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PROGRESS ON THE ST. LAWRENCE CANAL enlargement is reported as follows by a correspondent in a position to know: The enlargement of the Iroquois section of the Galops Canal is practically completed, and the canal will be opened in a few days. This section extends from Iroquois, on the St. Lawrence River, to a point three miles west, where it connects with the Cardinal Section. The work included 2¾ miles of excavation and embankment, about one mile of this being through the St. Lawrence River. The lock is 800 ft. long, subdivided into two chambers of 530 and 270 ft., 50 ft. wide, and 14 ft. deep on sill at low water; it has a lift of 12 ft. at normal river. The masonry walls are extended on both ends about 250 ft., making a total length of wall about one-quarter mile long and averaging about 33 ft. high. The contract was let to Larkin & Sangster early in 1897. In the balance of that year considerable excavation and embankment was executed and a crib dam with a puddle core was constructed around two sides of the lock pit, enclosing a part of the river. The greatest depth of water was 18 ft. By March 30, 1898, the earth was excavated from the pit and the rock work was commenced, and by July 30, 40,000 cu. yds. of rock were removed. The masonry was commenced about July 1 and by the end of 1898 42,000 cu. yds. had been built, with all the masonry above water level. In the month of September 12,500 cu. yds. of masonry were laid. All work is now done excepting the placing of the gates. This work was designed and carried out under the direction of Mr. T. S. Rutlidge, with Mr. G. C. Carmen as resident engineer, and Mr. R. A. Davy, engineer in charge of lock work.

THE NICARAGUA AND PANAMA CANAL ROUTES are to be visited by a delegation of Congressmen. The trip is being arranged by Mr. Hepburn, Chairman of the Committee on Interstate and Foreign Commerce, and in charge of the Nicaragua canal bill. The government will furnish transportation in a revenue cutter, but the Congressmen will otherwise pay their own bills. They will land at Greytown, pass over the line of the canal to the Pacific, and go down the Pacific side to Panama. The revenue cutter will again meet them at Colon.

EXPORTS OF AMERICAN MANUFACTURES, says the U. S. Bureau of Statistics, made their highest record last March, with $36,025,733, or 25% in excess of any preceding month. In 1898 this value for March was $28,214,450; in 1897, $25,876,861; 1896, $19,125,795. The increase is in nearly all lines, and covers agricultural implements, cotton cloths, chinaware, scientific instruments, including telegraph and telephone, builders' hardware, sewing machines, boots and shoes, etc. In this month, for the first time in the record of exports, manufactures formed more than one-third of the total exports; and in the nine months ending in March the exports of manufactured articles amounted to $242,883,645 against $194,226,695 of imports of manufactures. Both of these, however, have increased during the fiscal year 1899. It is also interesting to note that more than one-half of these exported manufactures go to the great manufacturing countries of the world. Of the 6½ millions worth of agricultural implements exported in nine months, 3¼ millions went to Europe; of bicycles, 2¾ millions in value out of 4 millions went to Europe; and of appliances for telegraph, telephones, etc., nearly 50% went to Europe, and even in watches and clocks, Europe took $511,000 out of $1,392,000 worth.

AMERICAN EXPORTS TO AFRICA, says the U. S. Bureau of Statistics, are now annually nearly six times what they were a decade ago, and nearly three times what they were in 1895. In 1889 the total exports from this country to Africa were valued at $3,496,505; in 1898 they were $17,515,730; and the figures for 1899, up to the present time, exceed those of 1898 by practically a million. These exports are of a great variety. Books, maps and engravings, for example, were exported to the value of $46,940 in the eight months ending February, 1899; as compared with $23,864 in the same eight months of 1898. The other chief gains are in bicycles, builders' hardware, typewriters, boots and shoes, cotton seed oil, lard, lumber, etc. These figures are taken from tables in the "British and South African Gazette," and that journal shows that the British exports to South Africa for February, 1899, are only $32,500 in excess of those for the same month in 1898, while the American exports increased $362,941 for the same month over the February of the preceding year.

AMERICAN BRIDGES FOR RUSSIA have been contracted for with the Phoenix Bridge Co., of Phoenixville, Pa. The contract comprises twelve bridges, and the order came from the Russian Government. The bridges are to be used on the Eastern Chinese Railway, the southeastern extension of the great Trans-Siberian railway. The plans have been received by the engineering department of the bridge works; and work on the structural material will, it is stated, be commenced in a few days and pushed as fast as possible, so that the material will reach Vladivostok before the winter sets in. The material will be shipped to St. Petersburg, and thence transshipped to Vladivostok by rail. M. Teperschoff, of the Imperial Engineering Corpts, St. Petersburg, is now in Phoenixville looking after the work as it passes through the bridge shops.

THE SIBERIAN RAILWAY, says U. S. Consul Murat Halstead, has had opened for it a further credit of $42,626,889 for improving the western and central portions of the line. The sum allotted for the current year is about $8,500,000. This large sum is in addition to $15,707,500 already allotted for the Siberian Railway, and $36,565,000 for other lines, in this year's estimates. Heavier rails are to be used; as the 54-lb. rails laid are too light under the traffic already developed, and 72-lb. rails will probably be adopted. There are already eight trains daily between Moscow and Krasnovodsk, besides the bi-weekly express. Last year's traffic on the western section showed 350,000 passengers, nearly 490,000 tons of freight, and 400,000 peasant emigrants. Of cereals alone 320,000 tons were carried.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Rochester & Lake Ontario R. R., at Rosenhaur's Corners, N. Y., on April 30. The accident happened to an excursion train bound for different points along the shores of Lake Ontario. From press reports it appears that the engineer lost control of the train, which coasted down a steep grade and finally jumped the track on a curve at the bottom. Three persons were killed, 12 others seriously injured, and fully 50 were more or less hurt. It is reported that the air-brakes failed to work owing to a leaky valve.

A TORNADO SWEPT OVER KIRKSVILLE, MO., and that vicinity on April 27, demolishing the eastern portion of the city and destroying everything along a path a mile long and 600 ft. wide. The latest reports state that 52 persons were killed, and fully 130 others were injured.

THE EXPLOSION OF A TORPEDO at the Du Pont Powder Works, Carney's Point, N. J., on April 29, killed five men, one of whom was Capt. Sidney E. Stuart, Ordnance Department, U. S. A., Inspector for the Government at the works. According to reports, the men were experimenting with a torpedo, which was one of a quantity ordered by the Government, when without warning it exploded.

THE SAFETY OF THE MANHATTAN ELEVATED R. R. is questioned in a report made by Sanitary Inspectors A. A. Brennan, W. D. Gardiner and De Witt C. Wheeler to the Health Board of New York city. The report of the inspectors is accompanied by a letter from Chief Sanitary Inspector Dr. M. B. Feeney, which sums up the alleged defects and the remedies proposed for them, as follows:

> Defects of a serious nature exist in both the material and in the construction of the structure on Greenwich St., and because of these conditions an element of insecurity is introduced and the safety of this portion of the structure menaced. Cracked base castings; the evident insecurity of column No 333; the improper alinement of the rails; the defective condition of the old sections of the superstructure, and the excessive strain as shown by lateral sway exceeding the vibration, are indications for the necessity for a thorough reconstruction in order to secure a structure that shall be safe and meet the requirements demanded by its present use. I would recommend that all cracked base castings of columns be replaced by proper new bases; that the base and foundation of column No. 333 be uncovered and such repairs made as shall render said column secure, and provide a stable superstructure; that the old sections of the superstructure be removed and replaced with a structure of quality and design equalling the newer and greater portions; that all decayed ties and guard rails constituting the wood portion of the road be securely replaced; that the track be aligned to gage, and that the two structures, the easterly and westerly, be connected with cross-girders or connections otherwise designed to resist the existing strains; that the entire structure be painted a color combining durability and light, and that pending such reconstruction and repair the use of this section of the road be discontinued if on further inspection it should be found necessary.

The officials of the road deny that the structure is unsafe in any way, and assert that it is regularly and thoroughly inspected and kept in constant repair to insure its present and continued safety. They assert that the changes and repairs urged by the Health Board are unnecessary.

THE LONG ISLAND R. R. TUNNEL under the East River, between New York and Brooklyn, is provided for in the bill which passed the New York state legislature almost at the closing hour of its last session. This bill permits the city of New York to grant a franchise of 50 years with the privilege of renewal for 25 years longer, thus abrogating for this particular work the general 25-year franchise limitation provided for in the city charter. This tunnel scheme was described in our issues of Jan. 14, and Nov. 11, 1898. President Wm. H. Baldwin, of the Long Island R. R., announces that work will be begun at once, and that the company expects to have the tunnel completed in 2½ years.

A GAS RATE WAR IN NEW YORK seems imminent. Two companies, the Consolidated and New York Mutual Gas Light, have announced that beginning May 1 their rates will be reduced from $1.15 to 65 cts. per 1,000 cu. ft. It is said that this is due to alleged encroachments and individual rate-cutting on the part of one or more rivals; also that it is a move towards consolidating the gas companies of old New York. The Brooklyn companies consolidated a few years ago.

STREET IMPROVEMENTS IN IOWA, and perhaps in some other States, have received a setback through a recent decision of the U. S. Supreme Court. It appears that the Iowa Legislature has authorized municipalities in that State to assess the whole cost of paving, sewers and (presumably) other classes of public work upon abutting property, without regard to benefit. A resident of Illinois failed to pay a paving assessment on some property in Des Moines, Ia. The property was sold for taxes, but the sum realized did not equal the assessment. The city sought to levy upon Illinois property held by the defendant and the case went to the U. S. Supreme Court. Justice Peckham rendered the decision, laying down the principle, long well established in some of the Eastern States, and we supposed held universally, that special assessments of this sort could not exceed the actual benefit to the property assessed; otherwise private property would be taken for public purposes without compensation. Even where assessments do not exceed the benefits the court held this law unconstitutional, since under it such a case as that cited might arise. There has been talk of calling a special session of the Iowa Legislature to pass a new act, in order that the cities heretofore depending upon this one for authority to make public improvements may not be entirely stopped from paving and sewerage work.

WASTE PAPER IN THE STREETS of Chicago is now being collected and removed by contract, on a new system, which is being tried for the first time. The Clean Street Co. has placed boxes at various points, in which the paper is thrown. The company has a contract with the city for a term of ten years, paying the city a percentage on its gross receipts. It has also a contract with the Salvation Army for collecting the paper and keeping the boxes clean inside and outside, the army having its own arrangements for sorting the paper before disposing of it. About eight tons of paper are collected each week, and the quantity is said to be increasing. The boxes are of thin sheet iron, with light angle-iron frames and legs, and are anchored to the pavement. A portion of one side is hinged at the top to swing inward. They are about the size of the street mail boxes for the receipt of newspapers and parcels, and cost about $4.50 per box, erected. There are now 1,010 boxes in use (417 on the South Side, 347 on the West Side, and 246 on the North Side), and they are mainly placed on street corners, at the edge of the sidewalk. The boxes are emptied twice a day in the down-town district, and once a day in all other territory. One-horse wagons of light construction are used for this work. The system originated with Mr. George H. Jenney, General Manager of the Clean Street Co., Ashland Block, Chicago, who has applied for patents on the boxes, and who also informs us that he has had correspondence with several other large cities with a view to the introduction of the system. We have briefly commented on this system in our editorial columns.

THE NEW RAILWAY STATIONS AT OMAHA, NEB.

(With full-page plate.)

I.

Introductory.

The city of Omaha, Neb., is a large and important city, and an important railway and commercial center, with extensive manufacturing and industrial interests. It has a population of about 140,500. Some 15 railway lines enter the city, and there are about 80 passenger trains per day. The city has large and handsome public and business buildings, but, strangely enough, it has never until recently had a railway station in keeping with its importance. The numerous railways entering Omaha have all used the tracks of the Union Pacific Ry., and their passengers have had to use a long, low, one-story frame building, which was erected about the time the first transcontinental railway was built. It afforded only limited and fifth-rate accommodation, had no modern conveniences, and was for years a shabby and dirty structure.

A new station, for the joint use of the Union

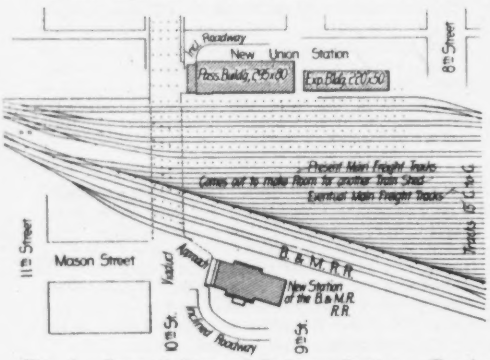

Fig. 1.—General Plan of Railway Stations, Tracks and Approaches at Omaha, Neb.

Pacific Ry. and the Chicago, Burlington & Quincy R. R., was projected in 1889 by the Omaha Union Station Co., of which the Union Pacific Ry. was the principal backer, while the city voted an issue of bonds to assist the project. The site selected was nearly opposite the old building, and close to the 10th St. viaduct. A bridge from the viaduct was to lead to an entrance in the end, while an inclined approach was to run from the viaduct to the main entrance at the rear end of the building, at the ground and track level. The building was to be of brick and stone, with iron floor framing, and was to have all modern requirements. Messrs. Van Brunt and Howe, of Kansas City, Mo., were the architects of this proposed building, a view of which was given in our issue of Aug. 17, 1889. Mr. V. G. Bogue, M. Am. Soc. C. E., then Chief Engineer of the Union Pacific Ry., estimated the cost at $700,000, of which the station building represented $325,000, the balance being for the viaduct, approaches, tracks, land, grading, paving, etc.

Work was commenced on this station in 1890, but when the construction of the lower part of the building was well advanced, the city authorities stepped in and made objections, claiming that the company was not adhering strictly to the plans approved by them, and that certain dimensions had been reduced, so as to provide for a building on a smaller scale than that originally planned. As the city threatened to repudiate the bonds, the company stopped work during the controversy; next came financial troubles for the company, so that work was never resumed, and eventually the project was abandoned altogether. In 1897 the uncompleted structure was torn down and removed. In 1896 a new project was started, providing for a union station nearer to the business section of the city, but nothing came of this. Some of the above particulars were summarized in the "Notes of a Transcontinental Trip," in our issues of July 16 and Sept. 3, 1896.

The Burlington & Missouri River R. R. (Burlington System) took the matter up again on its own account in 1897, and decided upon the construction of a station more befitting the importance of the city and the traffic. The original intention, we understand, was to make this a union station for the use of all the other roads also, but this idea was necessarily abandoned when these roads arranged to use another new station, to be built by the Union Pacific Ry. The Burlington station is now completed and in use, and, strange to say, occupies the site of the old Union Pacific Ry. station.

The financial vicissitudes of the Union Pacific Ry. for some years prevented the matter of providing better station accommodations from being again taken up, but during 1898 the reorganized company had adopted plans, the contract for the execution of which was let in October, 1898, and work was commenced very soon afterwards. The plans are for a union station, which will be paid for and owned by the Union Pacific Ry., but will also be used by five other roads as lessees. These roads are the Chicago & Northwestern Ry., the Chicago, Milwaukee & St. Paul Ry., the Chicago, Rock Island & Pacific Ry., the Kansas City, Pittsburg & Gulf Ry., and the Illinois Central R. R. The station will be on the north side of the tracks, almost on the site of the station begun in 1890, and nearly opposite the site of the old station of the Union Pacific Ry., and the new station of the Burlington & Missouri River R. R., above referred to. The daily traffic of these six roads will amount to about 10 through trains and 47 local trains per day, the latter including trains whose initial or terminal point is Omaha.

Fig. 1 is a general plan showing the arrangement of tracks, stations and approaches. Both stations abut upon the 10th St. viaduct and have entrances therefrom. As already noted, the new Burlington station is on the site of the old Union Pacific station; while the new Union Pacific station is on the site of the union station proposed in 1899. They are both through stations, but it may be noted that the project brought forward in 1896 (which never came to anything) was for a dead-end terminal station near the business center of the city, approached by a spur and Y from the through tracks. In our issue of July 16, 1896, we discussed this project, and took occasion to point out that the dead-end type is ill-adapted for stations having a large through traffic.

Having thus traced the history and development of railway station accommodation in Omaha, we may proceed to describe the two handsome new stations, of both of which that city may well be proud.

The Burlington Station.

The new station of the Burlington & Missouri River R. R., the Chicago, Burlington & Quincy R. R., and the other lines of the "Burlington System" is on the south side of the tracks, and is at an angle to the street layout. A widening of the 10th St. viaduct forms a convenient high level approach, while an inclined roadway leads from this approach to the carriage yard at the rear of the station. This yard is also accessible from Mason St. and 9th St. A view of the station, reproduced from a photograph, is given in Fig. 2, but the pediments will be filled in with sculptured figures. The design is in the Roman Doric order, a style which, as applied to railway architecture, is quite a novelty in this country.

The building is 316 ft. long, 111 ft. wide for a length of 85 ft. at the middle, and 72 ft. wide at the ends. The height from the track level to the parapet is 60 ft. It is a two-story structure, having the main floor on the level of the viaduct, with the baggage-room, employees' rooms, etc., on the lower floor, at the track level. The building is of light gray pressed brick, with columns and base courses of pink Colorado (Platte canyon) granite, and trimmings of buff Bedford limestone. The roof is of Ludowici glazed red tile, while copper and wire-glass are used for the platform and shelter roofs. The roof over the carriageway or porte-cochere at the viaduct entrance is of stone, supported on 4-in. brick arches. The granite is dressed as follows: Column shafts, 8-cut; caps, bases and all molded work, 10-cut; base courses, steps, platforms and walks, 6-cut; the curbing is pene-hammered. The Bedford stone is all rubbed-work. All openings on the lower floor are laid up in round-cornered brick of ¾-in. radius.

