry, or 13,957 B.t.u. as fired. The coal was thoroughly consumed, as is shown by the flue gas analysis, which gave 16 per cent. CO; 0.12 per cent. CO; and 2.7 per cent. oxygen.

At one time during the test a piece of 4 by 6 timber was purposely dropped into the centre hopper to determine the effect upon the stoker. This timber, of course, blocked the plunger in that hopper and sheared the safety pin located on the connecting rod. The plunger was then automatically withdrawn from the stoker upon the return stoker of the connecting rod and left at its outermost position. Upon the removal of the obstruction and the insertion of the new pin, all of which was done without stopping the stoker, operation was resumed as if nothing had happened. Of course, however, the feed of coal into the middle retort was interrupted until the adjustment had been made. The horse-power used by the blower was determined as 20, while 1.4 horse-power was used to operate the stoker. Separate motors were used to drive blower and stoker.

EFFECTS OF ELECTRIC CURRENTS ON CONCRETE.

By E. B. Rosa, Burton McCollum and O. S. Peters.

This paper deals with the results of an extended series of experiments carried out at the United States Bureau of Standards during the past two years. The investigations consisted of three parts, as follows: (1) Laboratory investigations relating to the nature and cause of the phenomena produced by the passage of electric current through concrete; (2) investigations in the field with a view of establishing the probable extent of the danger in practice, and the circumstances under which the trouble is most likely to occur; (3) a study of the various possible means of mitigating trouble from this source leading to specific recommendations. The experiments were for the most part carried out on cylindrical specimens six inches in diameter and eight inches high with an electrode, usually of iron or other metal, imbedded in the centre, serving as either an anode or cathode in different cases. These specimens were immersed in water in jars surrounded by a sheet-iron electrode, which served as the other terminal.

Anode Effects.—The tests were carried out with a great variety of voltages, ranging from 2 volts to 115 volts, with the imbedded electrode anode. On the higher voltages, which included all cases having more than about fifteen volts per specimen, there was exhibited the familiar phenomenon of cracking of the concrete and rapid corrosion of the imbedded iron, most specimens cracking within twenty-four hours under a current flow of from 0.5 to 0.8 ampere-hour.

On the low-voltage specimens, however, where the voltages ranged from 2 to 15 volts, very different results were obtained. At the outset of the investigation 90 specimens containing iron electrodes were placed in circuit on fifteen volts and watched for a period of seven and a half months. At the end of that time a number were broken open, the amount of corrosion determined, and the general condition of the concrete noted. A most conspicuous feature of the results of this test—and a very surprising one in view of the results previously obtained at higher voltages—is the fact that cracking almost universally failed to occur. Of the 90 specimens under test only three had cracked at the end of seven and a half months, and these were shown to be abnormal specimens. In practically all cases, also, there was no appreciable corrosion of the iron. It is important to note that the total number of ampère-hours per square inch of imbedded electrode surface in the case of the low-voltage specimens is considerably larger than for the high-voltage specimens, the former averaging 2.6 ampère-hours and the latter only 0.83 ampère-hour. It is evident, therefore, that the quantity of electricity that passes through the specimen does not alone determine the amount of damage that it may do, but that the rate at which the current flows is also an important factor. Moreover, it is evident from these observations that the rate at which damage occurs decreases with decrease in voltage much more rapidly when the voltage is lower, since in the present instance a reduction of voltage to one-fourth of the value used in the high-voltage tests enabled the specimens to run with little or no damage for a period over 200 times as long as was required to destroy the specimens in the higher voltage. It has been shown that this difference in the effect of high and low voltages is fundamentally due to a difference in temperature. So long as the heating effect of the current is insufficient to raise the temperature of the specimen to about 45° or 50° Centigrade, little or no corrosion results, but if the current is strong enough to raise the temperature materially above that point, rapid corrosion sets in.

Cathode Effects.—When the imbedded electrodes are made cathode, different effects are produced. In this case there is no tendency for the iron to corrode, and the conclusion has been largely accepted that when the current flows from the concrete to the iron no effects were produced. It was found, however, that after such specimens had been in circuit for several months with the iron cathode the bond between the iron and the concrete was practically destroyed. On laying the specimens open it was found that the entire region surrounding the cathode for a distance of one-sixteenth to one-fourth of an inch from the surface of the metal was considerably darker in appearance than the main body of the concrete, and was very soft. The cement here could be shaved off with a knife like soft soapstone.

Experiments with concrete containing no reinforcing material showed that the flow of comparatively heavy currents through the concrete produced no appreciable effect on its mechanical properties. The effects noted above are, therefore, solely electrode effects, and the softening of the cement at the cathode is attributed to the concentration of sodium and potassium hydroxide near the surface of the cathode, and it is this that causes the softening of the cement. The cracking of the concrete when the iron is anode is due to formation of oxide of iron, and the swelling action thus gives rise to a mechanical pressure which cracks the specimen. The pressure thus prduced was measured in several instances and was found to reach values of over 3,700 pounds to the square inch.

Rise of Resistance of Concrete.—It was found that in all cases the resistance of the concrete rose greatly, due to the passage of electric current, the rise being greater in anode specimens than in cathode specimens, the former showing an average increase of 137 times the original value at the end of seven and a half months, and the latter showing an average increase of fourteen times the original resistance at the end of about the same period.

The addition of a small quantity of salt to the concrete produced very marked effects. Two or three per cent. of salt added to the water used in mixing the concrete caused the anode specimen to be destroyed very quickly, even on very low voltages, because of rapid corrosion of the iron, and also greatly increased the rate at which the softening of the cement at the cathode progressed. The addition of salt likewise reduces the initial resistance of the concrete, and, more important still, prevents the rise of resistance which otherwise takes place under the influence of the electric current.

In discussing the possibilities of trouble from electrolysis in concrete structures under practical conditions, it is pointed out that, while the dangers from this source have often been greatly exaggerated, the possibilities of trouble are nevertheless sufficient to make precautionary measures necessary under many circumstances. A number of possible precautionary measures are discussed in the last section of the paper.

That development is proceeding steadily all over the lower mainland and on Vancouver Island is shown by the announced policy of extension and expansion of the British Columbia Telephone Company. Officials of the company toured Vancouver Island last week and will make extensions to outside plant in nearly all of the exchanges on the Island. Improvements have been in progress in Victoria for a couple of years past, and large works are now in hand there. The fact that the smaller exchanges throughout the Island show growth indicates a settlement on the agricultural areas, something that is badly needed in this province. In Point Grey, the company is expending much money, and plans this year to have telephones all over the Burrard peninsula.

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CONTENTS OF THIS ISSUE.

"MODERN METHODS OF ILLUMINATION."

Modern methods of illumination have had a great deal of study and investigation devoted to them during the last few years. It has been well justified by the admirable results obtained, and has been brought about not merely for commercial reasons, but from the necessity of protecting human eyesight from the intensity of illumination due to modern inventions in the field of illumination.

On another page of this issue will be found an article dealing with the use of Tungsten lamps in mills and factories. It is the invention and commercial advantages of such methods of illumination as the metal filament electric lamp that has helped along and adds stimulus to the solving of illuminating problems.

Whether the light was close to the eyes or in the line of vision or not was a matter of no great moment. In the successive improvements from the tallow candle through the oil lamp, yellow flame gas jet, incandescent gas mantle, and carbon filament electric lamp the conditions as to color and brilliancy were such that the available brilliancy was too small to cause discomfort, and, within limits which were fixed in the case of combustion lights by annoyance from heat, smell, and fumes, and in the case of carbon lamps by convenience of location, the source of the light was brought as close to the work to be performed as possible. The change from the more or less "mellow" light of carbon lamps to the intense white brilliancy of incandescent metal filaments had the immediate effect of raising complaints against the new light on the score of hurt to the eyes. The greatly improved efficiency as regards current consumption was not to be neglected, however, so that means were taken to mitigate the cause of complaint by placing the lights further away from the working plane. This movement had a retrograde aspect, however, since it necessitated the use of lamps of higher candle power, though still of greater efficiency, to maintain the previous intensity of illumination. The next step, therefore, was to search for means by which to reproduce this intensity without using lamps of higher power than before, and the increased use of enamelled tin and opal conical shades was the result. This has gone on till we find that in the lighting of shops, offices, warehouses, showrooms, and passages all that is wanted in the majority of cases is that a predetermined intensity of illumination shall be available at the working plane with a minimum current consumption and cost of installation. Shades and globes, on the other hand, are largely used in hotel lounges, restaurants, and private houses, where the sacrifice by diffusion of a small amount of the available light need not be considered and where appearance must not be sacrificed to first cost.

THE PANAMA CANAL AND ITS INFLUENCE ON THE COAST CITIES OF BRITISH COLUMBIA.

Nothing has probably occurred in the recent history of the continent of America calculated to exercise a more profound influence on the future of British Columbian cities than the coming opening of the Panama Canal. Much has been said in this regard by many writers. It would seem that the benefits flowing to the cities through the opening to traffic of this gateway will be very much as the people decide to make them.

They have a very strong strategical position. They have a country teeming with natural resources. They have the best natural harbors on the whole stretch of coast line running from Panama to Alaska—and it might be thought, in consequence of this, that their future is so well assured that they could afford to cease troubling about it. It would be the part of wisdom, however, for them to leave nothing undone to take full advantage of the splendid opportunities which are about to present themselves through the opening to traffic of the Panama Canal.

Capt. Logan, of Victoria, speaking on the subject, inclines to the conviction that three things will probably happen immediately on the opening of the Panama Canal which will have a direct effect upon the ports of British Columbia. First, there will be an increase in the volume of shipping; second, there will be an influx of immigration to the Province; third, there will be a material increase in the permanent population of the cities.

One of the first effects on Vancouver Island of the opening of the Canal will be to stimulate renewed agitation for the bridging of Seymour Narrows. No one disputes that, given all-rail connection with the mainland, Victoria would occupy a position of superiority and advantage over the other cities of the North Pacific seaboard.

In respect to immigrants, the continuous journey without change in a voyage of less than a month's duration and at a fare which will be practically little more than is now charged for passage across the Atlantic will assuredly result in bringing West a number of those now in the United Kingdom and elsewhere in Europe who will be drawn by the opportunities. It will be probably more comfortable for the emigrant from Europe whose destination is the Prairie Provinces to travel via the Canal than across the Atlantic direct and then by rail west. There will follow a stimulus to Island and mainland development, but this will not take the most advantageous course unless they have formulated some policy before the influx begins.

Victoria and the Island of Vancouver have a great future, and if the bridging of Seymour Narrows is ever accomplished Vancouver and the other cities on the coast will have a hard time to hold their own in rivalry.

TRANSMISSION OF ELECTRIC ENERGY IN BULK UNDER WATER.

The transmission of electric energy in bulk by cable under water is a problem that has not yet been seriously tackled, but the first sign of a possible new era is seen in the project now in course of realization for sending electric current from the Trollhattan Waterfall, in Sweden, to Denmark by submarine cable. The occasion for it has arisen through the need on the part of the municipality of Copenhagen for a reliable source of energy for its electric tramways. This point was forced on the municipality's notice at the time of the coal strike in Great Britain, as they have been accustomed to obtaining a fuel supply from there.