The main waiting-room floor is on the upper or viaduct level, and a plan of this is given in Fig. 3. At the main entrance, which is reached by an approach from the viaduct, there is a portico about 30 ft. deep, extending the full width of the building. This portico, including an extension which forms the roof over the carriageway, is supported by 28 columns, 32 ins. diameter at the base and 22 ft. high. This arrangement was designed not only with a view to architectural effect, but also for the purpose of breaking up and dividing crowds. Stone beams rest upon the columns and support a paneled masonry ceiling. At the front of the portico is a pediment which will be ornamented with a design of sculptured figures, the models for which are now being made by Mr. Bock, of Chicago. The portico roof itself is covered with stone. In the middle of that side of the building which faces the tracks is a recessed open gallery with a pediment supported by six similar columns. This pediment will also be decorated by sculpture.

A somewhat difficult problem arose from the fact that the difference in grade between the track and viaduct levels was considered too great to be accommodated in a single story. The problem was solved by placing the main waiting-room floor a few feet below the viaduct level, and making it accessible by a flight of ten broad and easy steps, extending the full width of the building. This feature at first met with some criticism, as presenting a possibility of dampness and discomfort at the entrance in wet or snowy weather. We are informed, however, that this part of the plan was carefully considered in the design, and that during the severe weather of the past winter there has been no difficulty in keeping the entrances in proper condition, as they are well drained and sufficiently protected from snow.

The three doorways of this main entrance open from the portico into the entrance hall, 35 ft. long and 24 ft. wide. On one side of this is a private office, 8 × 19 ft., and the ticket office, 26 × 19 ft. On the other side are a private office and the Joint Agency ticket office, of the same dimensions. The ticket offices have windows for the sale of tickets both in the waiting-room and in the en-

FIG. 2.—VIEW OF THE BURLINGTON STATION, FROM THE VIADUCT.

trance hall. The main waiting-room is 80 × 80 ft., and 34 ft. high to the top of the domed ceiling. Beyond this room is a hall or lobby of the same size as the entrance hall, leading into the women's waiting-room, 29 × 56 ft. This hall is flanked on one side by the restaurant, and on the other side by the news-stand, parcel-room, etc.

In the center of the main waiting-room is a double spiral stairway, arranged with the intent that passengers ascending or descending would naturally take different flights of stairs and thus prevent confusion. The stairways are about 10 ft. wide, and the steps are fitted with Mason's combined lead and steel treads. The ornamental railings are of wrought iron and bronze, and the newel posts are topped with heads of Rocky Mountain sheep, in bronze, after designs by Mr. Kemys, the sculptor. The stairway is designed after the one built by direction of Francis I., of France, at the Castle of Chambord, so that he might pass up and down in sight of his courtiers without conflicting with them. The conditions of movement in the palace, however, are very different from those in a railway station, and we are inclined to doubt whether such an arrangement will meet the convenience of passengers hastening to and from the trains, especially at busy times. Persons are likely to take either stairway indiscriminately, except that those coming directly from the main platform find one stairway facing them. As to the situation of the stairway, it may be remarked that it adds to the noise and bustle in the waiting-room, this room being simply a part of the thoroughfare between the trains and the street. This is an objectionable feature which we have before commented upon.

On the lower floor, the plan of which is shown in Fig. 4, the circular stairway is in the center of a circular hall, 57 ft. 6 ins. diameter, with four radial arms. One arm leads to the carriageway at the street level, while the opposite arm leads to the main platform. The other arms lead into rectangular halls or lobbies. The circular hall cuts off the corners of the central square of the building, and these corners thus form the lunch-room, smoking-room, station master's room and emigrant rooms. These are about 23 × 26 ft., except the first, which is longer. West of the hall is a lobby, 34 × 23 ft., with mail-room, 26 × 19 ft., telegraph-room and conductors' room, the latter being about 17 × 19 ft. each. Beyond this is a 9-ft. passage for trucks, followed by two large express rooms. East of the hall is another lobby, leading into a baggage-room, 54 × 65 ft., and flanked by the men's toilet-room, barber shop, kitchen and lunch-room.

At the back of the station is a curved inclined roadway, 30 ft. wide, affording access from the approach at the viaduct level to the yard at the back of the station, at the street and track level. It is carried by brick retaining walls, with granite trimmings. Under this roadway are placed the boiler-room, coal-room, machine-room and two storage rooms. The roofs of all these are of brick arches, carried by transverse I-beams resting on the brick walls. These rooms open upon a carriage-yard behind the station, which yard is 68 ft. wide, and paved with asphalt. The boiler-room contains two horizontal, multitubular boilers, 5 ft. diameter and 16 ft. long, and also the pump, tank, etc. In the outer wall is a hole 35 × 41 ins., for the breaching leading to the brick smokestack. This smokestack is octagonal in form, 10 ft. 10 ins. diameter at the base, offsetting to 8 ft. diameter above the base. It is 3 ft. 8 ins. diameter inside, and 74 ft. high above the top of the breeching.

The heater pipes are carried from the boiler-room to the station building in a brick-lined tunnel, 3 ft. wide, having 8-in. walls, and a 4-in. arch, with concrete squared up to a thickness of 4 ins. over the crown of the arch. The heating is by direct steam from the boilers, on the single pipe, low pressure, gravity-return system. There are flat radiators against the walls, and circular radiators in the middle of some of the rooms. The building, platforms and inclined roadway are lighted by electricity, taking current from the city lighting circuits, and there are 7 arc lamps and 960 incandescent lamps. The latter are arranged both singly and in groups, in ornamental fixtures.

There is no basement, and the framing of the upper floor is of steel I-beams. The floor construction is partly of brick arches (enameled brick being used to a great extent) and partly of 8-in. and 10-in. porous hollow-tile flat arches. The roof is supported by steel trusses of various spans. Over the waiting-room these trusses are of 60-ft. span, and of somewhat peculiar shape, in order to provide for an elaborate flat-domed ceiling of plaster laid on metal lath.

The interior finish consists mainly of white enameled brick to a height of 12 ft., with a marble cap or string course at this point, and plaster above. The bases, string courses, window sills, etc., are of yellow Sienna marble, and columns of the same stone are used at the arched entrances of the waiting-room, and at the ticket windows. The richly decorated ceilings of the waiting rooms, etc., are in distemper on plaster and metal lath. The ceilings of the lobbies, the cornices, and other decorative work is in ornamental molded plaster. The ceiling of the lower floor, with the exception of the baggage and express rooms, is formed by white enameled brick arches between the beams of the upper floor. The floors on the track level are mainly of artificial stone tile, except in the baggage and express rooms, where mastic is used. On the main floor, mosaic and tile are used, with slate and marble inlaid borders, etc.

On the track side of the building is a platform 30 ft. wide at its narrowest portion, covered by a 28-ft. shed roof supported by columns and trusses. Against the middle portion of the building, however, is a shelter roof 88 ft. long and 48 ft. wide, with triangular steel trusses of 40 ft. span. This roof extends across the track next to the main platform, affording shelter to passengers going to and from trains on the second and third tracks. The trusses of this roof have curved bottom chords, and are supported on steel columns of latticed construction. This roof and the platform shelter roofs, are covered with wire-glass. The island platform has an umbrella roof 15 ft. 6 ins. wide and 550 ft. long, supported by central steel columns with cantilever brackets. This roof, like the one at the end of the station, is of copper. Two tracks separate this platform from a second island platform which has no roof. The station has thus four through tracks for passenger trains, while at the west end of the building are four stub-end tracks for local and branch line trains whose initial or terminal point is at Omaha. These are served by open platforms. The platforms are partly of concrete, and partly of brick laid on edge.

The architects of the building were Messrs. Walker & Kimball, of Boston and Omaha, and all the work was done under their supervision. Mr. I. S. P. Weeks is Chief Engineer of the Burlington & Missouri River R. R. The cost of the station was about $400,000, including the building, platforms, approaches, etc., complete.

The general contract was awarded in July, 1897, to Frank Colpetzer, of Omaha. The sub-contractors were as follows: Structural iron work, the Kenwood Bridge Co., of Chicago, and the Koken Iron Works, of St. Louis; ornamental iron work, Winslow Bros. Co., of Chicago; the Ludowici roof tile and sheet metal work, Miller Bros., of Chicago; stone, A. Schall & Co., of Omaha; granite, Geddis & Seerle, of Denver, Colo.; brick, Omaha Hydraulic Pressed Brick Co.; marble and mosaic work, Grant Marble Co., of Milwaukee, Wis.

The railway company began to use the building for passenger business on July 4, 1898.

In a later issue we shall describe the new Union Station, referred to at the commencement of this article.

THE WET-BULB THERMOMETER, for determining moisture in the air, is made and used as follows, says the "Monthly Weather Review": Provide two thermometers and tie a bit of the thinnest muslin neatly around the bulb of one of these and keep it soaked with water. Lift this thermometer out of the water and whirl it briskly through the air for two minutes, if the air is very dry, and for three or four minutes if the air is very moist. Read it quickly, and it gives the temperature of a thin layer of water evaporated under the influence of the wind produced by the whirling. The dew-point of the air in which the thermometer is whirled is about as far below the wet-bulb as this is below the temperature of the dry-bulb similarly whirled and read rapidly. The two thermometers may be hung side by side on a short piece of string for convenience; and this is then called the "sling psychrometer."

TEST OF THE NORDBERG PUMPING ENGINE OF THE PENNSYLVANIA WATER CO., PITTSBURG, PA.

By R. C. Carpenter, M. Am. Soc. M. E.†

The pumping engine referred to was constructed for the Pennsylvania Water Co., to supply water for the cities of Wilkinsburg, Edgewood, Rankin, Braddock and a portion of Pittsburg, by the Nordberg Mfg. Co., Milwaukee, Wis. The water is taken from the bed of the Allegheny River through an extensive filter-bed constructed in the bottom of the river. A good portion of the water is distributed to towns situated in the Valley of the Monongehela River, and it has to be pumped over a mountainous ridge. The distributing reservoir for the company is situated on the top of this ridge, and with an elevation from 595 to 610 ft., depending upon the stage of the water in the Monongehela River, above the surface of the Allegheny. The water is drawn to the pump from the chambers below the filter through a suction pipe 24 ins. diameter and 600 ft. long. During the time of the test the water in the Allegheny River was quite yellow with mud, but all traces of discoloration were removed by the filter, so that the water pumped was perfectly clear and transparent.

The water passes from the end of the force main into a basin, from which it is discharged over the sill of a weir 3.14 ft. long into the reservoir. The length of the force main is 5,200 ft., and its diameter 30 ins.

The pumping engine is a quadruple expansion engine of the direct-acting type, provided with crank and fly-wheel, driven by means of links, rockers and connecting rods from cross-heads arranged between the steam cylinders and pumps. The pumps are two in number, double-acting, outside packed, one pump being directly beneath cylinders (I) and (III), the other directly beneath cylinders (II) and (IV). This arrangement brings the steam cylinders in tandem, and in each case the lower pressure cylinder is arranged above the higher. Receivers containing reheating pipes are located between the steam cylinders. The lowest part of the machine is a cast-iron base plate, which serves as a suction air chamber and as a support for the whole engine. The entire frame work rests on a base 11 × 18 ft. The total height of the pumping engine is 57 ft. The stability is such that during the tests the vibration at the top of the engine was scarcely noticeable, although the engine in some instances was operated at a speed of nearly 40 revolutions per minute.

The engine was designed for a capacity of 6,000,000 gallons in 24 hours, to be delivered against a pressure of 275 lbs. per sq. in. The boiler pressure to be 200 lbs., piston speed 250 ft. per minute. The size of steam cylinders are 19½, 29, 49½ and 57½ ins., the plungers are double acting, 14¾ ins. in diameter, the common stroke 42 ins.

The valve gears are of the Corliss type, except the exhaust valves on cylinders (III), and all valves on cylinder (IV), which are single beat poppet valves. The clearances for all cylinders is given in the accompanying table.

The principal peculiarity of the engine consists in the arrangement of a series of heaters through which the condensed steam is successfully passed on its journey from the hot well to the boiler, and in which it is warmed by steam drawn from the low pressure cylinder, the receivers and the jackets. The detailed arrangement of this system for heating the feed water is as follows: A surface condenser is employed which is kept at low temperature by large quantities of injection water drawn from and discharged into the suction main. The condensed steam is delivered by the air pump into a hot well, from which it is pumped into an oil purifying tank located on the outside of the building, and standing at a comparatively high level. From this tank the feed water passes to a heater, in which is arranged a series of shelves, over which it falls in drops through the ascending current of exhaust steam from the low pressure cylinder; this heater is under the same vacuum as the condenser, and is termed the exhaust of pre-heater. The water discharged from the pre-heater is pumped into heater (I), which is of similar construction to the pre-heater, heat being taken from the low pressure cylinder, however, for warming the feed water. The steam is drawn into the heater through a pair of auxiliary valves in the low pressure cylinder, which are opened after cut-off, when the piston has traveled ⅞ of the stroke. From heater (I) the feed water is discharged into heater (II) by gravity. In heater (II) the feed water is further warmed by discharge of steam from receiver (III). The water is then pumped from heater (II) to heater (III), where it is warmed by steam from receiver (II), and by the jacket discharge from cylinders (III) and (IV). It is thence pumped to heater (IV), where it is further warmed by steam from receiver (I) and by the discharge of water from the jackets of cylinders (I) and (II) and the reheaters of the receivers.

The temperatures which were actually obtained by the admission of steam as described in the various heaters were as follows: Starting with the water in the outside tank at 88°F., it is raised in the exhaust heater to 105°;

*Abstract of an article in the April issue of the "Sibley Journal of Mechanical Engineering."

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in heater (I), to 136°; in heater (II), to 193°; in heater (III), to 260°, and in heater (IV), to 311°. The temperature rise actually obtained was about 15° less than expected by Mr. Nordberg. The various pumps required for forcing the feed water through the various heaters are compactly arranged, and are all mechanically driven by attachment to the main pumping engine. The work of operating the pumps is included in the test as a portion of the friction of the main engine. The actual work of lifting the feed water from the point of discharge to an elevation equivalent to boiler pressure is about equivalent to lifting 150 lbs. per minute against a head of 500 ft., or about 2.3 HP.

Steam was supplied by a battery of Hogan boilers, and kept during the test at a gage pressure of about 200 lbs per sq. in. The steam for the main engine passed through a separator, the drip of which was returned to the boiler. The various cylinders of the engines were jacketed on the barrels, and the receivers between the cylinders were provided with reheating pipes. Steam for the jackets was drawn from the main steam pipe between the boiler and the separator. The jackets of cylinder (I) were supplied with steam of boiler pressure; it thence passed through a reducing valve and was reduced in pressure to 116 lbs.: thence into the jacket of cylinder (II); it thence passed into the reheating tubes of receiver (III) at a pressure of 105 lbs.; thence into the receiver tubes of reheater (II) at a pressure of 103 lbs.; thence into reheater tubes of receiver (I) at a pressure of 102 lbs.; thence the discharge lead through a trap into heater (IV). Jacket steam for the barrels of cylinder (III) was taken from the main steam line at the same point as the line previously described, and passed through a reducing valve, which lowered the pressure to 40 lbs. per sq. in., it thence passed to jacket of cylinder (IV), in which it had a pressure of 39 lbs., and from thence was discharged through a trap into heater (III).

The contract for the pumping engine guaranteed a duty of 110,000,000 ft. lbs. per 1,000,000 B. T. U., with a daily capacity of 6,000,000 gallons, the duty and capacity to be based on plunger displacement. The contract provided that a premium was to be awarded for any excess of duty. The results of the test indicated a total friction head in both pipe lines of about 3.5 ft.

Three series of tests were planned; the first to be the regular duty test 48 hours in length, during which time all the condensed steam should be carefully weighed, pressure and indicator diagrams should be taken and the water delivered should be measured in order to determine the capacity and duty of the pump on the basis of the contract requirements. The second run to be six or seven hours duration in order to determine the duty of the pump, the economy of the engines, etc., when the feed water heaters were not in operation in order to determine the saving due to the special feed water heaters. The third run to be six hours in duration to be made with the connections so arranged that the distribution of heat to the various parts of the engine could be determined.

At eleven minutes before the end of 36 hours duty run, a gasket in the feed pipe leading from the engine blew out causing a small leak. On account of this the duty run was closed at the end of 36 hours, making corrections for the leak in the feed pipe for eleven minutes of time. Next a test 6¼ hours in length was made without the heaters in use, and two days later a run seven hours in length was made in which the distribution of heat to the various portions of the engine plant was measured.

The arrangements for testing consisted in disconnecting the pipe leading to the boiler and arranging it so that its temperature could be measured when kept under substantially boiler pressure, then passing the steam through a cooling coil of considerable extent by means of which the temperature was reduced to about 110°, then delivering it to a receiving tank.

The general results of the duty test show the duty of the pump to be 162,948,824 ft. lbs. per 1,000,000 B. T. U. which the steam supplied the engine contained in excess of the feed water returned to the boiler.

The duty reckoned on the basis of 1,000 lbs. of dry steam was 150,254,138 ft. lbs. per 1,000 lbs. of dry steam. The indicated horse-power during the test is equal to 712. the dry steam per indicated horse-power per hour was 12.263 lbs., the heat units per indicated horse-power per minute was 185.96. The capacity of the engine on the basis of plunger displacement 6,225,052 gallons against a head of 602.7 ft. During the test hook gage readings were taken at the weir; after the test measurements were made to determine the leakage of the pipe line and pump, also of the amount of water drawn back for cooling purposes and for use of the boiler. The loss from leakage was small and was determined by the rate of settlement in a basin of known area at the top of the discharge pipe. It amounted to 4.73 cu. ft. per minute, or about 0.8 of 1% of the plunger displacement.

The results of the 7-hour test to determine the distribution of heat show essentially the same steam consumption, the amount varying by only a few pounds. The feed water temperature during the heat test was about 10° higher than during the duty run, thus indicating about 1% higher economy on the basis of the heat used by the engine. The test without the heater shows a steam consumption of dry steam of 11.4 lbs. per I. HP. per hour, a duty of 147,525,550 lbs. per 1,000,000 B. T. U. supplied and a duty of 159,824,700 per 1,000 lbs. of dry steam. It will be noted from this that the effect of the heaters is to increase the duty from 147.5 to nearly 163. millions, an amount slightly over 11%. The withdrawal of steam for use in the heaters, on the other hand, reduced the duty on the basis of 1,000 lbs. of dry steam used by the engine in the ratio of nearly 160 to 150. This computation would indicate that the gain from the use of the heaters was not compensated for by the higher economy in steam consumption of the engine when running without the heaters, or, in other words, that there is a distinct gain in using the heat of steam which has done some work in raising the temperature of the feed water.

The results of the test of the engine show on the basis of heat used by the engine an economy considerably higher than that of the famous Milwaukee engine, even when allowing for the higher steam pressure. A portion of this economy can be attributed to higher pressure steam and a quadruple expansion engine, but the greater part is to be accounted for by the use of the special heaters which act to bring the temperature of the feed water much nearer the boiling point due to the pressure of the steam.

The accompanying data shows the dimensions of the engine, the average of the principal observations, and the general results of the duty trial:

Test of Nordberg Pumping Engine, Wildwood Station, Pittsburg, Pa., March 24 to 26, 1899.

Dimensions of Engine and Pump.

Number of steam cylinders...	I	III	II	IV
Length of stroke..........ins.	42	42	42	42
Diam. of steam cylinders.. "	19.5	49.5	29.0	57.5
Clearance in steam cylind'rs, %	1.25	0.55	1.30	0.36

Pump cylinders A and B both had 42-in. stroke, and a plunger diameter of 14.75 ins.; cylinder displacement per revolution, cu. ft., 15.8396; cylinder displacement per revolution, gallons, 118.383; weight of water pumped per revolution, lbs., 988.65; elevation, top of tunnel above sea level, ft., 704; elevation, bottom of tunnel above sea level, ft., 698.

Steam Pressures.—Boiler pressure, gage lbs., 199.87; absolute pressure in boiler, lbs., 214.00; vacuum gage, ins., 26.60; jacket, gage lbs., No. 1, 199.81; No. 2, 116.05; No. 3, 39.78; No. 4, 38.74; receiver, gage lbs., No. 1, 85.47; No. 1, 24.77; No. 3, .90; reheater, gage lbs., No. 1, 102.08; No. 2, 103.69; No. 3, 105.36.

General Data.—Duration of trial, hours, 36; revolutions per minute, 36.52; pressure on gage on force main, lbs., 258.12; head in ft. on force main, ft., 595.57; vacuum gage on suction main, 6.80; total head from gage, corrected, ft., 602.69; total head by survey, ft., 598.625; feed water, lbs. per hour, 8850.4.

Temperatures, Degs. F.—Outside air, 34.9; inside air, 74.1; boiler feed, 310.8; water pumped, 42.65; in outside upper tank, 88.15; in pipe to exhaust heater, 88.06; between exhaust heater and heater I, 104.9; between heater I and heater II, 136.5; in heater II, 193.3; in heater III, 260.43; in heater IV, 311.0; receiver II to heater III, 198.32.

Heat per Pound of Steam.

Calorimeter in main steam pipe.—Temp. in calorimeter, Deg. F., 306.1; back pressure absolute, lbs., 18.65; boiling temp. in calorimeter, Deg. F., 224.3; quality of steam to engine, %, 98.74.

Jacket Calorimeter.—Calorimeter temp., Deg. F., 298.1; Absolute pressure in calorimeter, lbs., 16.70; boiling temp. on calorimeter, Deg. F., 218.7; quality of steam to jacket, %, 97.99; heat per lb. steam to engine, 1189.52; heat per lb. steam to jacket, 1183.23; heat per lb. of steam, 1183.62; temp. of feed water, 310.8; heat absorbed per lb. steam, 909.8.

Work of Steam Cylinders.

Number of steam cylinders....	I	III	II	IV
M. E. P., top................	69.35	12.85	35.16	8.85
M. E. P., bottom	70.68	14.02	33.98	9.33
I. HP., top	77.56	96.58	88.64	89.14
I. HP., bottom	77.55	104.09	84.99	93.63
I. HP., top and bottom........	155.11	200.67	173.63	182.77

I. HP., total, 712.18; feed water per hour, total, 8850.4; dry steam per hour, total, 8732.4; dry steam per I. HP., 12.263; B. T. U. per I. HP. per minute (above feed water temp.), 185.96.

Results of Pump Tests.—Capacity in 24 hours 36.52 revs. by plunger displacement, gals., 6,225,052; work of lifting water from pump diagrams, HP., 662.67; work consumed in overcoming friction, HP., 49.51; work consumed in overcoming friction, %, 6.95; friction head in pipe, difference between survey and gage readings, 2.5 ft. to 4.0 ft.; friction head in pipe, difference between survey and gage readings, %, 0.41 to 0.61; reduced friction of engine, %, 6.12.

Duty of Pump.

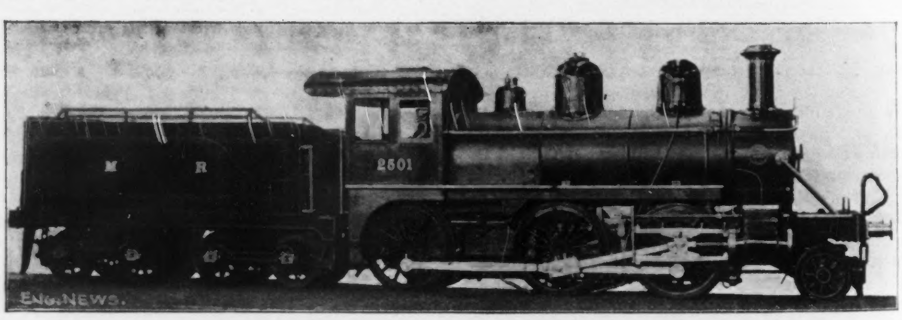
Per one million B. T. U. $\frac{595849.49 \times 2191}{8850.4 \times 909.8} = 162.948824$ millions of ft. lbs.

Per one thousand lbs. dry steam $\frac{595849.49 \times 2191}{8732.4 \times 1000} =$ 150.254138 millions of ft. lbs.

AMERICAN LOCOMOTIVES FOR ENGLAND.

We illustrate herewith one of the locomotives concerning which the British press and public recently became so excited because the Midland Ry. placed orders for them in this country, the English locomotive builders being both too busy and too slow to be able to furnish them within the time required. In fact, the English makers would not guarantee to deliver them in less than 18 months, while the American makers delivered them in about four months from the receipt of the order. The illustration represents one of the 30 engines built by the Baldwin Locomotive Works, of Philadelphia, Pa., and these works have an order for ten similar engines for the Great Northern Ry. of England.

The locomotives which have raised so much excitement and angry talk are plain mogul freight engines, of small size and light weight, and are by no means as handsome in appearance as ordinary American locomotives, owing to certain limitations in size and equipment. The engine has a straight-top boiler, with a short smokebox, and the boiler head is but just within the cab. American practice is followed in the position of the sandbox, but a supplementary box is placed under the running board for back-up movements, all the pipes being fitted with jet devices to blow the sand directly under the wheels. The fittings include the automatic vacuum train brake, spring buffers, chain and screw couplings, and "knives" to knock stones or other obstructions off the track. The tender is short and heavy, with its trucks set very close together, and this use of trucks for tenders is something as yet very novel in England, though not quite without precedent. The tank extends under the coal space and forms the tender deck. A screen plate holds back the coal, the fireman getting his supply through a hole like a fire door. We are surprised, however, to see this plain rectangular box tank without the flaring collar which is so distinctive a feature in English railway practice.



MOGUL FREIGHT LOCOMOTIVE FOR THE MIDLAND RY., ENGLAND.
Baldwin Locomotive Works, Builders.

The leading dimensions of these engines are as follows:

Driving wheels (6), diameter	5	ft.	0	ins.
Truck wheels, (2), diameter................	2	"	9	"
Tender wheels (8), diameter................	3	"	0	"
Driving wheel centers, diameter............	4	"	6¼	"
Journals, driving axles	7	x	8	"
" truck axles	5	x	8	"
" tender axles	4½	x	8	"
Wheelbase, driving	14	ft.	9	"
" total engine	22	"	2	"
" engine and tender................	43	"	0	"

Weight on driving wheels	83,100 lbs.
" on truck wheels	17,150 "
" total engine	100,250 "
" of tender, loaded	79,300 "
" engine and tender	179,500 "
Cylinders	18 x 25 ins.
Slide valves	Balanced, with vacuum valve.
Boiler, diameter of barrel	4 ft. 8 ins.
" barrel plate	⅝-in.
Working steam pressure	180 lbs.
Firebox (Copper)	6 ft. x 2 ft. 9¼ ins.
" depth	6 " 4¾ "
" side, back and crown plates	½-in.
" tube plates	½ and ¾-in.
Tubes, number	263
" diameter	1¾ ins.
" length	10 ft. 5⅝ "
Heating surface, tubes	1,247.1 sq. ft.
" " firebox	125.3 " "
" " total	1,372.4 " "
Grate area	16.6 " "
Capacity of tender tank	3,900 gallons

EXPERIENCES AND LESSONS FROM THE LIFE OF A BRIDGE ENGINEER.*

By John Stirling Deans, M. Am. Soc. C. E.†

The most important attribute of an engineer is a staunch character. The interests placed in his hands are vast and important, involving the success of great enterprises, the expenditure of vast sums, the marring or beautifying of city streets and parks and vistas, and involving also the safety of hundreds of human lives—these interests surely can only be trusted to men of the highest character. The engineer must be able to withstand the strongest pressure, and be able, at all times, to reach correct conclusions and make truthful reports. Sharp practices once entered into, work slighted, or false reports made, are not forgotten, and the engineer or firm so acting is more surely spotted and condemned than the unscrupulous lawyer or quack doctor. The profession is to be congratulated, that instances of breach of trust and professional dishonesty are rare. The report of an experienced and able engineer should, and does, carry with it the same grade of authority as a judge's decision.

Proceeding to the designing of the structures—the preparation of the stress diagram and the design of the general outlining of the structure, while calling for a high grade of ability and experience, demands, if possible, less experience than the detailing. This important work can only be left to the most painstaking and thoroughly trained engineers and draftsmen. The requisite knowledge and experience cannot be imparted by books or lectures; it is only obtained by actual and prolonged experience over the drafting table.

With the work designed and specifications written, it is ready for the construction in the mills and shops. Here the bridge engineer ceases to be the ruling factor; he should, however, maintain a close supervision of the construction, through a careful, intelligent inspection, during the various mill and shop stages and final passing of finished parts; but in the rarest instances should he interfere with or dictate shop practice—it is the final result he is after, and he is not interested in the intermediate steps leading to this result. To check mill and shop results, full size tests are often specified, mainly tests of eyebars; the result of these eyebar tests sufficing to satisfy the engineer that his structure is all right. This, however, has developed, in many instances, into a fad; it really adds but little knowledge as to the condition of the finished structure, composed of many members not eyebars. If general testing of various members is not done, the testing of eyebars might be dispensed with.

With the work finished in the shop, there remains one more stage to the completed structure, a stage which has been neglected by the great majority of engineers, although it offers every inducement and opportunity for the exercise of every faculty of the well-trained mind, both in theory and practice. I refer to the erection of the structure at the site. The engineer, to properly take charge of this field erection, must be familiar with the office to be performed by each member of the structure, and the method of shop construction. In carrying out this work, the engineer must depend upon the skill and fidelity of the bridge erector. These bridge erectors are little known and appreciated, except by those who are brought into close contact with them. They are a body of hardy, active, fearless young men, leading a life which necessarily makes them rough; yet they are tender-hearted to a fault to those in trouble. They are men, in other words, whom you can depend upon to stand shoulder to shoulder with you in all your efforts—to work for you day and night, without rest if necessary, to make a connection safe, when threatened by storm or flood. I number among them many of my best friends.

It is not easy for all men to make even passing acquaintances, much less to accommodate themselves to those in various walks of life, with whom they are necessarily brought in close contact. The successful engineer, however, must have this ability; if not natural, it should be cultivated at every opportunity. Start in early—you cannot begin too soon—in your visits to shops and important works in course of construction during your college course, become acquainted with not only the officers in charge, but meet the workmen if possible. Do not make the terrible mistake of thinking it may detract from your own standing as an educated engineer to associate with intelligent workmen, to talk with them in detail of their individual work, and to be interested in their remarks. Nine times out of ten they can give you valuable information, which will be of use to you in your practice of the profession.

How shall the young engineer enter the field and commence life in earnest? This first step from college is the beginning, and it is all important to take this first step and make these first associations carefully. It is most important to shun influential friends, who have it in their power to place you in positions beyond your experience; remember, it is just as important to progress step by step in the practical work in your profession as it is to follow your regular course in the university.

I would suggest as the first step a position in the erecting department of some well-known bridge company or firm of erection contractors, and the taking up of the work in the same manner as you would in entering a machine shop to acquire familiarity with the use of tools. Start in the gang and learn everything connected with the erection, and further, learn, as you gain in experience, the power of handling men and the business involved in this important part of your work.

After finishing in the field, I would suggest association with an inspecting firm, one that actually and intelligently inspects; there are many so-called inspecting firms to which the name is a misnomer. In this position as inspector you will be expected to see that your specifications and plans are adhered to, and this will not be hard to do if you proceed about it in the right manner. Do not start in by thinking all reputable concerns and contracting engineers are dishonest—on the contrary, they all court intelligent, sensible inspection, and will assist you. A sly, detective manner is not necessary, or "a-know-it-all" air, both of which are sure to bring trouble. While inspecting there is excellent opportunity to study shop practice, etc., and everything gained here will be of great benefit to you in the next step which I would suggest—the drafting-room. The young engineer who has learned to be accurate, has made a long step in advance. This is the first habit to be acquired in the drafting-room. A beautiful drawing is not essential: a correct one is an absolute necessity. A proper experience in detailing takes time; one drawing or many drawings might make simply a good draftsman, but it requires many months of actual work at the drafting-table to make a good engineer. After this training, the next is the designing room, where the general outline and main features of the bridge are decided upon, and where stresses are figured and main features are determined. All of the training at college and the practical experiences gained are needed here, and here the same and even greater accuracy and care must continue.

The four steps I have outlined very roughly compass what I would suggest as the training of a bridge engineer; it can possibly be obtained in ten years, certainly not sooner. Don't push yourself faster than you feel you are moving. Do not let a salary be your first consideration in these years of training, let the experience you are gaining have the greater weight. A proper salary will come later.

*Extracts from a lecture delivered before the students of Lehigh University.

†Chief Engineer Phoenix Bridge Co., Phoenixville, Pa.

CIVIL SERVICE EXAMINATION FOR INSPECTOR OF BOILERS, DEPARTMENT OF PUBLIC WORKS OF NEW YORK.

The New York State Civil Service Commission held an examination at Albany, on April 1, of candidates for the position of Inspector of Boilers and Engines in the Department of Public Works. Through the courtesy of Mr. Chas. S. Fowler, Chief Examiner of the Commission, we are able to present herewith the list of questions used. The duties of the office are akin to those of an Inspector of Boilers under the United States Navigation Laws. He will inspect the boilers and engines of steamboats plying the waters of New York State, and examine and license the engineers for the same. The salary is fixed at $3,000 per annum.

In marking, the practical questions on boilers, engines, etc., counted for 50%, and arithmetic and the candidate's experience and recommendations were considered to make up the other 50%. A mark of 70% was required for eligibility. The questions relating to boilers and engines are given below. The questions designed to ascertain the candidate's education and experience, and his professional and business record we omit:

1. What types of boilers are in use on the steamboats of New York State waters? Describe each type in its usual form and state the advantages and disadvantages of each.

2. In what way do the size of craft and use to which it is to be put affect the desirability of the different types of boiler?

3. How is the strength of a cylindrical boiler determined? Give rule.

4. Describe the most approved method for bracing and staying tube sheets and flat surfaces in steam spaces, giving by sketch the form of braces and stay bolts.

5. Describe in detail the best method of testing a new steam boiler for strength.

6. Describe how you would test an old boiler in place on board a vessel with the conveniences usually found on board.

7. Describe your method of inspecting small and large boilers, old and comparatively new, and their connections, stating the defects to be looked for, etc. State in full for each of the types usually found in lake, river and canal craft.