It would now seem that only the consent of the Swedish Government is needed and a contract will be entered into for the construction of a high-voltage transmission line from the Waterfall Trollhattan, in Sweden, along the coast for 160 miles and then by submarine cable across a ten-mile sound to Elsinore, on the Danish island of Zeeland. A central distributing station will be erected at Elsinore, and a current will be transmitted to Copenhagen, fifty miles south, and to other industrial centres of the island.

THE NEW CAPITAL OF AUSTRALIA AND ITS PUBLIC BUILDINGS.

Canadian architects, in common with members of the profession in all parts of the world, will shortly be given an opportunity to compete in the designing of the principal public buildings for Canberra, the capital city of Australia, which was officially designated a few weeks ago. Canadian Trade Commissioner D. H. Ross has forwarded to Ottawa from Melbourne, Australia, a report on the subject, in which he states that the sites for the principal buildings of the capital having been determined, it is proposed that competitive designs shall be invited from all parts of the world. The building sequence contemplates practically no interruption, and among the first public structures to rear themselves on the site will be the governor-general's residence, courts of justice, police buildings and jail, administrative offices, military depot and offices, schools, observatory, medical and hospital buildings, railway station, prime minister's residence, accommodation for members of parliament, post-office, printing office and town hall. Other buildings will also be erected, such as a state house and educational institutions.

ELECTRIC AND STEAM WINDING.

Electric winding at the gold mines on the Rand has made rapid strides during the last two years in spite of the fact that coal is both plentiful and cheap. Several of the large mining concerns have their own generating plants, but as a rule the power is purchased from the Victoria Falls and Transvaal Power Company. Those companies which generate their own power mostly use the Ward-Leonard system and those which use purchased power employ the three-phase system, but there are prominent exceptions.

In the Brakpan Mines, for example, both methods are at work, the three-phase generally for winding rock and the Ward-Leonard principally for men and materials. About 50,000 tons of ore are hoisted monthly from a depth of 3,825 ft.

On the whole, the costs for stores, repairs, and maintenance of electric hoists inside the engine-house are considered to be lower than those for a similar sized steam plant. The highest efficiency of coal at the lowest selling price for the best local quality would enable 816 ft. tons to be lifted by steam at a cost of a penny. In the instance quoted the electric winders lifted 260,727 tons of rock from a depth of 3,825 ft., and handled men and tools amounting to 40 per cent. of the total work performed, for a power cost of $20,000, and the work done in rock hoisting alone works out at 960 ft. tons for one penny as compared with 816 ft. tons for steam.

A better illustration may perhaps be afforded by taking the actual steam and electrical power costs at the Bantjes Consolidated Mines. At the No. 1 shaft a Grant-Ritchie winding plant is installed with 6 ft. drums driven through single-reduction gear ratio 127 to 42 by a 600 horse-power three-phase induction motor working at 2,000 volts and 362 r.p.m. From October, 1911, to July, 1912, inclusive, this particular hoist raised 133,684 tons and used 231,392 units, the units consumed per ton hoisted averaging 1.73, or, at 1.1234c. per unit, 1.944c. per ton hoisted. With spares, renewals, and labor the total cost was 2.32c. per ton. These engines were run by steam from November, 1910, to April, 1911, and, including coal, wages, and maintenance charges, the average cost was $498.52 per month. The average cost for electrical winding, including maintenance charges, from May to September was $363 a month.

ABSTRACT OF REPORT ON THE CITY OF TORONTO TRAFFIC REQUIREMENTS.

The report of B. J. Arnold, of Chicago, and T. W. Moyes, of Toronto, who were engaged by the latter city to examine into and report on street railway traffic requirements, has now been made public. The report itself has been finished for some time, but the city had refused to make its contents public.

The report as boiled down reads:—

Car congestion can be overcome by re-routing.

Overcrowding can be largely eliminated by the use of extra cars.

Track mileage has increased only 2.4 per cent., while the population increased 9 per cent.

The Toronto Railway Company spends 57.46 per cent. of gross income on operating and other expenses, while other companies spend 70 per cent.

Toronto spends less than 1 per cent. in maintenance of track and roadway. Chicago spends 2.27 per cent.

Thirty-five per cent. of the company's track should be rebuilt.

Faster service should be provided and trailers eliminated.

Equipment is so operated as to produce 28 cents per car mile, while expenses are 13 cents.

Toronto has 113 miles of single track. An addition of 127 miles should be made, which, with equipment, would cost $8,762,000.

Tubes are not needed at present, if better surface equipment is provided.

Motor 'busses will not meet the situation.

That the city has outgrown its transportation facilities is emphasized. They say there are few difficulties in the way of giving needed relief. Co-operation of the varied railway interests is suggested as a means of affording quick relief. "Car congestion could be overcome by re-routing a few lines in the congested district, and over-crowding could be largely eliminated by the use of extra cars during rush hours." They recommend faster time schedules, and say an improved service could be thus given without an additional car.

Cross-town lines and extensions into the outlying territory are recommended The experts are opposed to subways, which are not warranted.

Ordinarily, for a system covering an entire city under Toronto's conditions 70 per cent. of the income is required to operate and to meet the taxes and depreciation. The reports of the Toronto Railway Company for 1911 show that these items, exclusive of renewals, consumed only 57.46 per cent. of the gross incomes. This demonstrates the ability of the company to increase its service materially without sacrificing fair return from business, even if a liberal allowance is set aside for renewals.

The company's annual report to the Ontario Railway Board shows the total expenditure for maintenance to be only 8.58 per cent of the gross receipts. The average of all Chicago companies for 1910 was 8.6 per cent. But Toronto spends only .926 of 1 per cent on maintenance of track and roadway, while Chicago spends 2.27 per cent for the same purpose. The statement of the Toronto Railway Company shows no expenditure for renewals, which alone should be from 8 to 10 per cent. of the gross receipts Thirty-five per cent. of the company's tracks should be rebuilt and other improvements made. Fifteen to eighteen per cent of the gross receipts should be spent in upkeep, after the property is put in first-class operating condition.

Schedule speed of the cars should be increased, the report states, and trailers should be eliminated. The public and the crews of the cars should be more alert. Faster cars should be provided, and improved turnouts and curves installed.

The Toronto Railway Company is at present operating 113 miles of track over an area of about 10½ miles in length, east and west, by 3¾ miles in the extreme width, north and south. The business is conducted with 642 cars, 569 double-truck and single-truck motor cars and 73 trailers. The equipment is so operated as to produce 28 cents per car mile, notwithstanding the low fares, while the expenses are about 12 cents per car mile, a most favorable showing for surface lines in any city.

The total cost of the proposed additions to the present system for 127 miles of new track, 600 pay-as-you-enter cars, additional car-houses, sub-stations and other equipments, is estimated at about $8,762,000.

If the civic car lines and those of the Toronto Railway Company are to continue to be operated under more than one management until 1921, a terminal in the business section of the city is recommended. "Without proper outlets," the report states, "isolated lines generally lead a precarious existence and prove a disappointment."

The estimate of the cost of a complete new surface and subway system is $10,473,000. The present traffic would not warrant this expenditure, the experts state, but they admit that a subway system might be a financial success if the growth of population north of St. Clair Avenue and Danforth Avenue increased greatly.

The following radial lines are recommended: Yonge Street, Cottingham Street to the north end of the new city limits, with temporary arrangements for transfers with the Metropolitan Railway; double tracks to Eglinton Avenue this year, with double rails owing to the difference in gauge.

Davenport Road from St. Clair Avenue and Keele Street to Dupont and Bathurst Streets, to be double-tracked in 1916.

Dundas Street, from Keele Street to Lambton, double track in 1914.

Weston Road, from Dundas Street to Mount Dennis (Eglinton Avenue), 1916.

Lake Shore Road, as a terminal and outlet for lines west of Sunnyside Avenue, to be operated to the Humber as part of the King Street line as soon as the gauges are equalized.

Kingston Road, from King Street north-east and east to the city limits, to be double-tracked by 1916.

WORK ON ATLANTIC DIVISION OF C.P.R.

Word comes that Mr. W. Downie, general superintendent of the Atlantic division of the C.P.R., has issued the following statement in respect to the expenditure on maintenance of way, bridges, rails, culverts and the like on the main line from Megantic to St. John, not counting branches for the two years, 1911-12:—

	Capital.	Maintenance.	Total.
1911	$220,142	$528,985	$749,127
1912	348,417	674,663	1,023,081
Total for two years			$1,772,208

Mr. Downie pointed out the large yearly increase in these expenditures and the big total reached last year as compared with the expenditure in 1911, and said that during the last nine years the entire division from Megantic to St. John had been relaid with 80 to 85-lb. rails, while the line was ballasted throughout. Every wooden bridge taken out and replaced by steel with masonry or concrete and wooden culverts were replaced by concrete ones.

PANAMA WATER SUPPLY.

The committee, consisting of Mr. H. H. Rousseau, chairman; H. O. Cole, George M. Wells, James T. B. Bowles, and Louis Ernst, appointed to consider plans and make recommendations for a permanent water supply for the Pacific end of the canal, has submitted its report, and same has been approved by the chairman.

The plans contemplate the continued use of the Rio Grande reservoir, and the increasing of its capacity by raising the dam to elevation 265 feet, or 27 feet above the present crest. It is believed that with the increased capacity the reservoir will supply at least 6,000,000 gallons of water a day, except in years of minimum rainfall, such as 1888 and 1912.

It is further proposed to use the Camacho reservoir as an auxiliary supply. The surface of the water in this reservoir at high level is 100 feet above that in the Rio Grande, so that a gravity flow between the two reservoirs could be maintained by means of a pipe line, or by a small concrete-lined aqueduct laid around the main hills for a distance of about 13,000 feet. It is estimated that about 1,500,000 gallons of water a day would be added to the Rio Grande supply in this manner. Before final adoption of the Camacho pipe line, the committee recommended that an estimate be made of the cost of laying the line, as compared with an estimate of the cost of pumping the same amount of water a day from Gatun Lake.

Assuming that 7,500,000 gallons of water a day might be obtained from the above sources, the committee turned its attention to the matter of a further supply. The possibility of procuring water from the Pedro Miguel and Cocoli Rivers was discussed, but the idea was abandoned in favor of Gatun Lake.

The plan of pumping water from the lake at a point on the west side of the canal, just north of the entrance to Pedro Miguel Locks, would involve the installation and operation of electrically driven pumps, but it would provide an absolutely certain supply during all months of the year, and would take care of a consumption far beyond the present estimate.

The consumption will probably not be less than 8,000,000 gallons a day when the canal opens. In view of future expansion, the committee recommended that the maximum normal supply should not be less than 12,000,000 gallons a day, and that the purification plant, pump station, and accessories be designed not only for that amount, but that provision be made for their future extension and enlargement without interference with the continuity of the supply.