8. For what causes discovered in inspection would you condemn a boiler?

9. If not condemned, state how you would determine the safe allowable steam pressure in an old boiler.

10. Required the weight on the end of a safety-valve lever with the following data: Steam pressure, 85 lbs.; diameter of valve (circular), 4 ins.; length of lever (from fulcrum), 33 ins.; fulcrum to center of valve, 1 in.; weight of valve, 6 lbs.; weight of lever, 8 lbs.; fulcrum to center of gravity of lever, 13 ins.

11. Should the inspector of boilers and engines make any test of the strength and quality of iron in boilers, old or new? If so, what should be the nature of the test? What is the allowable limit of tensile strength for boiler plates for large boilers?

12. What determines the proper size of safety-valve opening?

13. Describe the steam-engine indicator and its use.

14. Illustrate the use of the indicator by sketching good and bad forms of diagram, and any singular forms of diagram that deserve notice. Describe their peculiarities and state the deductions to be made therefrom and the corrections, if any, to be made in operation of engine.

15. What is the source of economy in a compound engine? What are its advantages and disadvantages?

16. Describe the Stephenson link motion and state its advantages and disadvantages.

17. Describe the operation of an injector. What are its advantages and disadvantages?

18. For reasons of economy, where should feed water be introduced into a boiler?

19. Should oil be used in the cylinders and steam chests of condensing engines? Give reasons for and against its use.

20. Discuss the use of canal, lake and river waters as feed waters for boilers. What are the disadvantages in their use, and what precautions are to be taken to secure economy and prevent damage to boilers and apparatus?

21-24. Give in detail, an examination such as you would give a candidate for license as chief or first engineer of large passenger steamer having low-pressure beam engine. Indicate whether the examination is intended to be written, oral or a practical demonstration on the engines and machinery, or a combination of these methods. Give as far as may be, what you would consider a correct answer to each question proposed and describe the correct manner of performing the practical operations asked for. How far may the practical examination of the engineer be conducted in connection with the inspection of boilers and engines?

25. State what inquiry should be made into the character and habits of candidates for licenses.

HIGH-SPEED SIMPLE PASSENGER LOCOMOTIVES.*

By Clement F. Street.

The writer has recently collected some details regarding the locomotives used in this country in high speed passenger service; and the result will be found in the accompanying tables. These relate to 21 different locomotives which are in use on 18 different roads. Eleven of them have four drivers coupled and ten have six coupled, seven being eight-wheelers, three Atlantic or Columbia, nine ten-wheelers and one a mogul. Some of them are of new designs, which have not been in use one year, while others have been in regular and hard service for many years and are still hauling some of the fastest and heaviest passenger trains in the country. In making a selection no definite plan was followed, and these particular engines are given because they, in the opinion of the writer, represent fairly well the prevailing practice for single expansion engines in fast passenger service.

Table No. 1 gives some of the important dimensions of the engines, and Table No. 2 gives the data regarding the tractive power, heating surface, piston speed, etc., together with averages. In figuring the tractive power 80% of the boiler pressure is used, for the reason that this is the practice with some of the locomotive builders, as well as a number of the railways. It appears that the Master Mechanics' Association has no fixed rule regarding this proportion, and the only information thereon which I can find is a committee report read at the annual convention in 1887. This report contains a recommendation that 80% be used, but the only action of the association seems to have been the acceptance of the report without adopting its recommendations.

It will be noted that in Table No. 2 locomotive No. 12 is not included in the averages. The reason for this is that it can hardly be called a high-speed engine, and it is in many ways a departure from prevailing practice. It was thought best to give it, however, as it is claimed that it is the heaviest locomotive in regular passenger service. Another reason for giving it is the fact that it has frequently been said that this engine was over-cylindered. If such is the case, it is not the only one open to this

*Abstract of a paper presented at the March meeting of the Western Railway Club.

TABLE No. 1.—DIMENSIONS OF AMERICAN HIGH-SPEED PASSENGER LOCOMOTIVES.

No.	Railway.	Type.	Cylinders, ins.	Driving whls., ins.	Weight: Total, lbs.	Weight: On drivers, lbs.	Heating surface, sq. ft.: Tubes.	Fire-box.	Total.	Gr'te area, sq. ft.	Boiler pres., lbs.	Tubes: No.	Tubes: Dia., ins.	Tubes: L'gth ins.	Firebox: Wdth ins.	Firebox: L'gth ins.	Firebox: Type.	Boiler min. dia., ins.	Main journal: Diameter, ins.	Main journal: Lgth, ins.	Valve: Travel, ins.	Valve: Lap, ins.	Steam ports: Lgth ins.	Steam ports: Wdth, ins.	Rail to c. of boiler, ins.
1.	Penn.	8-whl.	18½×26	80	134,500	93,100	1,746.7	171.4	1,918.1	33.0	185	310	1⅞	136¾	40	119⅝	Belpaire.	58⅞	8½	12½	6	1⅛	20	1¼	107½
2.	Wabash	Atlantc	19 ×26	73	160,000	92,000	2,190.3	175.7	2,366.0	29.7	200	300	2	171	42¼	101½	Radial stay.	61	8	10	6	1⅛	19	1⅜	103
3.	N.Y.C. & H.R..	8-whl.	19 ×24	78	136,000	90,100	1,810.0	164.0	1,974.0	31.2	190	288	2	144	45⅝	117 3/16	Crown bar.	60	9	12½	5½	1	18	1¼	102½
4.	C., B. & Q.....	Colmba	19 ×26	84	128,700	84,450	1,442.3	157.2	1,599.5	31.8	200	210	2	158¼	42¼	108⅝	Radial stay.	58¾	8½	12	*6	1	21	1¾	105¾
5.	C.,C.,C. & St.L.	8-whl.	20 ×26	78	130,000	85,000	1,997.0	165.0	2,162.0	31.0	200	320	2	144	41	108	Radial stay.	62	8¾	11½	6	1	20	1⅜	105½
6.	C., R.I. & Pac..	8-whl.	19½×26	78	125,000	83,000	1,795.0	193.3	1,988.3	24.5	190	296	2	139	32⅞	108	Wootten.	61	9	11	6	1⅛	20	1½	101½
7.	Lehigh Valley.	Atlantc	19 ×26	76	142,000	82,000	2,081.2	148.9	2,230.2	64.0	180	216	2	181	83⅜	114⅝	Wootten.	61	8½	11	5¾	1⅛	19	1⅜	103½
8.	Ill. Central ...	8-whl.	18 ×26	75	120,000	80,000	1,649.0	192.0	1,801.0	27.4	200	274	2	139⅛	36⅜	107⅝	Belpaire.	60⅞	8½	11	6	0⅞	17	1¾	104
9.	C. & N-W. ...	8-whl.	19 ×24	75	125,600	78,000	1,715.6	159.3	1,874.9	26.9	190	287	2	138	40⅝	96 3/16	Radial stay.	61	8	11	6	1¼	20	1⅝	104
10.	Atl. C. Line...	Atlantc	19 ×24	72	125,800	73,400	1,913.7	133.5	2,047.2	26.0	180	258	2	171	42	89⅝	Radial stay.	58¾	8	10	5½	0⅞	16	1⅝	97
11.	C., B. & Q.....	8-whl.	18 ×24	69	100,000	66,000	1,298.7	110.0	1,408.7	24.5	180	217	2	138⅛	42	84	Belpaire.	56	8	9½	6	1 1/16	17¼	1½	94½
	Average		18.9×25.2	76.2	129,782	82,459	1,785.4	160.9	1,942.7	31.8	190	270		160 +	44.3	105 +		..	..	..	..	..	..	..	...
12.	Great North'n..	10-whl.	20 ×30	63	166,000	129,500	2,452.0	225.0	2,677.0	35.4	210	303	2¼	166¼	41¼	123	Belpaire.	70	9	11	*7	1⅛	18	2	105⅜
13.	Grand Trunk..	"	20 ×26	72	166,000	125,000	2,272.0	189.0	2,461.0	33.4	200	291	2	180	40¼	120	Radial stay.	62	9½	12	..	..	..	..	...
14.	Southern	"	21 ×28	72	158,000	121,210	2,217.1	192.9	2,410.1	34.9	200	295	2	152¼	41⅞	120	Radial stay.	62	8½	11	..	..	19	1¾	100¾
15.	Wis. Cent.	"	19 ×26	69	150,000	116,000	2,111.0	189.0	2,300.0	32.4	200	308	2	158¼	41⅜	113	Belpaire.	66	9	11	7	1⅛	18	2	107
16.	Balt. & O......	"	21 ×26	78	145,200	113,000	1,978.5	176.6	2,155.1	34.2	190	231	2¼	174½	41	120⅜	Radial stay.	60	8	10	5 13/16	..	..	..	104¼
17.	Northern Pac..	"	20 ×26	69	155,500	112,000	2,288.0	196.9	2,485.0	30.8	220	314	2	168	41	108 3/16	Radial stay.	62	9	11	6¼	1⅛	20	2⅛	102⅞
18.	Ill. Cent.	"	19½×26	69	144,500	109,000	1,854.6	177.1	2,031.7	28.0	200	264	2	161	32⅞	122 11/16	Belpaire.	64	8	10½	5¾	1⅛	20	1½	101
19.	C., B. & Q. ...	Mogul.	19 ×24	69	125,000	106,500	1,553.6	135.5	1,689.1	29.7	180	214	2	148⅞	42	108	Belpaire.	60	8	9½	5	0⅞	17¼	1½	95
20.	Mich. Cent. ...	10-whl.	19 ×24	68	132,000	99,000	1,566.7	137.1	1,703.8	28.5	180	241	2	150	43	96	Crown bar.	57	7½	8½	5½	0⅞	18	1⅝	98
21.	L. S. & M. S...	"	18 ×24	68	118,000	88,000	1,716.0	150.0	1,866.0	27.3	190	241	2	159	41⅜	95 1/16	Radial stay.	56	7½	9	5¼	1	17	1⅝	96
	Average		19.6×26	69.7	146,020	111,921	2,000.0	176.9	2,167.8	31.4	197	270		161.0	40.6	112.6		..	..	..	..	..	..	..	...

criticism, as the relation between the weight and tractive power is only 4.53% above the average of the other nine ten-wheelers given; it is only 1.2% above the highest, and among the eight-wheelers there is one engine in which this proportion is greater. The cylinder volume in relation to the heating surface is less than that of six other ten-wheelers, and it would, therefore, seem that there should be no difficulty in supplying steam.

It will be noted from Table No. 2 that in order to attain a speed of 60 miles per hour with this engine, the drivers must make 320 revolutions per minute, and the piston speed will be 1,600 ft. per minute. In what is to-day termed high-speed passenger service, this speed and much higher must be maintained for long distances, and as it is believed that this is not practical, the statement is made that this engine is not suited for high-speed passenger service. This engine was, I believe, designed to haul heavy passenger trains over very heavy, long grades, and published reports state that it is well suited for this service, and is using much less fuel than engines having shorter stroke and less tractive power.

One of the interesting features of Table No. 1 is the variation in the cylinder proportions and the diameter of drivers. In the eight-wheelers the cylinders range from 18 x 24 up to 20 x 26 ins. Three of them have 19 x 26-in. cylinders, and with these are used drivers 73, 76 and 84 ins. diameter. There are three 19 x 24-in. cylinders, and with them drivers of 72, 75 and 78 ins. are used. No two of the remaining five eight-wheelers have the same size cylinders. In the ten-wheelers, the variation in cylinder dimensions is greater, and the variation in diameter of drivers is less. The cylinders range from 18 x 24 up to 20 x 30 ins., and only two engines have cylinders of the same size. The average diameter of drivers on the eight-wheelers is 76.2 ins., while on the ten-wheelers it is only 68.7 ins. In the former there are five engines having drivers 78 ins. and above, while in the latter there is only one of 78 ins., and the next larger is 72 ins. Seven of this class have drivers 69 ins. and under.

This question of diameter of drivers has been the subject of many discussions, and it is one on which no hard and fast rule can be laid down, as it must be varied to suit conditions of service and roadbed. There was, however, some years ago a tendency to reduce the diameter of drivers from former practice, but of late there has been a reaction, and we find more large drivers in use than ever before in this country. There are good and valid reasons for this change. With the high speeds and long runs now demanded, a small driver must be turned so rapidly for long periods of time that the high journal and piston speeds are liable to give trouble. The wear and tear on the track and the engine itself is excessive.

On one of the trunk lines a certain class of engine was giving serious trouble from hot journals. Delays from this cause became so frequent that there was talk of putting the engines in another service, but before doing so the drivers on one of them were increased 6 ins. in diameter. The result was that the trouble entirely disappeared, and the other engines of the same class were changed with like result, and are now giving satisfactory results where they had formerly failed.

The increase in the diameter of the drivers naturally follows an increase in steam pressure. With the former pressures of 140 to 150 lbs. it was, with large drivers, difficult to obtain sufficient tractive power for starting heavy trains, but with the present practice of carrying 190 to 200 lbs., this does not obtain. It is true that the weight of the trains to be hauled has also been increased, but, on the other hand, the number of stops made by through fast trains is much less than formerly. Runs of from 80 to 100 miles without a stop are now made regularly on a large number of roads, while only a few years ago they were exceptional.

Another change in high-speed passenger service is the introduction of the Atlantic type of engine, and the indications are that this will eventually be the most-used type for heavy high-speed work, where the demands on the boiler are so great that it must be made too heavy to carry on two axles and the truck. This type has many advantages over the ten-wheeler, and it is not apparent just where there can be any advantage in using a third pair of drivers for passenger service, excepting for a few revolutions at starting.* When it comes, however, to a regular heavy, fast passenger service, with comparatively few stops, the Atlantic type is an easier riding, smoother working machine, and is fast coming into more extended use.

There has, of late, been considerable talk about long stroke engines, and some are arguing in favor of them for passenger service. These arguments have, however, very little, if any, solid foundation, and are more in line with the old rule-of-thumb methods than in accordance with modern engineering practice. By referring to Table No. 1 it will be seen that only two of the engines given have a stroke of over 26 ins. If a greater tractive power was found desirable in any one of these engines, it is believed that it would be much better to obtain it by increasing the diameter rather than the stroke of the cylinder. For example, take engine No. 4. The cylinder is 19 x 26 ins., and the tractive power 17 x 72 lbs. An increase of 1 in. in the diameter of the cylinder would give 19,897 lbs. without changing any other part of the machine, excepting a slight increase in the counterbalance to take care of an increase in the weight of reciprocating parts. An increase of 2 ins. in the stroke of the engine would give 19,252 lbs. tractive power, and would increase the piston speed, while running 60 miles per hour, from 1,056 to 1,137 ft. per minute. This increase in the piston speed increases the cylinder wear and the liability to trouble with piston rings. It also makes a much harder riding engine, and increases the wear and tear on both the engine and track. Just why an increase in tractive power, by lengthening the stroke, is better than a corresponding increase obtained by increasing the diameter of the cylinder is not apparent. It is stated that with the long stroke more work is obtained from the steam, owing to a greater expansion. This is true, but at high speeds and the short points of cut-off which go with them an extra inch or two on the stroke amounts to very little. If an engine is working at a cut-off of half stroke or over, as in heavy freight service, each extra inch of stroke means a considerable increase in the power of the engine and also in the work obtained from the steam. Even in this service, however, it is a very easy matter to get the stroke so long that when high speeds are attained, as they must be, and when running down hill the "slam banging" of the machine is hard on the crew and roadbed as well as the engine itself.

No. 1, Pennsylvania R. R.—Eight-wheel type, hauls Pennsylvania Limited, Jersey City to Pittsburg, 444 miles. Station stops, 3. Running time, 11 hours. Average speed, including stops, 40.3 miles per hour.

No. 2, Wabash R. R.—Atlantic type, hauls Continental Limited between St. Louis and Detroit, 431 miles. Number of cars, 3. Weight, exclusive of engine and tender, 164 tons. Heaviest grade, 48⅝ ft. per mile; length, 2¼ miles. Station stops, 17. Running time, 11 hours 50 minutes. Average speed, including stops, 40.7 miles per hour. Aug. 20, 1898, run from Palmer to Norrisonville, 4.6 miles, was made at the rate of 90 miles per hour; from Mitchell to Nameobi, 2.5 miles, was made at the rate of 100 miles per hour. October 6, 1898, run from Clarksdale to Palmer, 3.3 miles, was made at the rate of 99 miles per hour, and from Palmer to Norrisonville at the rate of 90 miles per hour.

No. 3, New York Central & Hudson River R. R.—Eight-wheel, Empire State Express, New York and Buffalo, 440 miles. Number of cars, 4. Station stops, 4. Running time, 8 hours 15 minutes. Average speed, 53.3 miles per hour.

No. 4, Chicago, Burlington & Quincy R. R.—Columbia type, Chicago to Burlington, 205 miles. Number of cars, 4. Weight, exclusive of engine and tender, 200 tons. Number of stops, 2. Running time, 3 hours 52 minutes. Ave. steep, including stops, 53.1 miles per hour.

No. 7, Lehigh Valley R. R.—Atlantic type, Black Diamond Express, New York and Buffalo, 450 miles. Number of cars, 5. Weight, exclusive of engine and tender, 225 tons. Heaviest grades, 47 ft. per mile for 4.5 miles, and 62 ft. per mile for 9.8 miles. Station stops, 14. Running time, 10 hours 40 minutes. Ave. speed, including stops, 42.25 miles per hour. Alpina to Geneva Junction, 44 miles in 42 minutes.

No. 9, Chicago & Northwestern Ry.—Eight-wheel type, Chicago to Omaha, 490 miles. Weight of train, exclusive of engine and tender, 123 tons. Number of stops, 16. Running time, 12 hours. Ave. speed, including stops, 40.8 miles per hour. Run is frequently made in 11 hours, or at an average of 44.5 miles per hour. This engine hauls

*Ten-wheel engines are largely used where heavy trains have to be taken over steep grades at high rates of speed. The B. & O. R. R. engine, No. 16, in the table, is a good example.—Ed.

TABLE No. 2.—Tractive Power, Etc., of American High-Speed Passenger Engines.

No.	Railway.	Type.	Tractive power per lb., M.E.P.	Tractive power: With M.E.P. = to 80% of boiler press.	Tractive power: Weight on driv'rs, %.	Grate area into heating surf.	Cylinder volume: Cu. ft. into heat'g s'rface sq. ft.	Cylinder volume: Cu. ft. into grate area, sq. ft.	Revs. required to run 60 M.P.H.	Piston speed, ft. per M. while running 60 M.P.H.
1.	Pennsylvania	8-wheel.	111.2	16,457	17.67	58.12	237	4.08	252	1,091
2.	Wabash	Atlantic.	128.5	20,560	22.34	79.53	277	3.49	276	1,195
3.	N. Y. Central & Hudson River.	8-wheel.	111.0	16,872	18.73	63.26	251	3.97	259	1,036
4.	Chicago, Burlington & Quincy..	Columbia.	111.7	17,872	21.04	50.29	187	3.73	244	1,056
5.	Cleve., Cin., Chic. & St. Louis.	8-wheel.	133.3	21,328	25.09	69.74	229	3.28	244	1,121
6.	Chicago, Rock Island & Pacific.	8-wheel.	126.7	19,258	23.20	81.15	221	2.72	259	1,121
7.	Lehigh Valley	Atlantic.	123.5	17,784	21.69	34.84	261	....	265	1,147
8.	Illinois Central	8-wheel.	112.3	17,968	22.46	65.73	235	3.87	269	1,264
9.	Chicago & Northwestern.	8-wheel.	115.5	17,556	22.50	69.32	238	3.40	269	1,076
10.	Atlantic Coast Line	Atlantic.	120.3	17,323	23.60	78.73	260	3.30	280	1,120
11.	Chicago, Burlington & Quincy..	8-wheel.	112.6	16,214	24.56	57.49	199	3.46	290	1,160
	Average	....	118.5	18,108	22.08	64.38	235	3.53	265	1,126
12.	Great Northern (not in avg.)..	10-wheel.	190.4	31,987	24.70	75.62	245	3.24	320	1,600
13.	Grand Trunk	"	144.4	23,104	18.48	73.61	260	3.60	280	1,212
14.	Southern	"	171.5	27,440	22.63	69.05	215	3.11	280	1,304
15.	Wisconsin Central	"	136.0	21,760	18.75	70.98	269	3.91	290	1,255
16.	Baltimore & Ohio.	"	147.0	22,344	19.77	62.90	207	3.30	259	1,121
17.	Northern Pacific	"	150.7	26,523	23.68	80.68	263	3.33	290	1,255
18.	Illinois Central	"	143.2	22,912	21.02	72.53	226	3.11	290	1,255
19.	Chicago, Burlington & Quincy.	Mogul.	125.5	18,072	16.96	56.77	214	3.77	290	1.160
20.	Michigan Central	10-wheel.	127.3	18,331	18.51	59.78	216	3.63	296	1,184
21.	Lake Shore & Mich. Southern.	"	114.3	17,373	19.74	68.35	164	3.86	296	1,184
	Average	....	139.9	21,984	19.95	68.29	226	3.51	285	1,214

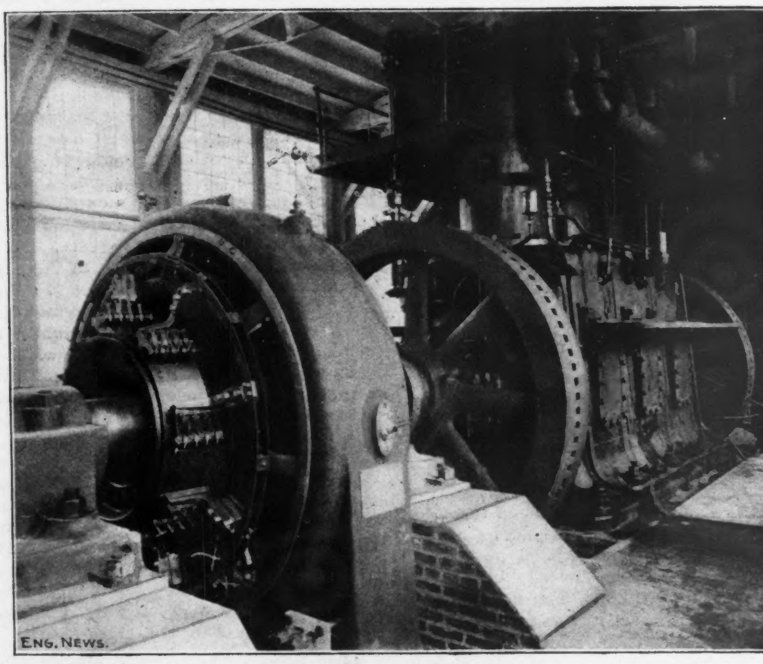
10 or 12 cars, weighing 423 to 513 tons, 138 miles in 3½ hours, making 8 stops, or an average of 39.4 miles per hour. New Fast Mail makes the run in 10 hours 15 minutes, or 46.6 miles per hour, and has hauled this train 138 miles in 133 minutes.

No. 16, Baltimore & Ohio R. R.—Ten-wheel type, Philadelphia to Washington, 137 miles. Heaviest grade, 40 ft. per mile; length, 1 mile. Number of cars, 4. Weight of train, exclusive of engine and tender, 169 tons. Station stops, 2. Running time, 2 hours 53 minutes. Ave. speed, including stops, 47.2 miles per hour. Special runs with 4-car trains weighing 192 tons, Baltimore to Washington, 40 miles, at 66.3 miles per hour. Laurel to Washington, 19 miles, at 74 miles per hour. Regular run, Camden to Washington, with 9-car train weighing 339 tons, 40 miles in 50 minutes, or 48 miles per hour.

No. 19, Chicago, Burlington & Quincy R. R.—Mogul type. Burlington and Creston, 190 miles. Number of cars, 4. Weight, exclusive of engine and tender, 200 tons. Number of stops, 5. Running time, 3 hours 58 minutes. Average speed, including stops, 47.4 miles per hour.

A 650-HP. GAS ENGINE DIRECT CONNECTED TO A 520-K-W. ELECTRIC GENERATOR.

An interesting example of recent progress in the design and construction of gas engines is afforded by the accompanying illustration, reproduced from a photograph taken in the power house of the Westinghouse Electric & Mfg. Co., at East Pittsburg, Pa. The engine develops 650 HP. at a speed of 150 r. p. m., and is said to be the largest gas engine in existence at the present time. It was installed over a year ago, and has been in constant operation ever since.



A 650-HP. GAS ENGINE DIRECT CONNECTED TO AN ELECTRIC GENERATOR.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa., Builders.

Referring to the illustration, it will be seen that the engine is of the vertical three-cylinder type with two overhanging fly-wheels, and in general appearance bears a striking resemblance to the well-known Westinghouse steam engine. It is direct connected to an 8 pole 400 K-W. 550 volt Westinghouse generator, capable of carrying a 30% continuous overload, furnishing current for operating a yard electric locomotive. In general design the engine embodies the main mechanical features of the Westinghouse steam engine, the upright self-contained construction and the self-lubricating features being closely followed.

The cylinders are so arranged that an explosion takes place at each revolution of the engine shaft. The ignition of the explosive mixture is accomplished by an electric sparking device or "igniter" mounted in a small casting, which can be easily removed and replaced.

The fact that the working stroke of the piston alternates so that an impulse is received once each revolution permits close speed regulation. This is further controlled by a sensitive governor, arranged to regulate the amount of explosive mixture admitted with each stroke, and hence control the force of the explosion. In this respect the engine is much the same as a steam engine, and light loads or no loads are accompanied, not by a reduction in the number of impulses, as with the ordinary forms of gas engine, but by a smaller charge of the explosive mixture. Owing to these two factors the engine works remarkably well when direct connected to an electric generator, as shown in the illustration. This is about as severe a regulation test as it is possible to impose, for the slightest variation in speed, one way or the other, is accompanied by a rise or fall of the voltage of the generator, which makes itself unpleasantly apparent at the lamps.

Another example of the satisfactory working of this type of gas engine is afforded by a 65-HP. engine installed at the works of the Consolidated Gas Co., New York city, at its 44th St. plant. This engine has two 12 × 14-in. cylinders and is belted to a centrifugal blower. This engine was started on Oct. 15, 1898, and during the 4½ months between that date and Feb. 28, 1898, the engine ran 3,058 hours out of a possible 3,288 hours. or an average of 22.32 hours per day. During this period the engine was shut down 230 hours, of which only 49 were occupied in taking care of the engine; 26½ hours for changing and improving the igniters, and 12½ hours in taking up bearings and for other adjustments. From Jan. 23 to Feb. 19 a run of 638 hours was made without a single stop.

The consumption of gas by this type of engine, of course, varies with the character of gas used, but in units of 20 HP. and upwards tests show the consumption to be from 10½ to 12 cu. ft. of natural gas per brake HP. hour. In the case of larger units, of say 1,500 HP., one of which the company is now building, it is expected that a considerable saving will be effected over this figure. The makers state that less than one pound of coal burned in an efficient gas producing plant will be required per developed horse-power.

The accompanying table gives particulars of a few large Westinghouse gas engines in use at the present time.

Particulars of a Few Large Westinghouse Gas Engines.

Operated by	Purpose.	No.	Type.	HP., each.
Consolidated Gas Co., New York, N. Y.	Operating coal conveyor	1	2 cylinders.*	..
	Centrifugal blower	1	2 " †	65
Westinghouse Co.'s power house, East Pittsburg. Pa.	Direct-connctd. to generator	1	3 cylinders.	650
Consolidated Gas Co., Long Branch, N. J.	Belted to generator	1	3 "	280
Detroit Copper Mining Co., Buffalo, N. Y.	Power.	2	2 "	25
Bradford Light & Power Co., Bradford, Pa.	Generators	3	3 "	150
		1	3 "	225
Laconia R. R. Co., Laconia, N. H.	Belted to generators	1	3 "	50
		1	3 "	85

*11 × 12-in. cylinders. †12 × 14-in. cylinders.

ALLOWANCES FOR DEPRECIATION IN THE PIPE SYSTEM OF THE LOS ANGELES WATER-WORKS.

A board of four engineers was appointed last year to assist the board of arbitrators engaged in appraising the value of the property of the Los Angeles City Water Co., which the city of Los Angeles proposes to acquire. This board of engineers was made up of Messrs. Jas. D. Schuyler, A. L. Adams, A. H. Koebig and J. P. Lippincott. An important factor in the value of the plant, according to the report of the engineers, was the various items of depreciation. The chief value of the works is in the distribution system and the discussion of depreciation is principally confined to it.

In considering the life of pipe, much importance was given to the character of the soil in which it is placed. Soil, ranging from salty shales and alkaline adobe to heavy clay are classed as poor and the balance as good. Of 25 miles of cement-lined pipe originally laid, only three miles are still in service, the balance having been taken up on account of failure. The remainder of this pipe was particularly well made and heavily coated outside with a high class of natural asphalt. The wrought-iron standard screw pipe now in use in the poorer soils was either undipped or defectively coated. All the pipe in use was classified by age as being 5 years, over 5 and less than 10, over 10 and less than 15 and over 15 years old, the average age for the latter being taken at 19 years. The depreciations established to suit varying conditions were as follows:

(1) Cast-iron pipe in the better soils, 1.25% per annum, which was applied to the mean of the periods in each of the four groups of age.

(2) Cast-iron pipes in the poorer soils, 2% per annum applied as above.

(3) Sheet iron and steel riveted pipe in the better soils, 4% per annum.

(4) Sheet iron and steel riveted pipe in the poorer soils, 6.77% per annum.

(5) Wrought iron standard screw pipe in the better soils, 3.33% per annum.

(6) Same, 5.71% per annum in the poorer soils.

(7) Cement-lined pipe, 2.86% per annum, all of which is classed as laid in the better class of soils, inasmuch as all of that grade of pipe laid in the poorer soils has failed and been abandoned.

We have included in these estimates of depreciation the cost of pipe, lead, gates, laying pipes, taking up and removing pavements, to all of which the rates given have been applied.

For internal depreciation, due to tuberculation, we have estimated as follows:

For all cast-iron pipe 4 ins. in diameter and over, a mean depreciation of 0.6% per annum.

For all cast-iron pipe 3 ins. in diameter, 2% per annum for ten years or under, and 1% per annum over 10 years of age.

For all sheet iron and steel pipe a mean rate of 0.75% per annum.

For all wrought iron standard screw pipe under 4 ins. diameter, a mean rate of 2% per annum for age less than 10 years, and 1% per annum over 10 years.

For 4-in. wrought iron screw pipe, a mean rate of 1.5% per annum of age.

For cement-lined pipe, no internal depreciation.

The above rates of internal depreciation have been applied to the values of the pipes after deducting external depreciation.

The average depreciation of service pipe was assumed to have reached 50%; hydrants, 40%; and meters, 60%. Varying rates were used for the portions of the works outside the distributing system.

It may be of interest to all that the total valuation of the distribution system, reservoirs, pumping stations, and conduits, was fixed by the engineers at $825,091, after deducting depreciation to the average amount of 29.31%. To this sum 10% was added for engineering, supervision and contingencies; to this new figure 6% for contractor's profit; and, finally, 4% was added to the last result, making a grand total of $995,389.

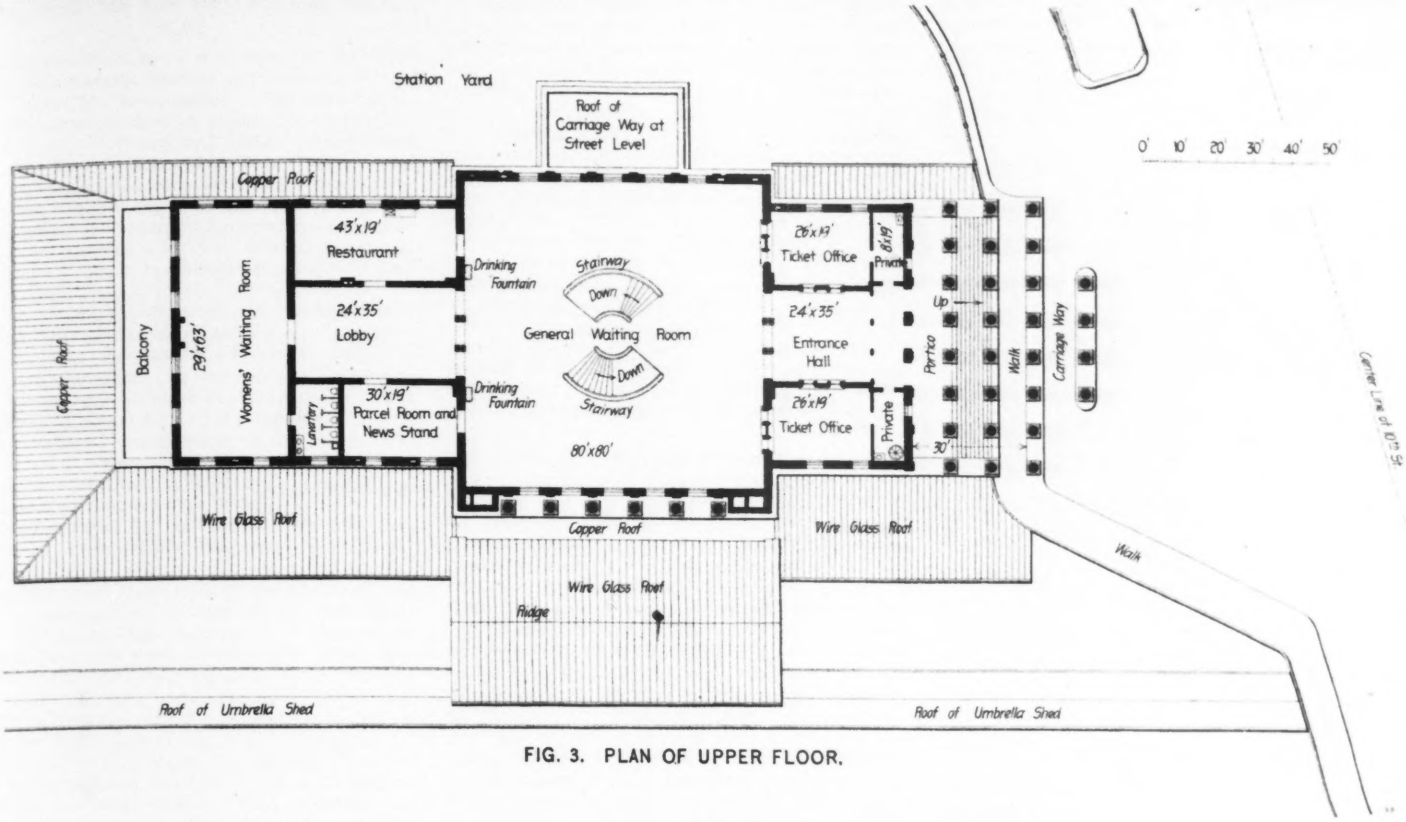


FIG. 3. PLAN OF UPPER FLOOR.