The experience gained during the past six years, and particularly during the last year of the Agua Clara plant at Gatun, conclusively indicated in the minds of the members of the committee that the stream waters of the Isthmus yield readily to aeration, and aluminum sulphate treatment, followed by sedimentation and sand filtration. Heretofore, little attention has been given to the bacterial efficiency of the treatment, because practically all the water used for drinking purposes has been taken from uninhabited watersheds, with very little risk from contamination. In the proposed new water supply, the use of Gatun Lake water makes the matter of bacterial efficiency an important one. It is believed that a properly designed purification plant, with aeration and sedimentation, using aluminum sulphate, followed by rapid sand filtration, will take care of such water, but to provide against the possible contingency of pathogenic bacteria getting into the filtered water mains, it is proposed to use a bleaching agent—hypochlorite of lime—in addition to the aluminum sulphate, this agent to be used only when the daily analysis of the water indicates the presence of B. coli. The cost of this treatment would be small.

The committee considered the relative merits of pressure filters, as compared with the rapid mechanical gravity filters. It was shown that the first cost would be less, and that there would be an approximate saving in head of from nine to 15 feet by the adoption of the mechanical gravity type. It was further shown that filters of this type are rapidly supplanting those of the pressure type. The committee recommended their adoption.

It was believed that in using both the present 20-inch and 16-inch mains from the Rio Grand reservoir into Panama, the best plan would be to install pumps on these lines just south of the proposed purification plant to act as "boosters" to the gravity head available, these pumps to be designed to deliver the maximum supply south of Corozal, with a terminal pressure practically zero at some point near the present low level reservoir at Ancon. At the latter point, it is proposed to install a second "booster" station with pumps directly on the main to lift water to the low and high level reservoirs. This line would be by-passed, so that the pumps could pump directly into the mains fed from the above reservoirs. All pumps and stations would also be by-passed, so that in case of trouble to the pumps, the head due to gravity would deliver some water through the mains. The "booster" pumps will obviate the necessity of laying an additional feeder line, at least until the estimate of 12,000,000 gallons of water a day is exceeded. "Booster" station No. 1 would probably be located on the west bank of the canal, north of Pedro Miguel Locks, and would contain the supplementary pumps furnishing Gatun Lake water to the purification plant. "Booster" station No. 2 would likely be situated at some point near the present pump station at Ancon.

At the present time there are at Ancon two high pressure reservoirs, each 1,000,000 gallons capacity, one situated on the east side of Ancon Hill at an elevation of 295 feet above sea level, and the other on a knoll back of Hotel Tivoli, at an elevation of 138 feet. The committee was of the opinion that additional high pressure storage is necessary, and recommended the construction of a new 1,500,000-gallon reservoir immediately adjacent and connected to the present high level reservoir on Ancon Hill.

There is installed in the masonry of the emergency dam at the north end of Pedro Miguel Locks, a 24-inch diameter cast iron main carrying the water from the Rio Grande across the locks. It was the opinion of the committee that, as a measure of safety, and to provide for a possible future increase, an additional cast iron main, 30 inches in diameter, should be carried across the locks to a junction with the present 16-inch and 20-inch water mains.

The committee investigated a number of sites with reference to the location of the proposed purification plant, but refrained from making a recommendation, except that the plant be situated at the best point available on the west side of the canal, north of Pedro Miguel Locks.

The committee recommended that such work be done as will make the old 16-inch main continuous from the Rio Grand reservoir to Panama, and that it be cross-connected to the new 20-inch main throughout its length.

In view of the fact that the elevation of the purification plant, the size of the "booster" pumps, and finally the quantity of water that the mains may be expected to deliver in Panama depends on the correct value of the coefficient of friction for these lines, the committee recommended that friction tests be made, and that the results obtained be adopted in connection with the computations involved in the design of the different plants.

THE PROBLEM OF THE STEEL RAIL.

The problem of the steel rail is, as it has been for years, a very real one. In this connection we present herewith an extract from a paper by A. J. Beaton, M.Inst.C.E., which appeared in the South African Railway Magazine. Mr. Beaton, in his paper, presents data secured from the United States, Great Britain and South Africa. The article is one which it will well repay those interested to read. We quote from Mr. Beaton's article as follows:

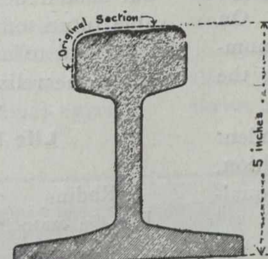
There is a considerable divergence of opinion among railway engineers, and many confused ideas exist, as to the average life of a steel rail. An expert authority has estimated that an 80lb. rail will be worn out after carrying about 250,000,000 tons of traffic. The railways of the world have a mileage of about 642,000 miles, and yet for strictly replacement purposes hardly two million tons of steel rails are used annually, although American rail mills are producing about four million tons of rails per annum, the bulk of these, however, being for new railway construction.

In New York State one rail breaks every year for each 3.8 miles of single track, or about one rail in every 1,220. The number of rail failures, covering 83 American railroads during the year 1910, according to the Committee on Rail, of the American Railway Engineering Society, ranged from 0 to 1,129 rails per 10,000 tons of new rail. On the continent of Europe one rail in from 1,350 to 2,000 breaks every year, while on the South African Railways for the year 1911, 301 rail breakages were reported, being about one rail in every 25 miles, or one rail failure in about every 8,600. The South African Railway figures do not embrace the rail failures in station yards and sidings.

The bulk of the breakages in America were of the 85lb. and 90lb. section, and included several 90lb. titanium rails.

None of the breakages have been attributed to inherent weakness of the rails, the failures being alleged to unusual strains induced by such severe conditions "as the action of flat wheels, defective counterbalanced wheels, wheels out of round, defective track, poor ballast and improper track fastenings," while the recent increase in axle loads and high speeds have considerably reduced the time factor for the reversal of stresses under the wheel loads, thereby inflicting more punishment on the rail than what would have taken place under lighter axle loads and lower speeds.

The rails on the American railways were of recent rolling, and the majority of the failures occurred during the three coldest months of the year, the month of Janu-



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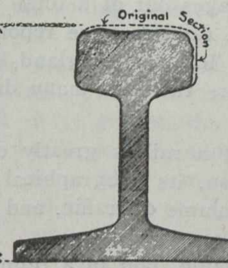

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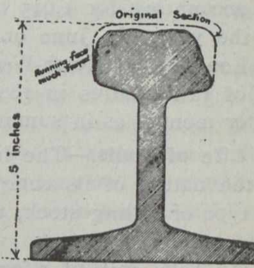

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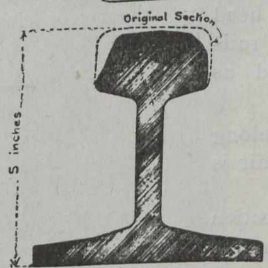

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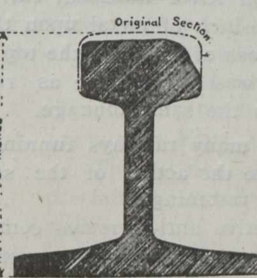

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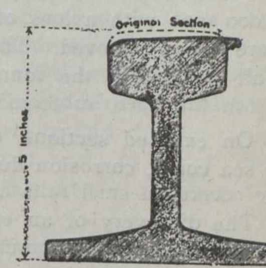

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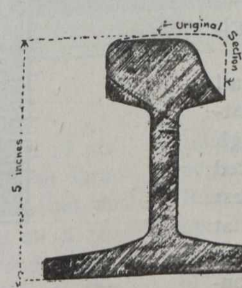

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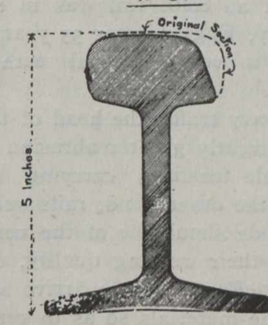

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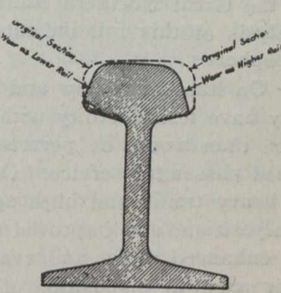

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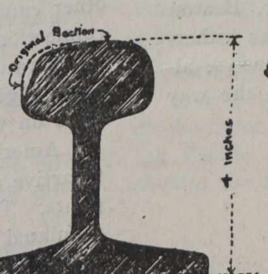

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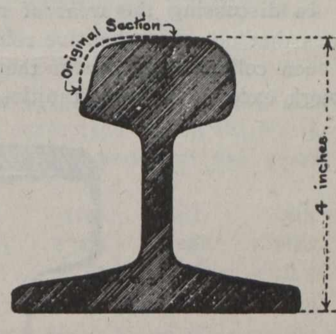

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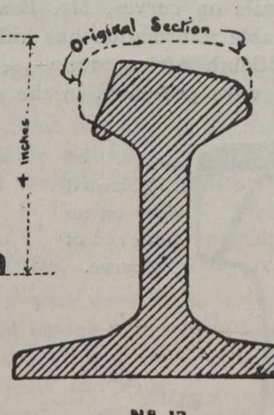

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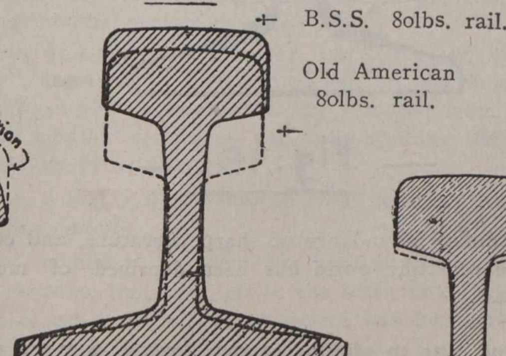
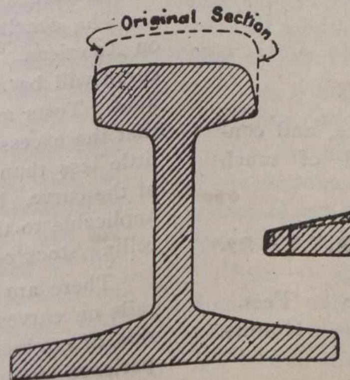


— Fig. 13. —



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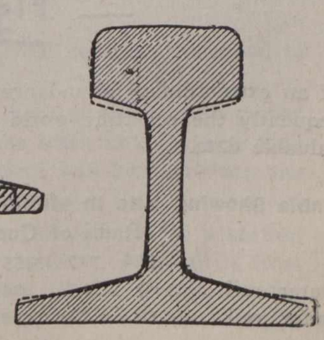


— Fig. 14. —

ary accounting for 1,645 breakages out of a total of 3,951 for the year. In June only 52 failures were reported. On the London and North-Western Railway, England, the number of rail failures in 1898 were twice as many during the winter months as in summer.

Life of Rails.—The life of a rail is greatly dependent on the nature of its composition, its geographical position, the type of rolling stock, the volume of traffic, and the quality of ballast.

An 80lb. rail, of 5-inch section, laid in a tunnel on the New York Central and Hudson River Railroad, carried 65,000,000 tons with a loss of ⅛-inch of metal upon the head before it was removed. The loss of metal on the top of rails on all sections of the tunnel was about twice as rapid as rails in the open subjected to the same tonnage.