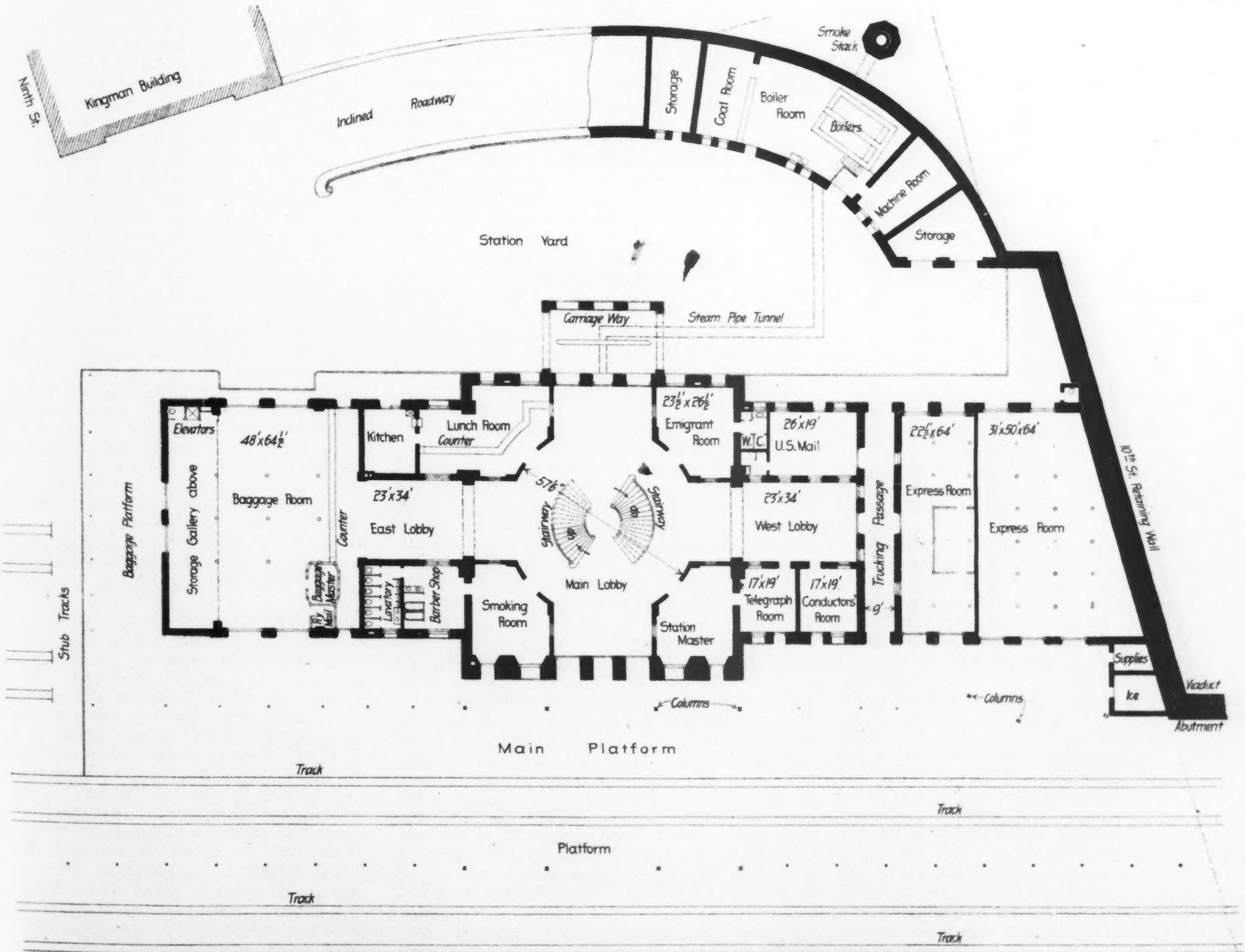


FIG. 4. PLAN OF LOWER FLOOR AND PLATFORMS.

NEW RAILWAY STATION FOR THE BURLINGTON SYSTEM, AT OMAHA, NEB.

Walker & Kimball, Architects. I. S. P. Weeks, Chief Eng., B. & M. R. R. R.

CHAS. HART, LITH., 36 VESEY ST., N. Y.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page XIX. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

A measure of far-reaching importance, known as the Ford franchise tax bill, passed the New York Legislature in its closing hours. The gist of the bill is that hereafter, throughout the great State of New York, all franchises for the use of public streets will be classed and taxed as real estate. At present, where franchises are taxed at all, it is as personal property, and the taxes can be sworn off or offset by indebtedness, such as mortgage bonds. Under the new law the valuation placed by assessors on water-works, lighting, street railway, telephone and other public franchises, cannot be reduced any more than the assessments on lands or houses. What this act may mean to New York city can only be conjectured as yet. An increase of hundreds of millions of assessed valuation and some $10,000,000 to $15,000,000 of taxes is predicted.

Naturally such a measure was strongly opposed by the interests affected. The public was so thoroughly in favor of it, however, that the final votes showed large majorities in each branch. The Senate passed the bill almost unanimously, but the House leaders determined to kill it. This they nearly succeeded in doing, notwithstanding a majority of all the members of the House signed a petition in favor of the measure, and the Governor sent in two messages urging its passage. One of these messages was actually suppressed, but Governor Roosevelt took care that the next one should be so presented as to make its suppression impossible. When it was seen that the bill must go through most of the members of the House took good care to record themselves on the right side, the majority being some 3 to 1.

With the passage of the bill certain franchise stocks in New York city declined sharply, but most of them recovered quickly, indicating that the lasting effect of the proposed tax on such stocks will not be great.

We believe this is one of the most wholesome pieces of legislation ever placed on the statute books of any state, and that it will prove to be of incalculable benefit to the companies themselves. It will tend to equalize the gross inequalities of taxation. By placing a fair proportion of the burden of taxation on the franchise companies a better feeling towards them will arise on the part of the general public, unless the measure is resisted unfairly and unwisely. The companies should see this and govern themselves accordingly. They should realize that this measure, properly carried into effect, may serve to check the wave of municipal ownership now sweeping over the country, and the demand for radical measures of many kinds affecting the interests of franchise companies.

There may be attempts to repeal or cripple the law, but the public is too fully convinced of its justness to tolerate anything of the kind. Graceful acquiescence will be of far more value to the corporations than resistance.

The removal of waste paper from the streets is being done in Chicago on a new contract system. This city is notorious not only for the filthy condition of its streets and alleys, but also for the astonishing amount of waste paper which litters the streets and gutters. Under the new system, which is briefly described in another column, the company which has the contract places sheet iron boxes on the sidewalks, and arranges for the regular collection of the paper which is thrown therein.

The contractor's main object, of course, is to make as much money out of his system as possible, and he is doing this by utilizing the boxes as advertising bill-boards, and they are now so covered with staring placards as seriously to disfigure the streets. Another objection which has been noted is that of fire in the boxes, caused by lighted matches or cigars being thrown into them through carelessness or mischief. Already a number of boxes have been destroyed in this way, the thin metal being warped out of shape by the intense heat. The police have been notified to look out for such practices, and large placards offering a reward for the detection of offenders have been pasted on the boxes.

The contractor proposed to extend the system to other cities, one of his main ideas being to make the boxes in different cities of uniform size and shape, so that an advertiser's printed placard may fit on any box.

We fail to see, however, why cities should enter into any arrangement of this sort. If it were seriously proposed in any city to grant a franchise to a bill-posting concern to place such disfiguring bill-boards in the public streets, or upon the sidewalks, a general public protest would be heard; but this waste-paper collecting scheme practically amounts to the same thing. It may be argued that the boxes, even with their staring placards, are less objectionable than it would be to have the soiled paper inside them blowing about the street. This is doubtless true; but the city should itself provide for the collection and disposal of waste-paper as it does for cleaning the streets from other dirt and refuse. If waste-paper receptacles in the streets are an aid in this work there is no reason why the city should not itself provide them.

Among the encouraging signs of the times are the recent organization of State Municipal Leagues. According to "City Government" such leagues have been established in Connecticut, Florida, Ohio, Illinois, Wisconsin, Iowa, Kansas, North Dakota and California, making nine in all. The general objects of these leagues may be shown by quoting Art. 1 of the Constitution of the Wisconsin League, as follows:

> The objects of this organization, which shall be known as the League of Wisconsin Municipalities, shall be the general improvement and facilitation of every branch of municipal administration by the following means: (1) The perpetuation of the organization as an agency for the co-operation of Wisconsin cities and incorporated villages in the practical study of all questions pertaining to municipal administration. (2) The holding of annual conventions for the discussion of contemporaneous municipal affairs. (3) The establishment and maintenance of a central bureau of information for the collection, compilation and dissemination of statistics, reports, and all kinds of information relative to municipal government. (4) To secure such legislation as may be beneficial to the municipalities of the State and the taxpayers thereof, and to oppose and prevent such as may be injurious thereto.

We think it obvious to all who have paid close attention to municipal affairs that associations with such objects as are outlined above may prove to be of great benefit to the participants, both as individuals and cities. The exchange of opinion and social intercourse among water-works officials, for instance, at their meetings for years past has undoubtedly been of great benefit to the members and the country. Most of the other classes of city officials who have engineering work in charge also have their organizations, which are of great profit to all concerned. Even if the reasons for forming associations for the less technical branches of municipal service are held by some to be less, and the difficulties involved greater, there is still much to be said in favor of their creation. The fact that the tenure of office of mayors and councilmen is shorter than that of water-works officials and city engineers, while in some respects an obstacle to municipal leagues, renders them all the more necessary, for they afford opportunity for the new officials to benefit by the experience of those who are older in service. We are indebted to Mr. S. E. Sparling, of Madison, Wis., Secretary of the Wisconsin League, for a copy of the constitution and first bulletin of his organization.

The railways of the United States pay annually in interest on their mortgage bonds about 250 million dollars, in round numbers. They paid in dividends to their stockholders only about one-third of this sum, or about 87 million dollars, in the last year for which figures are available. There are not wanting indications, however, that in future the tendency will be to increase the payments to stockholders, and decrease those to the bondholders. The fall in current rates of interest on first-class securities offers an opportunity to refund debts and reduce fixed charges, of which one great company after another is taking advantage. The refunding of the bonded debt of the Lake Shore & Michigan Southern, in 1897, on a 3½% basis, is still fresh in mind. The old bonds which these replace bore 7% interest. The Interstate Commerce Commission's statistics show that about 20% of the railway bonded indebtedness bears interest at 6% and upward, and 48% more bears interest of from 4 to 6%. Under the financial conditions which will probably exist in the near future, it is likely that at least 60% of the outstanding railway bonds can be funded at 3½%, and 3% will doubtless be reached on issues of first-class roads.

The Chicago, Burlington & Quincy Co. has just announced the authorization of a new issue of 50-year bonds to the amount of $85,000,000, of which $16,166,000, bearing interest at 3½%, are now offered to the stockholders, to retire outstanding issues bearing interest at 5 to 8%. This is but a sample of the change in railway financial methods now in progress which will place railway properties on a sounder financial basis, their fixed charges being reduced to such a point that they can be readily met, even in the worst of years.

Elsewhere in this issue is an abstract of a report of a test of a Nordberg pumping engine operated by the Pennsylvania Water Co., at Pittsburg, Pa. The results obtained indicate a remarkably efficient engine, and in comparison with the duty and economy figures of the engines given in the accompanying table it has established a new record for efficiency.

Pump.	Location.		Actual capacity, gallons per 24 hrs.	Duty, Per 1,000,000 B. T. U.	Duty, Per 1,000 lbs. dry steam.	Lbs. of steam per I. HP. hr.
Nordberg	Pittsburg, Pa.	With heaters	6,225,052	162,948,824	150,254,138	12.26
		Without heaters.	....	147,525,550	159,824,700	11.4
Leavitt	Chestnut Hill, Boston, Mass.		....	141,855,000	....	11.2
Snow	Indianapolis, Ind.		20,600,000	150,100,000	167,8[illegible],000	11.26
Allis	Milwaukee, Wis.		18,331,364	137,656,000	154,048,704	11.678

INVESTIGATING THE NEW YORK BUILDING DEPARTMENT.

The investigation by a committee of the New York Legislature of various departments of the New York City Government, which was begun on April 8, has resulted in exposing to public attention some very curious things in connection with the New York Building Department. The sessions which have been held at intervals during the past month are to be resumed on May 16. This seems a favorable time, therefore, to gather up and summarize what has been brought out thus far by the committee investigation in this especial field.

Readers of Engineering News will remember that some peculiar things in connection with the New York Building Department were made public in this journal in 1897. In our issue of February 4 of that year we reviewed at length the action of the Board of Examiners of the Building Department in refusing applications for the use of fireproof floors of concrete construction and requiring hollow tile to be used in its stead. The fight of the makers of concrete floor systems to have their systems approved by the Department was carried on all through 1897. They went to great expense to make elaborate tests showing the strength of these floors both under loads and under the most severe ordeals of fire and water that could be devised. The Board of Examiners, although the tests were arranged for by the Superintendent of the Building Department, refused to recognize the tests or to take them into consideration as an argument for permitting the use of the floors which passed the ordeal successfully.

They continued to refuse applications for permits to use concrete floors and to give no reasons whatever for their refusal. They in effect declared that they were the supreme authority, empowered by law to exercise their discretion and not obliged to state any reasons, as to why they granted a permit here and refused one there.

Of course, under these circumstances, the concrete fireproofing companies were practically driven out of business. Every architect knew of the way the owners of the Bowling Green building were harassed because of the use of the Roebling floor system in it, and of the treatment which Hon. D. O. Mills and his architect, Mr Arthur Flagg, received because of the use of the Expanded Metal floor system in the first Mills Hotel. Naturally no architect would continue to specify any system of construction, no matter what its merits, with the knowledge that its adoption would mean a long fight with the Building Department, vexatious delays and probably a final refusal. Those in charge of the Roebling system made a gallant fight for the adoption of their system in the Park Row 30-story building. The owners strongly desired to use it, since it meant a saving of $25,000 in the fireproofing cost besides a much reduced load on the ironwork and foundations. They even carried the matter into the courts and endeavored to have the Board of Examiners show cause why the system should not receive their approval. All the efforts were unavailing, however, and the building was fireproofed with hollow tile, some specimens of the work being illustrated in our issue of April 14, 1898.

So much by the way of preliminary explanation, now let us turn to the facts which have been brought out by the testimony before the Mazet Committee. It appears that early in the present year the Roebling Construction Co. was formed and took over the fireproofing business of the John A. Roebling Co., Mr. Frank Croker, a son of Mr. Richard Croker, was made secretary of the new company at a salary of $2,500 a year, and he owns 170 of the 500 shares. Mr. Croker is a young man just past 21, who graduated from college last June, and he testified that he was "learning the business" to earn his salary. He also declared that his father gave him $17,000 in currency which he paid to the treasurer of the company for the stock which he holds.

Since this new company was formed the Roebling construction appears to be no longer turned down as of yore. On the contrary, everything is made smooth for it. Recently the specifications of a new school building for the city were altered to permit either hollow tile or the Roebling construction, specifying the latter by name. General specifications for the fireproofing of school buildings were issued by the City's Department of Education in February and contain a verbatim copy of the description of the Roebling system in the Roebling catalogue. This system, and this only, was specified as the fireproofing to be used. Even the tile was turned down. In the Borough of Brooklyn, an architect who specified expanded metal floors, which are practically identical with the Roebling, for an addition to the Brooklyn Warehouse & Storage Co., was told at the Department of Buildings that only one concrete system, the Roebling, could be used. It is also of interest to note that the Roebling Co. some time ago retained as counsel one Chas. E. H. McCann, a nephew of Richard Croker and a Deputy Assistant District Attorney. Mr. McCann is a young man, apparently under 30. His retaining fee was $5,000.

It further appears that Mr. McCann's name is one to conjure by. The Roebling Company had found such good results from his employment as its counsel that the manager, Mr. Himmelwright, suggested to Mr. Watson, of the Expanded Metal Co., and Mr. Wright, of the Columbian Co., that Mr. McCann was a very proper person to look after their interests in certain lines.

It should be explained here that a commission to revise the New York Building Law was recently created, and has been holding "hearings" preparatory to the work of framing amendments to the law. The Roebling company employed Mr. McCann to appear before this commission and advocate such a framing of the law as would permit the use of the Roebling system, and Mr. Himmelwright proposed to Messrs. Watson and Wright that their companies might also employ Mr. McCann for the same purpose, his fee for such appearance being only a little matter of $5,000 to $10,000.

The suggestion to Mr. Wright appears to have borne fruit, as we shall see later on. The suggestion to Mr. Watson also bore fruit, but of a different sort. Mr. Watson testified that in accordance with Mr. Himmelwright's suggestion he had an interview with Mr. McCann in the Roebling company's office, lasting some three-quarters of an hour. Mr. McCann offered to appear before the Building Code commission to present the claims of the Expanded Metal Co. and said that if the law as finally framed permitted the use of the Expanded Metal system in buildings not over 100 ft. in height, his fee would be $10,000. If its use was made legal for buildings of a greater height, the fee would be larger. If the law was not framed so as to permit the use of the Expanded Metal system, notwithstanding Mr. McCann's persuasive oratory, then he would make no charge at all.