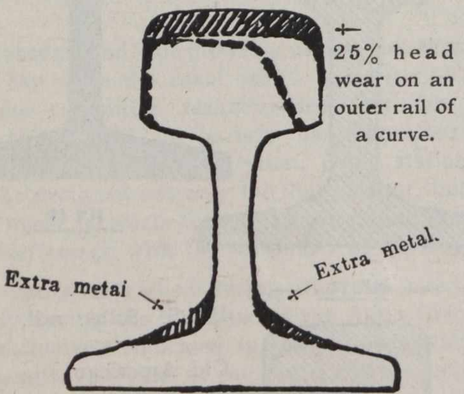
On exposed sections of many railways running along the sea coast, corrosion due to the action of the sea-air is very severe on steel rails and fastenings.

The discovery of an effective anti-corrosive composition will be valuable and remunerative, both to the inventor and railway companies.

It has been recorded that an 80lb. rail was in service on the Great Northern Railway, England, for 35 years. The analysis of this rail indicated a very soft rail with high phosphorus.

On lines with slow and heavy traffic the head of the rail may have less ductility with slightly greater abrasion resistance than would be permissible for lines carrying a high speed passenger service. On the other hand, rails subjected to heavy traffic and high speeds should be of the very best composition, and improved in their wearing quality, even at an enhanced price, and every effort made to arrive at the best scientific disposition of the materials so as to synchronize the life of every section of the rail.

In discussing the wear of rails on curves, Mr. Beaton states that no comprehensive reliable information has hitherto been collected on any of the South African railways, although exceptional opportunities were presented in the way



— Fig. 15. —

of an extraordinary abundance of sharp curvature, and consequently the scientific world has been deprived of much valuable data.

Table Showing Life in Months of 75lb. Rails, A.T.S.F.Ry.

	Radii of Curves in Feet.						
	574	717	955	1146	1433	1910	Feet.
Outer rail . .	9	15	24	40	56	72	Months.
Inner rail . .	18	24	48	60	72	96	

Statistics are not compilations for satisfying curiosity, but should be of such practical commercial value as to enable future efforts to be directed into more successful channels, and to assist in correct deductions being arrived at. When the reliability of statistics is once assured they should

Life in Months of 100lb. Rails on P.R.Ry.

	ft.	ft.	ft.	ft.	ft.	ft.	Tan-
Radius	637	717	955	1433	2865	5760	gent.
Life in months . .	9	14	20	30	60	90	120

be accepted and acted upon, even if they upset one's pet theory, or clash with popular preconceived conclusions.

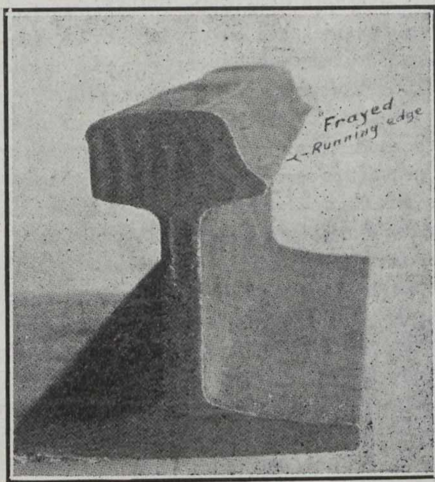


Fig. 16.

In Europe, where curvature is not so severe as in most other countries, although elaborate tests have been made in connection with determining the wear of rails due to errors in curvature, no very extensive experiments are recorded in regard to the excess wear on curves in relation to the wear on tangents.

American railways have, however, made some attempts to arrive at the relative life of rails on sharp curves and tangents. The Aitchison Topeka and Santa Fe Railway has tabulated the approximate times of removal of 75lb. rails on the sharp curves on the mountain section of their system, particulars of which are given in the above table.

Investigations made by the Pennsylvania Railway in this connection have not differentiated between the wear of the outer and inner rail, the table given above merely indicates the average wear on 100lb. rails on various radii, under heavy main life traffic.

This table corroborates the accepted axiom that the excess rail wear on a curve varies approximately as the degree of curvature

The conclusions arrived at from the experiments made on American railways are that the excess wear on a 574ft. curve will be about 230 per cent. of the rail wear on a tangent. Tests made on the Northern Pacific Railway indicate that the excess wear on a curve over that on a tangent, is a little less than one-quarter of the tangent wear per degree of the curve. It is, however, doubtful if these results will be applicable to the 3ft. 6in. gauge and the type and weight of rolling stock on the South African railways.

There are many important factors affecting the wear of rails on curves which might well claim the closer investigation of engineers on maintenance of way, and practical experience and minute inspection is the best school in which to acquire the requisite knowledge. It is a well-known fact that errors of over 8 per cent. from the true curvature reduces the life of a rail from one-third to one-half its natural life, had the curvature been true. Similarly, irregularity in gauge or in super-elevation have a disturbing influence on the wear of rails and on the smooth riding of the track.

The writer observed on a 12 degree (478ft. radius) curve,

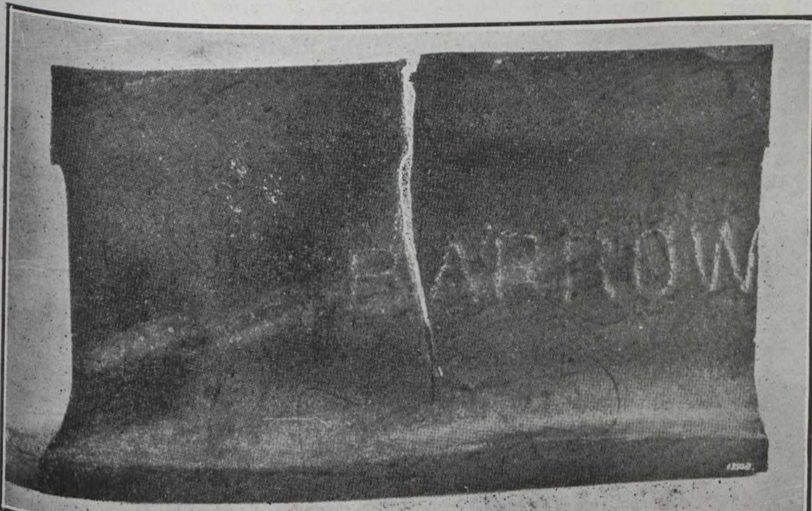


Fig. 18.

with 4 inches of super-elevation and a gauge width of 3ft. 6⅝in. on an up-grade of 1 in 50 compensated, that the abrasion on the lower rail of the curve was very severe, but no side wear was apparent on the higher rail, while on a 140 deg. (410ft.) curve, with a similar super-elevation and grade, but with only a gauge width of 3ft. 6½in., the wear on the running edge of the higher rail was very marked. On another portion of this curve, where the gauge was widened to 3ft. 7in., no side wear of either rail was observable. This points to the necessity for allowing liberal "slack to gauge" on very sharp curves, rather than increasing the super-elevation, as is sometimes practised.

On a single track railway there is the insuperable difficulty of securing the correct super-elevation for both directions of traffic, thus on a 1 in 50 down grade, on a 10-chain curve with 4 inches of super-elevation, a speed of thirty miles per hour is permissible with passenger rolling stock, but anything approaching this speed cannot be attained by an up grade passenger train, while heavy goods traffic barely reaches ten miles per hour, hence for such slow speeds only half an inch super-elevation would be required; it, therefore, becomes necessary to approximate the super-elevation to about the mean speed of the up and down trains, for if the full theoretical super-elevation demanded for the maximum permissible speed on sharp curves is adopted on a steep down grade, then undue wheel flange pressure will be exerted on the lower rail by upgrade slow trains. It would, therefore, appear as if the maximum permissible safe speed cannot be permitted on sharp curves with steep gradients.

It was the practice on the Central South African Railways to remove side-worn rails from the higher side of curves and replace them in the lower side of the curve, while in many instances, when the versed sine of a rail was not over 3 inches at the centre the rail was reversed in its original side of the curve; generally after the side wear on the head of the rail indicated a loss of from three to four pounds, the rail being finally removed from passenger lines after losing about 10 per cent. of its original weight. The average services of 60lb. rails on 150 metre curves ranged between three and four years. Unfortunately, no record was kept of the rolling tons of traffic which passed over the track.

A similar practice obtained on the Rhodesian Railways, although in Natal, owing to the rapid wear of rails on 300ft. curves and 1 in 33 grades, the practice of exchanging the rails was not adopted, but in some cases side worn rails were laid on tangents, a practice which does not give so satisfactory results as when reversed in their original position or transferred to the opposite rail in the curve.

On the Cape Government Railways curve worn rails were not exchanged, as was the custom on the other administrations.

Sections of worn rails recently removed from curves on the South African Railways are seen in Figs. 10, 11, 12 and 12a.

The table given will serve to better appreciate the value of the above sections of rails.

On some American railways 90lb. rails are removed from the main line after showing a head wear of 25 per cent. A safe practice is to remove all worn rails from passenger service lines when they show a loss on their original weight of 8 per cent. on curves and 10 per cent. on tangents, dependent, however, on certain factors of speed and traffic obtaining on particular sections. Professor Webb describes some interesting tests conducted on the Northern Pacific Railroad, regarding the wear of rails on curves. The figures obtained indicated that the rail wear is comparatively small during the first half of the life of a rail, and that the rate of wear grows in geometric ratio, especially so on sharp curves. This may possibly be due to the wear of the rail conforming to the outline of the wheel tyres, causing an acceleration of the abrasion on the running face of the rail through the close contact of the knuckle of the tyre

The average yearly loss in weight in lbs. of five rails on the outer side of a 10 degree curve (578 ft.) on the Northern Pacific Railway, extending over a period of five years, showed the following results:—

	1st year.	2nd year.	3rd year.	4th year.	5th year.
Loss in lbs. ...	10.85	9.55	7.75	11.65	16.55

The tests were made over a variety of kinds of steel, each rail having lost a little over 8 per cent. on their weight, and are described as "badly worn," yet not actually removed from the track.

Remarks.—Nos. 1 and 2 are still in the track, having done 54 months' service to date.

Nos. 3, 4 and 5 were in the track for 47 months, on higher side of curve, then turned end for end in their original side of the curve, and finally removed from the track after 17 months' service on their new running face, after a total service of 64 months.

Nos. 6 and 7 were removed from service at the end of the above periods.

Nos. 10 and 11 represent the wear on rail after a period of 215 months, but were left in the track until 1912, a total service of 240 months, but no record was kept showing the wear after final removal from the track.

Figs. 16 and 17 represent the photographs of a section of an 80lb. rail from the Boven Deviation. This rail is from a 410 ft. radius curve 1 in 70 grade. It did service in the high side of the curve for 35 months, and was then changed over to the low side, and finally removed from the track after being 17 months in the low side of the curve owing to the excessive "fraying" of the new running edge, so clearly shown on the photographs.

A number of rails by various makers, and collected from different railways in England, showed very little deterioration or wear on the top of the rail. After a service of an average of sixteen years, and having carried an average of 100,000,000 tons, the head wear only showed a little over ¼-inch on average.—(Vide Proceedings Inst. C.E., Vol. CXXXVI.).

Fig. 21.

Forty-five per cent. of the rails on the London and North-Western Railway broke after carrying between 25,000,000 and 50,000,000 tons of traffic, while only 17 per cent. failed after carrying between 50,000,000 and 100,000,000 tons.

It is, however, very difficult to say what internal deterioration takes place in rails from "fatigue" of the metal, or what brittleness is developed by the cold hammering of the wheels; therefore, loss of weight or severe abrasion of surface cannot alone determine the limits of the usefulness of a rail. On the other hand, the Colonial maintenance engineer has not the necessary apparatus at hand to accurately determine the various factors affecting the durability of a steel rail; he must, therefore, for the present, at any rate, fix the limit of its usefulness by its loss of weight or other visible physical defects which renders it unsafe for use in the track.

In connection with the excessive wear of rails on curves, more attention might be devoted to this important matter, and it would well repay maintenance engineers to give the subject closer scrutiny and more scientific study, with the view of elucidating the relative life of a rail and its resistance to wear in varying degree of curvature, gauge, and super-elevation, as any accurate data obtained in this connection would undoubtedly form a valuable asset to track economics.

Improved Rail Section.—The first thought suggesting a remedy for excessive rail head wear is to increase the area of the metal subjected to the greatest wear, and such a proposal has been submitted for discussion by Mr. W. S. Potter, of the Manganese Steel Rail Company, New York, whose suggestion consisted of the addition of more available head metal and increasing the thickness of the base by the addition of fillets between the web and base.

The section shown in white outline, is an American 90lb. rail, the shaded areas indicate the proposed additional section which adds 15lbs to the weight of the rail, while the heavy dotted line on the head of the rail represents a loss of 25 per cent of metal on the head of a worn outer curve rail.

As side-wear on curves is much in excess of on straights, Mr. Potter's suggestion is not quite practicable, as it involves a redundance of head metal on tangents, or else necessitates having different depths of rails on curves and tangents, with the attendant objectionable joggled junction fishplates.

The additional area in the fillets of the web of Mr. Potter's rail also appear somewhat excessive, as the bulk of failures in the web originate where slots are provided in the base of the rail for spikes—presumably to stop creep—cutting notches for spikes in the edges of the flanges of a rail is not good practice, knowing how sensitive steel is to any detrimental form, of which the angular shape is the most aggravating.

1	2	3	4	5	6	7	8	9	10
Reference to Sections Illustrated.	Name of Railway.	Radius of curve and (cant).	Grade compensated.	Type of Rail.	Original weight of Rail	Loss of weight per lineal yard.	Which leg of curve removed from.	Gross Rolling load passed over rail.	Length of service
No.		Feet (ins.)			lbs.	lbs.		In 10,000 tons.	months
1	"Boven Deviation" Eastern Line	478' (4")	1 in 66	B.S.S.	80	2¾	Higher	880	52
2		478	1 in 66	,,	80	3¾	Lower	880	52
3	Transvaal. .. .. Ditto	410 (4¼")	1 in 70	,,	80	6¾	Higher Higher	800 280	47 17
4	Ditto .. .. .. Ditto	410' (4¼")	1 in 70	,,	80	6½	Higher Higher	800 280	47 17
5	Ditto .. .. .. Ditto	410' (4¼")	1 in 70	,,	80	6	Higher Higher	800 280	47 17
6	Natal Main Line ..	300' (5")	1 in 30	,,	80	4½	Lower	900	10½
7	Ditto	300' (5")	1 in 30	,,	80	7½	Higher	640	7½
8	Eastern Line Transvaal.	500' (4")	1 in 50	Z.A.S.M.	60	4¼	Higher	—	36 to 48
9	(Low Velt)	500' (4")	1 in 50	,,	60	6½	Higher & Lower	—	240
10	O.F.S. Main Line ..	495' (3¾")	1 in 80	C.G.R.	60	3	Higher	Not ascertainable.	240
11	Donker's Poort ..	495' (3¾')	1 in 80	,,	60	3	Higher		
12	Natal Main Line ..	500 (5")	1 in 39	N.G.R.	78	12¾	Higher Lower	,,	120 22 12
		300'		N.G.R.	80	12¼	Lower	,,	
12a		(5")	1 in 33	B.S.S.					

South African Railways.
Table Showing Details of Grade, Wear, etc., on Sections of Worn Steel Rails.

The suggestion of increasing the area of the fillets to a small extent between the web and the base, is, however, worth further investigation, as many rails fail at these points before other sections are exhausted.

Fig. 13 shows the present prevailing 80lb. standard steel rail of American railways, with the old section of the American steel 80lb. rail super-imposed thereon in dotted lines. Fig. 14 shows the B.S.S. 80lb. rail super-imposed in dotted lines on the existing standard 80lb. rail of the American Railway Engineers' Association.

The American Railway Engineering Association has observed "a difference between rails of different mills when the sections and chemical compositions are practically the same," and has consequently deputed steel experts to determine by actual tests which of the leading steel manufacturers turn out the best rails.

The figures 18 and 21 are reproductions of photographs taken of a worn-out 78lb. rail from the Natal Main Line. Mr. Chas. G. Bateman, Assistant Superintendent of Maintenance, quotes the life history of this rail as follows:—"It was laid on straight about 1898. Removed from straight and put in high side of 500 feet radius curve at 42¼ miles, on the 6th December, 1908; taken out from high side of this curve on 2nd November, 1910, and was relaid again on the 9th of the same month for relaying low side of 300 feet radius curve at 40½ miles, 'Satan's Hole,' and broke under combined train on the 5th August, 1912, when it was scrapped. Grade 1 in 30, and trains usually negotiate this grade fairly steadily. Loss of weight, 13 lbs. 5 ozs. per yard." This represents a loss of about 17 per cent. which is somewhat in excess of the recommended maximum.

It will, therefore, be seen how important it is to give a close and observant study to everything affecting the wear on rails, in order to effect every economy possible in connection with a unit which is far and away the most expensive constituent part of the permanent way.

Even from these meagre notes it must appear manifestly clear that a wide field of research is open to the railway engineer in connection with the problem of the steel rail, and any careful investigations of a practical or scientific nature will be welcomed as an effort to assist in solving a hitherto neglected factor which reflects so materially on the economical functions of railway engineering.

GOVERNMENT HEARING ON THE GRAND RIVER CONTROL.

On Wednesday, April 16th, at 10 a.m., a delegation received a hearing from the Ontario Government on the question of the control of the Grand River. The Government was represented by Hon. Dr. Reaume, Minister of Public Works; Hon. Mr. Duff, Minister of Agriculture; and Messrs. Pattinson, M.P.P., Mills, M.P.P., and Richardson, M.P.P.

The delegation was a large one, representatives from all the municipalities along the river, from Dunnville to Fergus, being present.

Mr. J. P. Jaffray, of Galt, the President of the Grand River Improvement Association, in presenting his argument for Government action, said that the Grand River valley ran through one of the most thickly populated sections of the province, and also one of the most important in manufacturing, agriculture, and general interests in the Dominion. He added that delegations had been approaching the Government during the past twelve years. The flood menace was constantly increasing, while the low-water flow was dwindling.

Mr. T. H. Jones, City Engineer of Brantford, spoke of the work done on the river by the Hydro-Electric Power Commission last year, and of their recommendation that this work should be continued on a more thorough scale so as to get all data and designs required. He added that the Commission should be requested to fully report on the project. He spoke of the large expense incurred by the city of Brantford (over $100,000), and flood protection was still far from satisfactory.

Mr. Kerr, of Fergus, spoke of the desirability of a Government reservation of large size on the waste land, or nearly so, of the head water areas of the Grand River.

Mr. W. H. Breithaupt presented his reasons for believing the Government should take action, and his argument is given at some length in this account, as it gives some valuable data on the Grand River.

The Hon. Dr. Reaume stated that he was strongly impressed with the urgency of the case, and would recommend Government action. He suggested that municipalities along the river should contribute a part of the funds required to carry on the investigation.

The following data on the Grand River was presented by Mr. W. H. Breithaupt, M. Inst. C.E., in the course of his address:—

Drainage area of the Grand River, 2,600 square miles, essentially the central part of the peninsula of southwestern Ontario; parts of the counties of Grey, Dufferin, Perth, Oxford, Norfolk, Halton, Wentworth and Haldimand and the whole of Wellington, Waterloo and Brant. The drainage area is wide, and of largest expanse along the upper part of the river. The Conestogo branch rises also on the head plateau almost as far north as the main river.

Total fall of the river from the head plateau of its rise to its outlet into Lake Erie is over 1,100 feet.

The head water plateau was originally largely swamp, probably to the extent of 400 square miles in area or more. During the last fifteen or twenty years especially this swamp area has been cleared and drained. Run-off from it is now very rapid at times of snow melting and heavy rainfall, whereas formerly it was slow and snow melting was greatly retarded. In consequence spring floods of the river have greatly increased.

Tributaries of the main river in their order from upstream are the Conestogo from the west, the Eramosa-Speed from the east, and the Nith from the west.

Precipitation, rainfall and snowfall are not definitely known in the watershed of the Grand River. There are but few observing stations. From other stations and from partial records it appears likely that the total precipitation, rainfall and snowfall in the upper part of the watershed is 35 to 40 in. or more, whereas on the lower part, which is also narrower, the annual precipitation is somewhat less. There are no data on run-off, but it is safe to estimate that for the head-water area it amounts to 12 in. or more per annum.

There are various methods of flood control of a river. Deepening of the channel and the construction of dykes along the banks allows a large increase in the volume of the water passing. Another method is to raise the general level of the banks which are to be kept above water. All such methods are palliative only and benefit the immediate locality only. A much better method is to remove the cause of floods by impounding near the sources. It is apparent that this method is not applicable to all rivers. Certain topographical conditions are essential to its success, as also definite general conditions of the drainage area. Impounding must be at locations where a large part of the flow of the entire river can be arrested, and for a reservoir the valley must contain an extended basin with high enough banks and a reasonably narrow neck, again with high banks, for the construction of a dam.

The only possible method by which uniformity of flow or an approach to such uniformity, can be secured, is by storing surplus waters in seasons of flood and releasing them in seasons of drought. It may be stated that as a general rule a sufficient amount of storage can be artificially created in the valley of any stream to rob its floods of their destructive character, but it is equally true that the benefits to be gained will not ordinarily justify the cost.

The determining factors in the control of the flow of a river by storage are:—

(1) The flood flow of the river.

(2) The amount of sustained flow, for low-water period, that can be provided for. And further:—

(3) The cost, including the value of the area flooded as compared with the benefits to be derived.

(4) The situation of the storage basin: whether it can be placed so as to have enough contributory drainage area and at the same time properly control a sufficient length of the river to make it worth while.

(5) The character of the water to be impounded, whether it is clear or so charged with sediment that silting will unduly shorten the life of the works.

From general indications it appears that the Grand River is peculiarly well adapted for storage control, and that the required works can be carried out at a cost to make them well worth while. Before definite conclusions can be drawn, however, it is necessary that much more detailed and extensive examinations should be made.