To this proposition Mr. Watson replied that he would have to consult his principals. A week or so later Mr. Chess and Mr. Golding, of the Expanded Metal Company, met Mr. McCann by appointment and he repeated substantially his offer to Mr. Watson. They asked him why, when the Roebling construction was approved without trouble, under the present law, it was necessary to have the law altered to obtain approval for the Expanded Metal system, which, so far as strength and safety is concerned, is practically identical with the Roebling. This question, however, was too much even for Mr. McCann's expensive legal mind.

The Expanded Metal Company's construction is being erected and accepted without question in all other cities of the United States, and is also in use abroad. It is nothing new, but has been in use for many years. The managers of the company, we understand, have no idea of employing Mr. McCann. They propose to do business in New York in an honest business way, and they have refused and will continue to refuse to pay tribute to anybody for the privilege, preferring rather to abandon their business if compelled so to do.

Mr. McCann, in his testimony, was compelled to assent to the correctness of the statements of Messrs. Watson and Himmelwright. He modestly remarked that he thought that he was a rather young man to handle the matters in question alone. We extract the following gems from the verbatim report of his testimony:

Mr. Moss—Was the amount of your compensation mentioned at that time? A.—We had some little discussion as to what my services would be worth.

Q.—Name the amount. A.—In a rough way, if I remember, Mr. Himmelwright was present at the time. I think it was $5,000 or $10,000; something like that. I am not sure.

Q.—Is a matter of $5,000 or $10,000, the difference between the two, so slight that you don't recollect which it was? A.—No, not that.

Q.—You don't undertake to say you don't know which it was, $5,000 or $10,000? A.—Let me explain that. That, at that meeting, was not considered of any importance. The first thing was whether this law could be complied with and whether these people could come under that law.

Q.—You don't mean to say that your professional fee was so slight a matter as not to enter into the business engaged in? A.—In this case, I thought I could handle that, but at that time, I imagine, under the law, that some constitutional questions might come up, and——

Q.—What constitutional questions could come up in the construction of a fireproof plan like that? A.—As I say, the question might come up whether the system was infringement, whether there was an infringement of a patented system, in the sense——

Q.—What constitutional questions belonged to that? A.—In interpreting that law——

Q.—You thought there might be constitutional questions which would arise? A.—In the construction of the law, if you want to put it that way.

Q.—You phrase it. What was this question which was troubling you? A.—Whether the systems, as they made their construction at the present time, could be used in view of the law, supposing they would be legal. I had not looked at the matter at this time.

Q.—You were considering the great constitutional questions that were involved more than you were the engineering questions? A.—I did not lay great stress on them. I laid stress on the merits of their fireproofing material, and they placed in my possession everything necessary pertaining to the merits, so that it could be laid before the commission, so when we went before the commission we could answer such questions.

No more lucid explanation could be obtained from Mr. McCann as to his reason for setting so exalted a value upon his services. Certainly if his proposed arguments before the Building Code Commission were to be similar examples of clear statement, the value of his services could hardly be estimated.

Naturally, in view of the above relations as to the position of Mr. McCann and Mr. Frank Croker in the Roebling Company, and the happy fortune which appears to attend that company of late, the public were anxious to hear what Mr. Richard Croker might have to say in explanation. Mr. Croker was given an opportunity to explain upon the witness stand; but he refused to say whether he had given his son money to buy his stock in the Roebling Company, declaring that it was his private business.

Next let us see how some other concrete fireproofing companies are faring. Mr. Geo. S. Hayes, Assoc. M. Am. Soc. C. E., is associated with Mr. Wm. P. Tostevin, as the Tostevin-Hayes Fireproof Construction Co. Mr. Hayes testified that John A. Dooner, Superintendent of Buildings of the Borough of Manhattan, advised him to go and see one Con. Daly and agree with him on "terms," and he would then have no more trouble with the Building Department. Mr. Tostevin testified that he went to see Daly, whom he found behind the bar in his saloon. After some conversation Daly said that the Building Department's approval could be secured if he, Daly, were given $2,000 of stock. He also stipulated that he should be made a director of the company.

Messrs. Tostevin and Hayes did not care to do business on that basis, and Mr. Tostevin informed Commissioner Brady of the acts of Dooner and Daly, and Brady promised to investigate the matter. Mr. Dooner still holds his place however. Later a client of Hayes and Tostevin, who desired to use their system, again saw Daly and was told by him that he had seen Commissioner Brady and had been told that the Hayes-Tostevin system could not be used on any building in New York. A system practically identical, installed by a competitor, however, received approval. Mr. Hayes also testified that his company was the lowest bidder for the fireproofing of the Catholic Protectory building. Both the general contractor and the architect for the building told him, however, that the Columbian Company, who were higher bidders, "had the Department fixed" so that the Hayes company had no chance. Notwithstanding this Mr. Hayes persisted in his application and appeared before the Board of Examiners in support of it, offering to explain anything the Board desired to know. Mr. Samuel McMillan, of the Board, then asked why he did not use the Columbian system, and informed him that

the Board considered that system better than his. The Hayes system was illustrated in connection with the report of a test of its fire-resisting qualities in Engineering News of Nov. 12, 1896. The Columbian system was illustrated also in connection with a test in our issue of Jan. 7, 1897. We leave it to our readers to compare these two systems and form their own conclusions as to the reasons of the Board of Examiners for refusing one system and allowing the other.

At the session of the Committee on Saturday, April 22, Mr. Wm. J. Fryer, of the Board of Examiners of the Building Department, was placed upon the stand, and his testimony was of exceeding interest. If any of our readers have believed us too severe in our editorial criticisms of the Board of Examiners, we suggest that they obtain a copy of the New York "Tribune" of April 23 and read the verbatim report of Mr. Fryer's testimony. Our space permits only the briefest abstract of some of its most salient points, as follows:

In the first place it appears that no less than five members of this Board are, or have been, associated in business together as "The New York Building & Land Appraisement Co." These five are Mr. Fryer himself, the Mr. McMillan mentioned above, who was so anxious to turn down the Hayes fireproof system and approve the Columbian; Mr. Cornelius O'Reilly, Mr. Warren A. Conover, and Mr. Thos. J. Brady the present head of the Building Department. Mr. Fryer is in business also by himself as a "Consulting Architect, charges high; services good," to quote from his published advertisement, which has appeared for several years in the "Record and Guide." As an example of his business, he testified that for "advice and directions," in regard to one building which was undergoing alterations, he received a fee of $750. The plans for this alteration were first presented to the Board of Examiners, which refused its approval. The owner then engaged Mr. Fryer to advise him what should be done to make the plans acceptable to the Board. Mr. Fryer gave him the advice, received his $750, and the revised plans were presented to and received the approval of the Board. This is merely a sample case in Mr. Fryer's business. He further testified that he had "frequently" been retained as "Consulting Architect" on matters on which the Board of Examiners had to pass. In all such cases, however, he refrains from voting upon the application in the Board. His abstinence from voting, he admitted, amounted really to half a vote in favor of his own application, and in addition was a notice to his colleagues on the Board that the matter was one in which he was acting as "Consulting Architect." So far as he could recall, none of the plans in which he was interested had ever been rejected by the Board. He saw nothing improper or immoral in retaining his membership in a board of judicial character and at the same time accepting fees to secure the passage of applications by that Board. He feels perfectly satisfied with the present condition of things in the administration of the building department, which, in view of the testimony quoted above, is not altogether surprising.

Here is another interesting incident of Mr. Fryer's career. In 1895 he gave a letter to a Mr. Young, of S. McMillan & Co. (the same McMillan who is referred to above), introducing him to Mr. Chas. C. Haight, the architect, and asking Mr. Haight to give him an opportunity to make estimates on the iron work of some building of which Mr. Haight was the architect. Mr. Haight, unluckily, did not recall at the moment who Mr. Fryer was, and asked Mr. Young to tell him. Mr. Young went back in high dudgeon, and when he told Mr. Fryer that Mr. Haight had asked him who Wm. J. Fryer might be, Mr. Fryer was in higher dudgeon. He forthwith sent a letter to Mr. Haight, from which we quote as follows:

> Mr. Young told me after seeing you that you did not seem to know who I was. . . . I write now to say that it may turn out at some future day that you will know who I am. You may sometime have something else similar to your club building alterations, and something else akin to your American Theatre case, etc. . . . .

This letter was written on the paper of the "New York Building & Land Appraisement Co.," with the names of five members of the Board of Examiners upon it as officers, as referred to above.

Turning again to the Board of Examiners, Mr. Fryer testified that they held one session each week, and on the session preceding the date of his testimony they passed upon 77 cases in a session lasting a little over three hours. He also testified that the cases before the Board presented architectural difficulties and engineering problems of magnitude, and left the committee unenlightened as to how such matters could be railroaded through at such speed.

His testimony on fireproofing matters was unique. He admitted that he had at one time held stock in a terra cotta company, and from his knowledge of the system then gained had conceived a certain affection for it. He had repeatedly voted against the J. W. Rapp concrete floor system in the Board of Examiners, and yet he gave an opinion to the Controller of the City approving the rental of a building for city offices in which this floor had been used. He claimed that he gave this opinion, however, under a private agreement with the owner that he would remove the Rapp system and substitute hollow tile. For this opinion, he acknowledged, after considerable pressure, that he was to receive $150, in case the rental of the building was effected, from the agent of the building. Notwithstanding his opposition to the Rapp system, he testified that in the revision of the building law he would make provision for all the fireproofing systems, including the Rapp.

Mr. Fryer is a member of the Board which is charged with the duty of revising the Building Law. He was appointed, he supposes, "because of his acknowledged fitness for that kind of work." It is interesting in this connection to note his remark that in the new law it is proposed to reduce the standard loading per square foot for school buildings to 60 lbs., whereas in the present law 70 lbs. per square foot is required for dwellings and 120 lbs. for places of public assembly. Mr. Fryer also remarked that he preferred cast-iron columns to columns of steel or wrought-iron.

Mr. Fryer besides his strictly professional work does something in a literary way for the "Record and Guide," already referred to. He evinced great disinclination to speak of it, however, and only after much pressure and when confronted with a copy of the paper did he admit writing for the above journal an article advocating the giving of presents, such as drinks, cigars, a suit of clothes, or some other "substantial" gift, to the official inspector of the Building Department in charge of a piece of work.

We may not take space for farther evidence as to the conspicuous unfitness of Mr. Fryer to continue in the position which he at present holds. The fact that he has been a member of the Board of Examiners for ten years is conclusive proof that the system by which the Board of Examiners is created is radically wrong. As our readers will recall, this Board is made up chiefly of the representatives of half a dozen trade and technical societies. These representatives are not responsible to the people, to any public official, or even to the societies whose delegates they are. They are accountable to nothing save their own consciences, and that organ, as is well known, sometimes suffers atrophy by disuse.

In our issue of Feb. 4, 1897, we reviewed and condemned in the strongest terms the action of this Board in favoring tile fireproofing construction and refusing permits for the use of concrete floors. Its actions of more recent date lack even such small measure of consistency as they formerly possessed, in that some concrete systems are refused and others are permitted, in a manner which suggests anything but an impartial and judicial attitude on the part of the Board.. In view of the revelations of Mr. Fryer, it is to be hoped that the Mazet committee will elicit further information concerning this Board's proceedings until public opinion shall be educated to the point of demanding its abolition.

The committee will also do well to investigate the composition of that remarkable commission which is revising the city's building law. Let us see whether it has any other members who are in the practice of accepting fees for professional advice with one hand and writing an official approval of that advice with the other. Let us learn why oratorical argument before it by youths of potential relationship commands so high a figure. Let us know why all the attempts of well-known citizens to have the new Board made up of acknowledged experts in engineering and architecture were fruitless. Let the public be informed why the same old "New York Building & Appraisement Co." coterie, Fryer, Brady and O'Reilly, who have so long dominated the Board of Examiners, are put upon the commission to frame a new law. Let all these men, and also their colleagues, Gallagher, McCafferty, Guilfoyle, et als., be given an opportunity to display on the witness stand the depths of professional knowledge and high expert attainment which have caused their selection for such important and responsible duty.

LETTERS TO THE EDITOR.

The Calculation of Stresses in the Bonn Bridge.

Sir: Referring to the latter part of Mr. A. R. McKim's letter, published in your issue of April 27, in which comment is made on an engineering feature of the Bonn Bridge, viz., on the curvature of the chord members of the arch ribs, I do not agree with Mr. McKim's statements for the following reasons:

There is no reason why a curved chord member of the arch truss, and, in consequence, the eccentricity of the stress acting in said member, should affect the remainder of the framework any differently from what the same member would if it were not bent, and was subjected to axial stress only. Therefore, the eccentricity has a purely local effect on the respective member, and does not complicate or render more statically indeterminate the framework as a whole, and can, without involving objectionable statical complications in the rest of the truss, be readily taken care of by a handy and perspicuous formula, such as given. The only real objection to the bending which might be made, and the designer was well aware of it, is the apparent waste of material, which, as before stated, amounts to 20% or even more, and forms a considerable item in a heavy and large structure like the Bonn Bridge. But if it is considered that additional metal in the chord members, and thus in the most appropriate place of a bridge, greatly adds to the general rigidity of the structure and also provides against oscillation and unforeseen conditions of strains, then the seeming waste of material loses a good deal of its objectionableness.

Finally, I beg to differ from Mr. McKim's opinion that the two-hinged arch is "a form of truss full of difficulties and uncertainties." The two-hinged arch is a single, statically indeterminate framework for which it does not afford any difficulty correctly and reliably to establish the true values of stresses under any load. The practical application of mathematical resources known as the "theory of elasticity" in connection with the theorem of Maxwell and others, has been developed to such a high standard within recent years that the well versed civil engineer will hardly find any problem beyond his efforts to calculate successfully. There undoubtedly exist—outside of the indeterminate quantity—unknown moments and stresses at every panel point, owing to the fixed joint connections, but because of these stresses we should no more designate the system as complicated than we would in speaking of a simple riveted Howe truss where the same secondary stresses occur. As a practical proof of the fact that the stresses figured in the manner above outlined are not after all a work of fiction, I beg to draw your attention to measurements of stresses made by means of measuring appliances directly attached to a member of the bridge. I do not recall whether such measurements have been taken at the Bonn Bridge, but I know that the carefully figured stresses of the well-known Muengsten Bridge in Germany have been satisfactorily corroborated by such means. This latter structure is an arch without hinges, therefore it is threefold statically indeterminate, and for that reason would be far more than the Bonn Bridge subject to uncertainties if such actually existed.

Respectfully yours,

Fritz Mueller von der Werra, C. E.

22 William St., New York city, April 28, 1899.

Engineering Notes in Porto Rico.

IV.

Sir: In the past week I have seen some of the most interesting portions of the interior of the western part of the island. In this time we have journeyed over short stretches of military road near the coast, but the larger part of the trip was over so-called second-class or cart roads, which are in no place better than poor trails, and in some places over trails which were scarce worthy of being dignified by that name.

At Ponce we were provided by the army with good Western saddle mules, a couple of pack mules and two civilian packers. The first short day's journey was to Adjuntas, about 18 miles northwest of our starting point. The first 12 miles of the way was up the valley of the Rio Magueyes to the divide between that river and the headwaters of the Rio Portugues, which was crossed at an altitude of 1,720 ft. We descended in the next mile to the Portugues, the altitude of which at this point is 1,550 ft. Thence two miles more of travel brought us to the main summit at an altitude of 2,320 ft., distant 15 miles from Ponce. Three miles of steep descent, to a height of nearly 900 ft., brought us to Adjuntas, the altitude of which is about 1,440 ft. That the grades on this road are heavy is evident from the above. They are still heavier than is there indicated, for the reason that the first three miles is along the costal plain and the ascent is scarce 20 ft. Thence the ascent is gradual to Corral Viejo, 6 miles from Ponce, altitude 400 ft. At 9 miles out the altitude is but 1,200 ft., thence the ascents and descents are as already stated.

The first 9 miles from Ponce is over a macadamized road as well constructed and maintained as is the main military road to San Juan. Thence to Adjuntas the hillsides have been blasted out and the roadway graded by the Spaniards, but the roadbed has not been metaled, and it is, therefore, very much cut up into deep ruts by the teaming which has been recently done over it by the Army wagons. It is to be said, to the shame of the present military government, that they have greatly injured this portion of the road, and have not put a day of work into repairing the damage done. It is about all the inhabitants can do to haul their heavy two-wheeled ox carts over it with from 6 to 8 yoke of oxen. With but comparatively little work at this time in laying a proper road surface and in maintaining it this road will be in excellent condition to stand the heavy service to which it is put in hauling produce to and from the interior. Beyond Adjuntas to Utuado the temporary military road, known as the "Roy Stone" road, from the name of the American officer who built it, was put in fairly good condition at the time of the conquest of Porto Rico. At that time a great deal of money and a tremendous amount of labor were expended on this short bit of military road. To-day, but a few months after its construction, this bit of road is as impassable as any of the worst of the cart roads on the island, and is in striking contrast with the excellent work done by the volunteer engineers in repairing bridges and other portions of the military road towards San Juan.

The Rio Portugues has a minimum discharge of about 60-sec. ft., and the Rio Mayagues discharges about 35 cu. ft. a second, the former discharging at the ford near the summit about 25 cu. ft. a second. During the larger portion of the year both of these rivers, like all others on the island, discharge much larger volumes. It is therefore seen that they are capable of furnishing an excellent and abundant supply of water for Ponce, and in their 1,500 ft. of descent are capable of providing a large amount of energy if it were only properly developed through the agency of modern water wheels. All these streams have steep rocky channels, and in places they descend abruptly in series of cascades for considerable heights. From the summit to Adjuntas the roadway is down the gorge of the Rio Grande de Arecibo, the minimum discharge of which at Adjuntas is 35-sec. ft., while at its mouth near the city of Arecibo its discharge is nearly as great as that of the La Plata or Loiza rivers. The descent of this stream from the summit to Adjuntas is extremely abrupt, and the amount of water power available at this point is unusually large for the volume.