Observation extending over many years confirms that all larger floods come primarily from the head-water area and extend the length of the river, as naturally occurs by reason of the wider expanse of this area and the greater precipitation there It is evident, therefore, that control of the yield of the head-water area will enable prevention of the destructive crest of the flood throughout the length of the river, as also reasonable maintenance of sustained flow for the whole river. Land condemnation for reservoir sites will be comparatively moderate in cost. The drainage area of the main river to the outlet of the Conestogo branch is approximately 460 square miles, while that of the Conestogo branch is approximately 330 square miles. A storage basin of sufficient size located on the main river a short distance above the outlet of the Conestogo, another smaller one on the main river above Fergus, also a considerable storage basin on the Conestogo branch as near its outlet as may be—these three basins with a total dischargeable capacity of, say, 2,500,000,000 to 3,000,000,000 cubic feet, would, it is estimated, suffice to catch the destructive part of any flood, and would have enough contributory drainage area to give a sustained flow of 400 to 500 cubic feet per second below the outlet of the Conestogo branch. Storage also on the Eramosa-Speed and on the Nith tributaries could not only materially better this result for the main river below their respective outlets, but give required flood protection to the large population centres, especially on the Speed, as well.

The definite data to be obtained are:—

Extended records of rainfall and snowfall at various points throughout the drainage area, and particularly on the head-water area.

Continuous stream-gauging at a sufficient number of points in the main river and branches to determine the run-off factor, as also rapidity of run-off.

Full topographical survey of possible storage basins and examination by test borings of dam site for each basin.

Delimitation of the upper river drainage area and of the head-water areas of the branches.

BRICK PAVEMENT SPECIFICATIONS.

The American Society of Municipal Improvement has published standard specifications for brick pavements as adopted by the society at its last annual convention. An interesting paragraph of the specifications is that the brick shall not lose of their weight more than 22 per cent. when submitted to the rattler test.

Samples of brick of uniform shape and appearance are required to be taken from each car (estimated at 10,000 brick). Brick having defects that would cull them shall not be used. Three grades of samples shall be tested—one of the softest, one of the medium and one of the hardest burned. If all of the tests overrun 22 per cent. loss, the car shall be rejected. If one or two of the tests overrun, another test of said grade or grades shall be made. Should only one of these tests overrun 22 per cent. loss, the contractor may cull said grade, provided they do not exceed 10 per cent. of the amount of the brick in the car, and deliver the balance on the improvement. Otherwise the whole car will be rejected. In order to prevent the continued shipments of inferior brick, only two cars of two separate shipments of any make of any brick will be tested. Should they fail to meet the requirements stated above, said make of brick will be rejected for this improvement.

Among the cities which permit no more than 22 per cent. loss by abrasion are Baltimore, Grand Rapids, Akron, Toledo, Newark, Philadelphia, etc. Only 21 per cent. loss is allowed by Chicago, Indianapolis, Canton and Columbus.

MODERN INDUSTRIAL LIGHTING SYSTEMS.

That the Tungsten lamp has already become the permanent standard illuminant for mills and manufacturing establishments is the opinion of Albert L. Pearson, electrical engineer, of Lockwood Greene & Co., as presented in a recent paper read before the American Society of Mechanical Engineers at the Boston Engineers' Club. The following remarks are taken from this paper:—

For certain work in which line distinction or clearness in combination with wide diffusion is the prime requisite, the mercury arc is a close competitor. One principal objection to the mercury arc, however, is the entire lack of red light waves in its spectrum. A fluorescent reflector, which will supply to a certain extent these missing red rays, makes the light more natural and at the same time less objectionable. On the other hand, the Tungsten lamp gives a nearly white light, approaching the ideal sunlight. Its high efficiency and ready adaptation to varying intensities also partly account for its adoption as a standard lighting unit.

In addition to providing a suitable form of lamp, a great deal of attention and careful study is now given to the proper arrangement of the lighting system itself. Lamps should be arranged to give uniform illumination at the working plane, avoiding shadows as far as possible, and paying particular attention to the requirements of each machine and each operation. White walls and ceilings are advantageous, and add to the effectiveness of any lighting arrangement. With modern individual drive it is possible to keep the rooms clearer of belts and shafting than with the mechanical or group drive, thus benefiting the lighting system. On account of glare, low, exposed units should, of course, be avoided wherever possible, and in places where lamps hung low down are necessary, reflectors which will entirely conceal the filaments should be used. In such cases a few lamps well placed close to the ceiling will overcome the effect of light and darkness.

The position of lamps should be carefully determined, both as to spacing and mounting height. Mr. Pearson believes that each problem must be considered by itself. He says that no general rule can be given, even for plants doing the same work, as changes in layout will greatly affect any system of illumination, but that in general the height of the lamp above the floor should be such that, with the spacing available, the lines representing the angles of maximum illumination with a given type of reflector will cross at the working plane.

The amount of light and the arrangement of lamps depends also upon the nature of the work and the character of the machines. Good lighting should provide safety for employees, better sanitary conditions, and, in many cases, better quality of work and increase in productivity. The best lighting should be provided for the most particular processes. In places where good light is not required, or where it is used for a comparatively short time, obviously it is not necessary to invest as much for this part of the equipment as in places where light is required for longer periods or is depended upon for quality in the work.

The day of working out a lighting system arbitrarily as so many watts per square foot of floor space or so many foot candles is passed. A study must be made of the conditions and a layout designed which will prove both economical and give the best illumnation. The distributing systems also should be designed to secure as good voltage regulation as possible and circuits arranged to eliminate waste of power for lighting any sections not in use.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

The Elements of Chemical Engineering. By J. Grossman, M.A., Ph.D., F.I.C., with preface by Sir William Ramsay, K.C.B., F.R.S. Cloth; second edition; 50 illustrations. Price, $1 net. Charles Griffin & Company, London, Eng.

Reviewed by J. Watson Bain, B.A.Sc.*

It is a matter of common remark that the superintendents of many of our factories are being drawn from the ranks of university graduates, and this is particularly true in the chemical industries. After a more or less lengthy apprenticeship in the laboratory and in the factory, the man with a good technical training and a sufficiency of common sense usually develops into a valuable official, and the rapidity with which this end is attained depends very largely upon the rate at which a familiarity with routine operations and apparatus is acquired. In the school or university the instruments employed are small and easily handled, while the use of glass and porcelain overcomes the difficulty of dealing with corrosive liquids. The college graduate then, on entering the manufacturing field, finds himself confronted by new problems which arise in the handling of large quantities of material, and it is here that valuable time is often lost in the endeavor to cope with changed conditions. To the chemist who finds himself in such circumstances or to the student who has not yet graduated, Dr. J. Grossman's "Elements of Chemical Engineering" will be of great assistance. Dr. Grossman has set himself to bridge the gap between the laboratory and the factory, and has produced a short treatise, which deals with the subject in a clear and interesting manner. The comparison of the simple forms of laboratory apparatus with their factory equivalents is emphasized in a novel fashion and assists materially in acquiring ideas as to the construction and uses of the latter. The author draws attention continually to the differences between an operation as carried out on a small scale in the laboratory and as executed on a large scale in the factory; such emphasis deserves particular commendation in view of the not infrequent blunders which arise from a lack of appreciation of this important distinction.

The chapter on technical research is particularly valuable to the young students and will suggest to him that manufacturing materials are not pure, that the solubilities of his ingredients are important and that careful experiment must be carried out in the devising of a factory process. The actual design cannot be treated in a volume of this size, and the student is referred to the more extended literature dealing with this phase. The fact that there is no other short treatise in English which covers the same field will make this book a welcome addition to the library of the young chemical engineer.

The illustrations are numerous and well chosen, while the author advises his readers to make a collection of catalogues and price lists.

* Associate Professor of Applied Chemistry at the University of Toronto.

Electrical Machine Design. By Alexander M. Gray, B.Sc., Assistant Professor of Electrical Engineering, McGill University, Montreal. Publishers, McGraw-Hill Book Company, 239 West 39th Street, New York. Cloth; 500 pages, with illustrations and charts. Price, $4 net.

Reviewed by J. A. Johnson.*

In the preface to this work the author states: "The study and design is of the utmost importance to all students, because only by such a study can a knowledge of the limitations of machines be acquired." A statement of this sort is very apt to be made by specialists who happen to hold professional positions. Each one seeming to believe that his own particular subject is the one really essential one. If they all were allowed to have their way students would have to devote their lives to preparing for their life work. It certainly is arguable, that engineers would do better to have a knowledge of the limitations of machines; that, in fact, the progress in design comes from the demands of those big-minded men who know nothing about the limitations of machines, but do know what they want and keep after it till somebody finds out that the so-called limitations are no limitations after all.

The book is of approximately 500 pages divided into four sections and forty-nine chapters. The four sections are respectively of direct current machinery, alternator and synchronous, polyphase, and induction motors and transformers. The method followed is, as to each section: First, the consideration of the theory of operation followed by a description of the types and forms of construction; consideration of characteristics of performance, procedure in design and typical specifications; the latter would stand considerable improvement, especially as to form. Mechanical design is not gone into except incidentally. One chapter only is devoted to the consideration of a few of the fundamental mechanical problems.

The author states that the work was compiled as a course of lectures. Its value as a text-book would seem to be confined pretty largely to the use of special students of design, as it seems rather too voluminous to find a place in the regular course for all students, except at the expense of time that

* Electrical Engineer, Ontario Power Company, Niagara Falls, Ont.

would be more profitably spent otherwise if broad-gauge, open-minded engineers rather than specialists are the object of the trade.

Building Construction and Drawing. (Elementary Course.) By Charles F. Mitchell, Lecturer on Building Construction to Regent Polytechnic, London, Eng.; Head Master of the Polytechnical School, assisted by Geo. A. Mitchell, A.R.I.B.A. Cloth; 472 pages; 7 x 4½ inches; about 1,100 illustrations; eighth edition; by D. VanNostrand & Company. Price, $1.50 net.

The book aims to give with conciseness and accuracy a statement of the principles which should govern the execution and building work. The authors wish it to be equally valuable as a guide for students engaged in building. The contents comprise of fourteen chapters including Instruction to Beginners, Brickwork, Masonry, Girders, Joints in Carpentry; Floors, Partitions, Wood Roofs, Composite Roofs, Iron and Steel Roofs; Joinery Plumbing, Slating and Tiling, Building Quantities, and Memoranda. A few exercises are included in each chapter, and the appendix contains an index and treats with the Examination Papers and Syllabus of the English Board of Education. It contains the subject matter of previous editions carefully revised and subjects not hitherto treated or emphasized are: Isometric Projection, Monolithic Brickwork, Bonding of Brick Footings, Hollow or Storm Walls, Facing Bond, Fixing Bricks, Example of Face Jointing in Masonry, Polishing of Marbles, Calculations of strengths of Timber Pillars, Expansion Joints for Girders and Trusses, Quotations from the L.C.C. General Powers Act, 1909, Prevention of Dry Rot, Relative Position of Members in a Typical Roof, Ferro-Concrete for Roof Construction, Description of Door Hinges, and the New Rules (1910) for the Admeasurement of Slating and Tiling.

The present issue is the eighty-seventh thousandth which speaks for itself as to its usefulness and appreciation by those interested in building construction.

Building Construction.—A text book on the principles and details of modern construction for the use of students and practical men (advanced and honor courses). By Charles F. Mitchell, Lecturer of Building Construction to Regent Polytechnic, London, Eng., Head Master of the Polytechnical School, assisted by Geo. A. Mitchell, A.R.I.B.A. Seventh edition revised and much enlarged; 885 pages; 800 illustrations; cloth. Price, $2.50 net.

The authors state that since the publication of the sixth edition considerable advances have been made in knowledge of building materials and methods of construction, thereby rendering it necessary to again revise and amplify and bring their book into line with current practice. Calculations have been rechecked; fresh examples added, and the text revised, and neither labor stinted nor counsel disregarded to make the new edition deserving of the approbation bestowed upon the former issues.

It contains 28 chapters. The chapter subjects are: Limes and Cements; Concrete; Asphalt; Plastering; Stones; Bricks; Tiles; Terracotta and Stoneware; Iron and Steel; Timber; Paints and Varnishes; Glass; Foundations; Brickwork; Flues; Fire-places and Tall Chimneys; Masonry; Carpentry; Half-timbered Work; Pillars; Columns and Stanchions; Graphic Statics; Girders; Fire-resisting Construction; Reinforced or Ferro-Concrete; Joinery; Stairs and Hand Rails; Sanitation Water Supply; Hot Water Apparatus and Ventilation; Electric Bells and Lighting.

The effects of the London County Council regulations in connection with skeleton framed buildings, and of those proposed to be adopted by the council with regard to buildings of reinforced concrete, have entailed the complete re-writing of the chapters dealing with these subjects, and as these regulations may serve as models of their kind it has been thought desirable to give their text in full.

Due note has also been taken of the revised report of the Royal Institute of British Architects on Reinforced Concrete, as well as of the recommendations of the District Surveyors' Association and of the recent work of the Engineering Standards Committee.

Throughout the book, the endeavor has been to describe the essential principles of good construction and to illustrate them by typical examples selected as far as possible from actual practice.

No further comment is needed on the merits of this book than the fact that with the present issue it will have reached a circulation of 52,000.

A Handbook of English for Engineers. By Wilbur Owen Sypherd, Professor of English in Delaware College. Flexible leather cover; 314 pages; 4 x 7 inches; Scott, Foresman & Company, Chicago and New York. Price, $1.50 net.

The author's aim and hope that the contents of this book should be "of practical assistance to engineers in college classes and the early years of professional life" should most certainly be fulfilled. He has apparently, in preparing the book, carefully read the available literature on the subject and been painstaking in partly compiling and selecting from same. The book should be very useful in higher engineering classes and will doubtless find a place on the shelves of many engineers.

The book contains five chapters, dealing respectively with General Problems of Engineering Writing, Mechanical Details Common to the Various Forms of Technical Writing, Business Letters, Reports, and Articles for Technical Journals.

The first chapter touches on the problems of technical writing. In the second chapter directions for the use of abbreviations, punctuation marks, capital letters, etc. To engineers desirous of strengthening their English these two chapters are likely to be most serviceable.

The third chapter, on business letters, briefly states the main principles governing successful business correspondence and supplies examples of good and bad usage. There is, however, no mention of methods of drawing special emphasis to points under consideration.

The fourth chapter contains a systematic treatment re rhetoric of engineering reports. The author discusses the general essentials of reports; then gives more fully the requirements of reports on tests, reports on inspection work, and periodical reports, with examples of each kind.

The fifth chapter deals with articles for technical journals. He divides his subject into short articles and longer articles, including under the former editorials, summaries and abstracts, book review and explanations of new inventions.

It is a book dealing with a subject important to every engineer, and which in the first efforts to become technically proficient is often sadly neglected by them. Many an engineer, capably equipped technically, is sadly handicapped for advancement in his profession by neglect of just such niceties of rhetoric as this book brings out. It would be well for those who have not given much thought to this subject to possess themselves of the book.

PUBLICATIONS RECEIVED.

Bureau of Railway Economics. Bulletin No. 45. 30 pages. Address, Washington, D.C.

Municipal Bulletin. Issued by the Ohio State Board of Health, Columbus, Ohio. Vol. 3, No. 2.

Municipal Bulletin. Issued by the Ohio State Board of Health, Columbus, Ohio. Vol. 3, No. 3.

Illuminating Engineer. Special gas centenary number. Address, 32 Victoria Street, London, S.W.

Canal Statistics for 1912. 111 pages; issued by the Department of Railways and Canals, Ottawa, Ont.

Manitoba Engineer. Published by the Engineering Society of the University of Manitoba. 80 pages.

Resources of Tennessee. April issue. Published by the State Geological Survey. Address, Nashville, Tenn.

Metallurgie. Journal published by the Society of Engineers and Industries, 20 rue Turgot, Paris, France.

Commissioner of Works' Report. Seventh report. 27 pages. Address, Department of Works Office, Toronto.

Report of Commissioner of Public Roads, State of New Jersey, year ending 1912. Cloth; 6 x 9 inches; 160 pages; illustrated

University of Wisconsin. Bulletin of summer session. 105 pages. Issued by University of Wisconsin, Matheson, Wisconsin.

American Society of Mechanical Engineers. Journal of the Society for April, 1913. Address, 29 West 39th Street, New York City.

American Institute of Electrical Engineers. Proceedings of the Society, April, 1913. Address, 33 West 39th Street, New York City.

American Society of Civil Engineers. March issue of the Proceedings of the Society. 620 pages. Apply 220 West 57th Street, New York City.

Irrigation. (Part of Part VI.). Annual report of the Department of the Interior for year 1912, together with maps. 123 pages. Address, Ottawa.

Farm Forester, by E. J. Zavitz, Professor of Forestry (Bulletin No. 209); 30 pages; issued by the Department of Agriculture, Toronto, Ontario.

American Waterworks Association. Proceedings of the 32nd Annual Convention. Apply to the Secretary, J. M. Divin, 47 State Street, Troy, N.Y.

Department of Mines. Annual report for Province of Nova Scotia, 1912. Prepared by the Commissioner of Public Works and Mines, Halifax, N.S.

Oil and Gas Wells Through Workable Coal Beds. Bulletin No. 65. By G. S. Rice and O. P. Hood. Issued by the Bureau of Mines, Washington, D.C.

Summary of Commerce and Finance of the United States for February, 1913. Issued by the Bureau of Farm and Domestic Commerce, Washington, D.C.

Conference Rulings of the Interstate Commerce Commission. Bulletin No. 6; cancels and includes Bulletin No. 5. Issued April 1, 1913, at Washington, D.C.

Review and Expenses of Steam Roads in the United States for December, 1912. Bulletin No. 49; issued by Inspector Commerce Commission, Washington, D.C.

Geographic Board of Canada. Eleventh report for year ending June, 1912. A supplement to the annual report of the Department of Marine and Fisheries, Ottawa. 240 pages.

Ignition of Mine Gases by Filaments of Incandescent Lamps. Bulletin 52. By H. H. Clark and L. Ilsley. Issued by Department of Interior, Bureau of Mines, Washington, D.C.

Patents. Illustrated official journal of patents for Great Britain, April 2, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C Price 6d.

Patents. Illustrated official journal of patents for Great Britain, March 19, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C. Price, 6d.

Apparatus for the Exact Analysis of Flue Gas. Technical paper No. 31. By G. A. Burrell and F. M. Siebert. Issued by the Department of the Interior, Bureau of Mines, Washington, D.C.

Report of Board of Commissioners, Water and Lighting Department of the City of Harrisburg, Pa. Twenty-fifth annual report, for 1912. Apply, Commissioners' Office, Harrisburg, Pa.

Metal Mine Accidents in the United States for the Year 1911.—Technical Paper Number 40; 54 pages; compiled by A. H. Fay, Department of the Interior of the Bureau of Mines, Ottawa, Ont.

International Geological Congress. Second circular, Canadian edition of the programme of the coming meeting of the International Geological Congress, in Canada, summer of 1913. 45 pages. Apply to the secretary, Victoria Memorial Museum, Ottawa, Ont.

CATALOGUES RECEIVED.

Corrugated Pipe Company.—Thirty-page catalogue, 8 x 5 inches. Address, Stratford, Ont.

American Locomotive Company.—Bulletin No. 1,012. Mikado type locomotive built for Chesapeake and Ohio Railway.

Concrete in Farming Improvements.—Sixteen-page pamphlet, published by the Canada Cement Company, Montreal, Quebec.

Castings.—A reference for buyers of foundry equipment and supplies; Vol. 12, No. 1. Published by the Gardner Printing Company, Caxton Building, Cleveland, Ohio.

Chicago Giant Rock Drill, Tappet Type.—Bulletin No. 137. 16 pages; illustrated. Published by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Chicago Giant Rock Drill, Mountings.—Bulletin No. 138. 10 pages; illustrated. Published by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Chicago Giant Rock Drill, Appurtenances.—Bulletin No. 139. 16 pages; illustrated. Published by the Chicaga Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Dolarway Pavements.—Well illustrated catalogue, 9 x 6 inches; 34 pages. Important to everyone interested in pavements. Apply, Dolarway Paving Company, Whitehall Building, New York City.

Universal Bulletins.—Published by Uuiversal Portland Cement Company. 10 pages; illustrated. Apply, Publicity Bureau of Universal Portland Cement Company, 72 West Adam Street, Chicago, Ill.

The Labor Saver.—Publication issued monthly by Green Publishing Company in the interests of the mechanical handling of material for Stephens-Adamson Manufacturing Company. Address, Aurora, Ill.

High-Grade Engineering Instruments.—Illustrated pamphlet, 8 x 5 inches; 72 pages. A very complete list with instructions as to adjustments. Published by the Hanna Manufacturing Company, Troy, N.Y.

Jeffrey Swing Hammer Pulverizer. Bulletin No. 31 L. A typical and practical machine for reducing ground limestone for agricultural purposes. Size, 9 x 6 inches; illustrated. Issued by the Jeffrey Manufacturing Company, Columbus, Ohio.

Co-operative Information Bureau, of Boston.—Bulletin No. 4, giving aims and officers of this society. organized in 1912; a voluntary association of persons and organizations for mutual assistance in the ascertainment of sources and places of information.

The Ransome Concrete Machinery Company, Dunellen, N.J., have issued a well-illustrated 80-page general catalogue covering the entire Ransome line, which includes every piece of equipment necessary in a complete concrete plant. This catalogue will be sent to anyone interested upon request. Write the nearest office of the company for a copy of the "Red Book."

A new standard price list on "Sterling" new code rubber-covered wire has been issued by the Standard Underground Cable Company, of Canada, Limited, Hamilton, Ont. The price list is in convenient and durable booklet form, printed in two colors, and gives prices on their "Sterling" wire for bases ranging from 13 to 20 cents for solid and stranded wire of all commercial sizes. Appended are explanatory notes and a list of electric wire cables and cable accessories manufactured by this company. The price list will be sent on request to the company.

Bitumen Cable and Mining Accessories.—The British Insulated and Helsby Cables, Limited, of Prescot, Lancashire, England, of whom the Canadian British Insulated Company, Limited, of Montreal, are the sole Canadian representatives, have forwarded a copy of their catalogue on bitumen cables and mining accessories. The catalogue is a most handsome one typographically, and the illustrations show very clearly the different types of cables and the many wiring accessories incidental to mining work manufactured by the company. Copies of the catalogue may be secured by addressing the Canadian British Insulated Company, Montreal.

The Engineering Works of Canada, Limited, Montreal, send us a copy of their catalogue "G," which is devoted to alternating current generators. The catalogue contains a very carefully prepared and illustrated description of the construction of these generators and will no doubt be read with a great deal of interest by electrical engineers all over Canada. These generators are built under the patents of the "Société Alsacienne de Constructions Mecaniques." The pamphlet contains 20 6 x 9 pages, and is very fully illustrated, and any reader interested may obtain a copy by addressing the Engineering Works of Canada, Limited, New Birks Building, Montreal, Que.

Strauss Direct Lift Bridge is the title of a very attractively gotten-up bulletin which we have received from the Strauss Bascule Bridge Company, of Chicago. It contains a very interesting illustrated description of the Strauss direct lift bridge which involves an application of the counter-balancing mechanism of the Strauss bascule to the vertical lift bridge. The pamphlet, which contains 22 pages, is illustrated by means of a colored half-tone and several line drawings, and no doubt bridge engineers will be interested in seeing this pamphlet, copies of which, we understand, can be secured by addressing the Strauss Bascule Bridge Company, 104 South Michigan Avenue, Chicago, Illinois.

Refined Asphalt for Municipal Paving Plants is the title of a very interesting 22-page pamphlet which we have received from the American Asphaltum & Rubber Company, of Chicago. The pamphlet contains a good deal of information concerning the qualities of asphalt as a paving material. City engineers, roadway engineers and paving contractors would do well to secure a copy, which can be done by addressing the American Asphaltum and Rubber Company, 600 Harvester Building, Chicago, Ill.; the Canadian Mineral Rubber Company, Canadian Express Building, Montreal, Que., or the Canadian Mineral Rubber Company, 503 Canada Building, Winnipeg, Man.

The Lagonda Reseating Machine.—Bulletin G 1. Illustrated pamphlet, 6 x 9 inches; describing construction and use of the Lagonda Manufacturing Company's portable carborundum wheel for removing soot and scale from the faces of caps and tube ends on boilers. These wheels are driven by either electric, water, steam or air motors and the photographs showing actual cleaning operations greatly assist in understanding the value of this reseating machine for making a steam and water-tight joint when replacing the caps on B. & W. and similar boilers after having been removed for tube cleaning purposes. Copies may be had by addressing the company at Springfield, Ohio.

Peebles Alternating Motors, Polyphase Induction Type.—Pamphlet No. 16 B. 25 pages; 8 x 10 inches. Eight different types of standard machines dealt with on pages 6 and 7 of the pamphlet. The company are always prepared to design machines to meet special conditions. A very full specification of the motors is given in the pamphlet, together with illustrations of various parts and of some of the different types of motor referred to above. In addition, outline illustrations and full lists of approximate weights and dimensions of every size which they manufacture are given, while full lists of technical data for 50 and 25-cycle motors are also given, machines being dealt with for three separate ranges of voltage from 110 up to 3,500 volts, at speeds of from 1,500 down to 150 r.p.m. Issued by Bruce Peebles & Company, Limited, Edinburgh, Scotland.

Messrs. Gent & Company, of Leicester, England, send us their catalogues Nos. 4, 5 and 6. Catalogue No. 4 is devoted to a description of their Tell-Tale clocks, designed for checking the movements of watchmen in warehouses, factories, mills, etc. Catalogue No. 5 is devoted to a description of their silent electric impulse clocks and electric turret clocks, which are suitable for public buildings of all kinds, such as fire halls, municipal buildings, railroad stations, etc. Catalogue No. 6 is devoted to their water level indicators and alarms, the object of these being to indicate and record inch by inch the variations in depth of water in distant reservoirs, wells, rivers, docks, etc. The Canadian representatives of Messrs. Gent & Company are Messrs. E. A. Mansfield & Company, P.O. Box 223, Hamilton, Ont.

Catalogue of book "Essentials of Electricals of Electricity." Text book for wiremen on electrical trades. By W. H. Timble. 271 pages; 224 figures; cloth. Price, $1.25 net. Publishers, John Wiley & Sons, New York.

Catalogue of book "Steam Engineering." By William R. King. 450 pages; 177 figures; cloth. Price, $4 net. Publishers, John Wiley & Sons, New York.

Messrs. Vickers, Limited, have been commissioned to build a Parseval airship for the Admiralty, the builders to pay royalties to the German company on every ship they build. The Admiralty are naturally anxious that all aircraft for the navy shall be built in Britain, and after the arrival of the first Parseval the remainder will be built in England.

COAST TO COAST.

Vancouver, B.C.—An engineering party of the Pacific Great Eastern Railway under the direction of S. A. Dice, has completed the final location between the Second Narrows through North Vancouver to Point Atkinson lighthouse, and is now engaged on similar work between the lighthouse and Newport at the head of Howe Sound. This is regarded as evidence of the intention of P. Welsh, the contractor, to undertake construction on the lower section without further delay. It has now been definitely established that the maximum grades between those two points will not exceed one per cent. The route will follow the shore line virtually all the way and will only be a few feet above high-water mark. Instead of winding past the Point Atkinson lighthouse the railway will cut through a natural draw east of the lighthouse, then strike Howe Sound and follow it all the way to Newport. The project of bridging several of the indentations along the coast has been abandoned and the road instead will be through a number of tunnels, one of them to be about 820 feet long, thus making several advantageous cutoffs. The construction from the lighthouse to Newport will be exceedingly heavy, as the cost of considerable of the milage, it is estimated, will be at least $100,000 a mile. The location of the line between Lillooet and the vicinity of Fort George, a distance of 290 miles, is now in progress. The work now being undertaken is on the lower section of the route north of Lillooet, actual construction on which is to be undertaken this summer. Eleven hundred men are now employed in the various camps along the route from Lillooet south along Seaton and Anderson Lakes and beyond to Pemberton Portage.

Ottawa, Ont.—Chief Engineer Bowden of the Railways and Canals Department, and Engineer Weller, who is in charge of the work on the Welland Canal, have returned from a trip to Panama, where they spent the past month studying and investigating the latest engineering developments as exemplified on the Panama Canal, with a view to applying the ideas to the new Welland undertaking. The government is anxious for the Welland to be the latest word in modern canal construction. The two engineers are starting work at once on designing the canal construction, and tenders will be called for as soon as possible. The preliminary work is already well under way, the route having been decided upon and the first surveys being also about complete. It is almost impossible for the contractors to get more than a start this year, but the next five years will see great activity along the line of the "big ditch" across the Niagara peninsula. The canal that is being planned is designed to meet future needs for a long period, and will be one of the greatest works of its kind on the continent.

Niagara Falls, Ont.—Regulation by the state of the amount of water which may be diverted from the Niagara River above the Falls on the American side for power purposes will be provided for in a bill introduced by Majority Leader Wagner, of the United States Senate. The measure, which embodied the recommendations of Attorney-General Carmody, recently submitted to the legislature by the governor in a special message, is designed to repeal practically all outstanding grants for diversion for power purposes and to limit diversions to the Niagara Falls Power Company and the Hydraulic Power Company.. If the measure becomes law, future diversions by these two companies will be restricted to 8,600 and 6,500 cubic feet per second respectively. These are the same restrictions which were contained in the Burton Act, which expired in March last. Provision will be made that the remainder, 4,400 cubic feet per second, not utilized under the Burton law, remain under the jurisdiction of the conservation commission. The bill would vest in the conservation commission authority over measurements of waters diverted and would provide severe penalties for violation.

PERSONAL.

MR. GEO. SMITH, engineer of Lindsay, Ont., has been appointed town engineer of Midland, Ont.

MR. MERVIN D. HALLMAN, of Berlin, has been appointed county road superintendent for the county of Waterloo.

MR. H. J. BOWMAN, M.Can.Soc.C.E., and partner of the firm of Bowman & Connor, consulting engineers, of Toronto and Berlin, has been appointed engineer of the county of Waterloo., Ont.

MR. E. G. AITKEN, chief geographer of the Lands Department of British Columbia, has been elected a Fellow of the Royal Geographical Society of London. Mr. Aitken, who came to the provincial service from the Geological Survey Branch at Ottawa, has had long experience in the United States and also at the Edinburgh Geographic Institute.

STEWART McPHIE, of Hamilton, Ont., has formed a partnership including B. Frank Kelly and E. H. Darling as consulting engineers. Mr. McPhie was for several years connected with the Hamilton Bridge Company. Mr. Darling is a mechanical engineer, graduate of Toronto University, and an associate member of the Canadian Society of Civil Engineers. Mr. Kelly is a member of the Ontario Association of Architects.

MR. R. A. ROSS, acting manager of the Toronto Hydro-Electric System, has made the following appointments on the Hydro staff: Percy E. Hart, as electrical engineer; J. Orr, general superintendent; George Stevenson, general inspector; Geo. Schwanger, as engineer of distribution; J. M. McNeilly, superintendent of meter department; R. J. Lee, contract agent; J. B. Kitchen, engineer of operation department, and G. Devlin, as head salesman.

MR. H. H. COUZENS, general manager and electrical engineer of the corporation of Hampstead, London, Eng., has been appointed general manager of the Toronto Hydro-Electric System. Mr. Couzens has had a wide experience in the practical work of designing and carrying out of the construction work involved in the complete installation of electrical plants, having held important positions on an ascending scale with the corporations of Taunton, Bristol, West Ham, and Hampstead. He will assume his duties in a few weeks.

A. R. KETTERSON, A.M.Can.Soc.C.E., and Associate of the Royal Technical College. Glasgow, Scotland, has been appointed assistant engineer under J. G. Sullivan of the Canadian Pacific Railway, looking after bridge works, western lines. Mr. Ketterson has been in the employ of the Canadian Pacific Railway about seven years. He commenced as field inspector on bridge work in Quebec, Ontario, Alberta and British Columbia. His next step up was the appointment as bridge draughtsman in the office of the engineer of bridges, Montreal, and his third rise was to the position of engineer, designing bridges in the same office. Mr. Ketterson left that position to come to Winnipeg.

The following engineers have been assigned to fixed districts in regards to the hydrographic work of the British Columbia government: F. W. Knewstubb, who surveyed the upper Columbia River watershed; E. Davis, who reported on the watershed of the Kootenay, west of the Selkirks, and the Slocan River watersheds; Clifford Varcoe, who mapped the

Kettle River and Arrow Lakes watersheds; O. F. D. Norrington, who surveyed the Okanagan watershed; W. R. C. Morris, who also reported on the Okanagan; J. F. Rowlands, who reported on the Nicola River watershed; W. R. Pilsworth, who surveyed the Thompson and Bonaparte Rivers.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO SECTION).

The sixth regular meeting of the Toronto section of the American Institute of Electrical Engineers will be held at the Engineers' Club, 96 King Street West, at 8 p.m., on Friday evening, April 25th, 1913.

Mr. E. E. F. Creighton, of the General Electric Company, Schenectady, N.Y., will address the meeting on "Electrical Protection." This address will deal with electrical disturbances and will be illustrated with numerous photographs and experiments. H. T. Case, secretary, 709 Continental Life Building, Toronto.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Sixth regular meeting will be held at the Engineers' Club, 96 King Street W., April 25th, 1913. Secretary, H. T. Case, 709 Continental Life Building, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, A. R. Décary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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