From Adjuntas to Lares the way was over a fair cart road for the first couple of miles, a low summit, altitude 1,500 ft., separating the headwaters of the Rio Arecibo from those of the Rio Yahueca, a branch of the Rio Prieto, which enters the western ocean near Anasco. Where this stream is first encountered its minimum discharge is about 20-sec. ft., while at the point at which the trail leaves it at Casa Bernasal, distant about 7 miles from Adjuntas, its discharge is 50 cu. ft. a second. At this point, the altitude of which is 1,350 ft., the trail goes by way of Dulce, and rapidly climbs to the summit of the steep ridge separating the drainage of the Rio Prieto from the numerous small streams which flow to the north coast. This summit, called La Torre, has an altitude of 2,000 ft., and from it one of the most magnificent views to be had in any portion of Porto Rico was obtained. To the south and east the high summits of the cordillera, dominated by El Guilarte, the second highest on the island, were in plain view. This ridge stretched westward to near Mayagues. To the northeast and to the west great mountain masses, separated by deep gorges, were to be seen in every direction. To the northwest the ocean was visible, and between it and the view point was a curious topographic feature consisting of a long ridge of low sugarloaf-shaped coral hills, a striking feature in the landscape. From this summit the descent was quite rapid for about 6 or 8 miles to Lares, altitude 907 ft. The larger portion of the entire route from Adjuntas was over comparatively narrow trails, in the red clay soil which was encountered near San Juan. In this the native animals have tracked ruts like steps, so that our mules plunged into these mud holes at each step, and if by accident they placed their feet upon the smooth summits, 18 to 20 ins. in height, which separated them, they were sure to lose their footing and flounder or fall. No more difficulty should be encountered here, however, in building a well-surfaced and well-drained road than has been met elsewhere on the island. Road metal of all sorts is abundant in the form of hard limestone and trap rock, and near Lares there is an abundence of excellent hard coral rock, which forms a naturel road metal. Some of the roughest road surface passed, however, was between Lares and San Sebastien, where coral reef rock had been washed about so as to leave great bowlders, or where bullock carts had worn the rock into deep ruts.

From Lares to San Sebastian the way lay along the slope of the ridge which descends toward the Rio Culebrinas. For half of the distance the way was over low coral hills, and in many places an excellent green sand marl, which will make a valuable fertilizer, was observed. The grade was comparatively uniform, ascents and descents being of but little amount. For the remaining 6 miles of the journey the road descended rather gently, from altitude 990 ft. to 270 ft. at San Sebastian. In the neighborhood of this city are several deposits of a fairly good lignite, which may be developed into a fuel of some value. About 6 miles beyond San Sebastian, at Alto Sano, is the terminus of the narrow-gage railway which runs thence to Anasco, a distance of about 15 miles. The railroad is partly graded between Alto Sano and San Sebastian. The grade is easy, and there are practically no summits of any moment, the railway following the course of the Rio Prieto. The highest point between San Sebastian and Anasco is Alto Sano, elevation 360 ft.; thence the descent is rapid to the river for about two miles, where the elevation is about 80 ft. Our way was by the so-called cart road, the route of which followed closely that of the railway. It differed from the latter, however, in that the Rio Prieto had to be forded nearly a dozen times, and was everywhere sufficiently deep to render fording not the easiest of processes.

The Rio Culebrinos below San Sebastian, at elevation 140 ft., has a discharge of 100-sec. ft., a bed width of 125 ft., and a velocity of about 4 ft. a second. The Rio Prieto, where it was first crossed, at elevation 80 ft., has a bed width of 150 ft., water surface of 75 ft., velocity of 5 ft. a second and a discharge of about 600-sec. ft. This stream, therefore, discharges about the largest low-water volume of any upon the island. Near Anasco the grades are so low that the river has, in order to discharge its full volume, such a depth and width as to be unfordable.

Just outside of Anesco on the road to Mayagues the Rio Prieto, here called the Rio Anasco, is crossed on a typical American cable ferry. Wagons and animals are driven on to a flat-bottomed scow, which is moored to an overhead wire cable, and sculled or towed across the stream, just as is done in our own southern and western states. Whether this institution was introduced from the United States or not I was unable to learn. At this point the military road approaches the river on a high embankment terminating in masonry bridge abutments. It was proposed to have spanned the river at this point with a bridge, but I was unable to learn whether such a structure had been erected and had been carried away, or whether the Spaniards had only gone so far as the construction of the approaches. The latter I judged to be the case from the appearance of the surrounding country, as I doubt from the character of the near topography that sufficient volume of water could have been carried in the Rio Anasco to have destroyed a bridge built on the existing abutments.

In spite of its distance from the coast, and consequently from markets, the whole of this interior mountain area is well inhabited and is comparatively well cultivated. From a point about 12 miles out of Ponce, where the road enters the coffee elevation, to within about an equal distance of Anasco, the prevailing crop is coffee. The country is practically deforested, as everywhere else on the island, only a little original timber being left on the highest summits, as El Guilarte. Yet the whole country appears to be well covered with woods, the shade for the coffee. In this portion of the island there are many great plantations, the largest in Porto Rico being near Adjuntas, the plantation of Mr. Pietri, an American, whose cleanup for this year was 450,000 pounds of coffee, which netted about $75,000. On the Pietri plantation one of the few specimens of machinery other than in sugar houses observed on the island was to be seen. All the coffee crushing and roasting apparatus was modern in type and arrangement, and was operated by turbine water wheels, which derived their power from a nearby stream. There is no other staple agricultural product in this region, yet a very excellent grade of oranges are grown abundantly, and bananas and plantains of an inferior quality are also extensively cultivated for consumption by the natives. A variety of cotton grows wild, the bush of which is so large as to appear almost like peach or apple trees, the plants usually being 8 to 12 ft. in height, and often having a trunk 4 to 6 ins. in diameter. After the valley of the Rio Anasco was entered, the character of the agriculture changed entirely. The river bottom was extensively cultivated in beans and Indian corn, and nearer the coast great plantations of sugar were found, in which, as elsewhere upon the island, the best modern machinery is employed. Between Lares and Anasco were seen some of the first evidences of over-cultivation of the soil, the latter having become so worn out as to have much of the appearence of the "old fields" of the South. These barren or "ruinate" lands, as they are called in the West Indies, could easily be brought into bearing condition again, however, by the use of fertilizers, of which a great abundance exists all through this portion of the island in the form of green sand marls.

The demand here for modern transportation methods is of the most urgent kind. Every pound of coffee moved to the seacoast for shipment, and many hundreds of thousands of pounds are so moved, has to be carried on the backs of ponies. Even the cumbersome bullock cart cannot be used until the larger cities near the seacoast are reached. In addition, all the merchandise purchased in the cities has to be carried back to the interior by the same means, and were transportation convenient and cheap, there are great possibilities here for the development of fruit industry in the cultivation of oranges and the propagation of marketable grades of bananas. No engineering difficulties are presented in the matter of locating or constructing electric or steam railways. In the ascent of one or two of the highest summits some extensive developments must be made in location in order to obtain grade, but the topography lends itself naturally to such location. On the southern slopes of the mountains the soil is of a kind in which construction will not be expensive, though some heavy rock work will necessarily have to be encountered near the summits. From near Adjuntas summit to within a few miles of Lares the cost of maintaining a roadway would be great because of the character of the red clay soil which I have described in a previous letter. Thence the rest of the way is through coral rock or gravelly limestone, where both construction and maintenance are easy, the rock being so soft as to be almost wholly workable with a pick, and yet of such kind as lends itself well to maintenance as road ballast or road surface.

The little narrow-gage railway from near San Sebastian to Anasco, where it connects with an existing portion of the French railway, which extends part way around the island, is crudely constructed and poorly maintained. A train runs over this road twice a week only. No difficult construction was observed anywhere along the line of this road, there being a little heavy side hill excavation and a few short iron plate girder bridges crossing side drainage. The water supply, as already noted, is abundant everywhere throughout this portion of the island, and no difficulty whatever should be experienced in obtaining all the power from this source necessary for the operation of electric railways.

One American syndicate is already in the field in Porto Rico acquiring water powers. They have employed a bright young American engineer and a lawyer, who have already purchased or obtained options upon some of the best powers on the island. I understand from this engineer that three such water rights, of 500-HP., and a couple of 1,000-HP. each have already been obtained on the headwaters of the Plata, Manati, Arecibo and other rivers. I believe that the most profitable way to develop a transportation system on this island is the reverse of that employed by the French railway company. The line of this latter clings closely to the coast where it has to compete with coasting vessels. It does a considerable business in handling the great quantities of sugar raised in the coast playas, but that constitutes the bulk of its trade. The interior of the island is equally productive and is capable of producing or already produces just as much material for shipment as does the coast. Yet this is entirely inaccessible at present. The main line of the electric road near the summit, from the extreme eastern to the extreme western end of the island, with a few branches to the important sea ports, would, I believe, control the transportation of the island. If this were of the typical suburban American type it would be most useful to the inhabitants as well as to the owners. This should consist of a well-macadamized highway constructed in conjunction with the electric railway, and the latter should be built especially with a view to handling freight. The highway, with such branches as may be built later by civil authorities, would naturally attract the pack animals and carts of the natives toward it, and in addition it would become one of the most beautiful and picturesque drives in America.

The aesthetic side of this island should not be overlooked, as its development will undoubtedly have great influence upon its future. Porto Rico is naturally one of the healthiest of tropic countries. With proper sanitation in the cities it should be almost ideal as a winter resort. The interior of the country is exceedingly picturesque, and it should soon, with encouragement, attract a large winter population from the United States. Many of the class of people who will go there will doubtless invest in coffee properties in the mountains and live upon their plantations during the winter months. These are the months in which their presence is necessary, because it is then that coffee is being gathered, the picking season being from November until March. They may be absent during the summer with little risk to their property. This class of people will have their horses and carriages for driving, and their presence will be greatly encouraged by the construction of good highways on which to take their drives and from which to enjoy the magnificent scenery. The only objection that can be urged to the construction of such an arterial highway upon the higher summits, is that apparently the heavier traffic, that from the plantation to the railway, would have to be hauled up hill. In point of fact, this is not the case, for whereas the highway will follow the general line of the commanding summits, it will necessarily skirt these, and as my previous statements of the topographical features will indicate, its elevation near the higher points of the island will never exceed 2,000 ft., and will average about 1,200 to 1,500 ft. Practically, all of the coffee is grown above the elevation of 1,200 ft., so that its movement to the highway will be down grade. Such a trunk line of electric railway as has been suggested might extend from Fajardo to Naguabo, Gurabo and Caguas, thence via Aguas Buenas, Comerio and Barros to Utuado or Adjuntas, from which point it might extend via Maricao or Lares to Mayagues. Main branches of this would naturally extend to the coast ports of San Juan and Guayama, Ponce, Arecibo and Aguadilla.

From Anasco to Aguadillo on the north, and to Mayagues toward the south, there is an excellent piece of macadamized military road similar to the other first-class roads on the island, and there also is in operation a portion of the French railway. The sugar plantations in this portion of the island are of the most extensive kind, numerous great sugar houses being operated, to which the cane is hauled over temporary tramways, which are moved from one part of the plantations to the other as the gathering of the crop requires. The cars on these tramways are sometimes hauled in trains of half a dozen or more by as many as eight or ten yoke of oxen. The speed made is, therefore, in keeping with the general disregard for time evinced by the Spanish-American.

From Mayagues, via San German and Yauco, to Ponce the character of the country is quite different from anything seen elsewhere on the island. There is a great area in the southwestern portion of the island which consists of low limestone hills separated by broad valleys at comparatively trifling elevation above the sea. The character of the soil is not unlike that found in western Texas, and the climate being exceedingly arid, the crops resemble those of our southwest. Beans and Indian corn predominate, though sugar is extensively grown in the low alluvial playas. Over portions of the way the military road is in fairly good condition, for though not macadamized, the roadway is so dry as to be easily passable with army ambulances and wagons, and little work will be required to put it in first-class shape. At Yauco is the terminus of another portion of the French railway, which extends thence to Ponce. The streams which reach this portion of the coast are fairly numerous and large, because they drain greater areas than do the average streams of the island. Their various discharges, however, are comparatively small, because of the aridity of the climate.

The cities, excepting the larger ones, are of the same general type. The residences in the smaller ones are neat wooden structures, sometimes of masonry, however, and are cottage-like in appearance. The business houses are all of brick masonry, plastered with stucco work and colored in oriental flat tints, as in San Juan and Ponce. Lares has 1,600 inhabitants; San Sebastian about 1,200; Anasco, 4,000; Agnadilla, 5,300; Hormigueros, 3,000; Mayagues, the third largest city on the island, has 11,600; Adjuntas 2,300; Yauco has a municipal jurisdiction of 24,500, and is one of the most important coffee centers on the island. The sanitation of all these cities, excepting Mayagues, is of the same type as heretofore described. All house drainage is into the street gutters, with the exception of a little which is occasionally discharged into the cesspools. A few of these cities are even more unsanitary than some I had previously visited. Thus in San Sebastian no cesspools were observed, and the house drainage was generally into the backyards, where the soil is deep-soaked with foulness. Anasco, which is one of the few cities on the island built on an alluvial plain, must be relatively very unhealthy, as the country is so flat as not to permit of natural drainage. Moreover, it is at scarcely any elevation above the river, which here has an exceedingly sluggish course. Adjuntas and Lares are much more cleanly than the others, the latter being unique in having a good system of open sewerage, while all the house and street drainage is passed through underdrains to these open gutters. As the grades of the streets are quite steep in Lares, and the rainfall relatively heavy, showers occurring almost daily, the sewage is quickly flushed off. Adjuntas enjoys nearly equal advantages, and receives a fairly good water supply from a mountain stream, which is piped to nearly all the important houses. The water supply of Lares is, however, chiefly from rainfall, as is that of Anasco. These two cities will prove two of the healthiest winter mountain resorts on the island.

Mayagues is the cleanest, most wholesome and most sanitary and modern-looking city on the island, scarcely excepting San Juan. It is the only city, moreover, in which a modern street car line, operated by horses and mules, is in existence. This line of street cars extends about a mile and a half, from the Plaza in the heart of the city to the Playa or Port of Mayagues, through a main thoroughfare somewhat similar to that between Ponce and Ponce Playa, only much better built up, resembling in many respects a main street in a city. Mayagues impressed me as the most promising city on the island for present winter habitation by Americans. The people themselves are even more sociable and friendly toward America than those met elsewhere. The streets are well macadamized, and are kept scrupulously clean. The slopes and grades of the streets are good, and as a result no stagnant drainage was observed anywhere upon them. The buildings are especially well constructed, the stores and warehouses being most substantial, and the private residences are all of masonry and separately constructed in portions of the city devoted to residential purposes, rather than being sandwiched among the business houses, as is the prevailing custom elsewhere. The street car line is well managed, the cars running regularly at intervals of five minutes, and doing as a result a fairly good business. The city of Mayagues receives an excellent gravity water supply from the Rio Mayagues, the perennial discharge which is sufficient for its present and near prospective wants. This is delivered, first, into two distributing reservoirs having a combined receiving capacity of three days. Thence it is carried in well-constructed underground conduits into the city, from which water is piped under pressure to every house of any importance. A modern sewerage system has been planned for Mayagues, the details of this and an additional water supply having been carefully worked up by competent Spanish engineers, and in all likelihood this sewerage system will shortly be constructed, as its cost and the difficulties of construction are not matters of serious moment.

Before closing this farewell letter, as I am about to leave Ponce for Santiago de Cuba, I wish to say a little of the general aspects of the various cities noted. I was agreeably surprised in every case by the substantial character of the buildings, the excellent pavements and sidewalks, and the general cleanly appearance of the streets and plazas in even the smallest cities. Places which we would call villages, as Aibonito, Adjuntas and San Sebastian are invariably well paved, either with macadam, gravel, or, quite frequently, cobblestones. The gutters are well lined, and flagstones are used to span the street crossings. Nearly all of these cities are provided with some form of gravity water supply, a few only being wholly dependent upon rainfall, and though there is no proper system for the collection of garbage or the handling of sewage, there is generally some municipal street cleaning. Many of these cities, even the smallest, are lighted either by electricity or by the ordinary oil lamp on a suitable lamppost. In fact, most of these cities would put to shame in many respects towns of equal size in our southern states. But little is needed in the case of any of them in the way of money expenditure to put them in first-class sanitary condition and to render them safely habitable by people from the United States. In nearly every case, the topography, especially the street grades and slopes, and the adjacent water supply, lend themselves admirably to inexpensive improvement of the sanitation and water supply.

The most difficult and expensive problem connected with the improvement of the public works of the island is in connection with the construction of highways. This is chiefly because of the heavy rainfall and the character of the soil over two-thirds of the island. This difficulty as I have endeavored to point out, will, I believe, be most readily met by the construction of electric roads, concessions for which should make it obligatory to improve the adjacent wagon-way. H. M. W.

Ponce, Porto Rico, Feb. 25, 1899.

Notes and Queries.

P. W., Little Rock, Ark., writes:

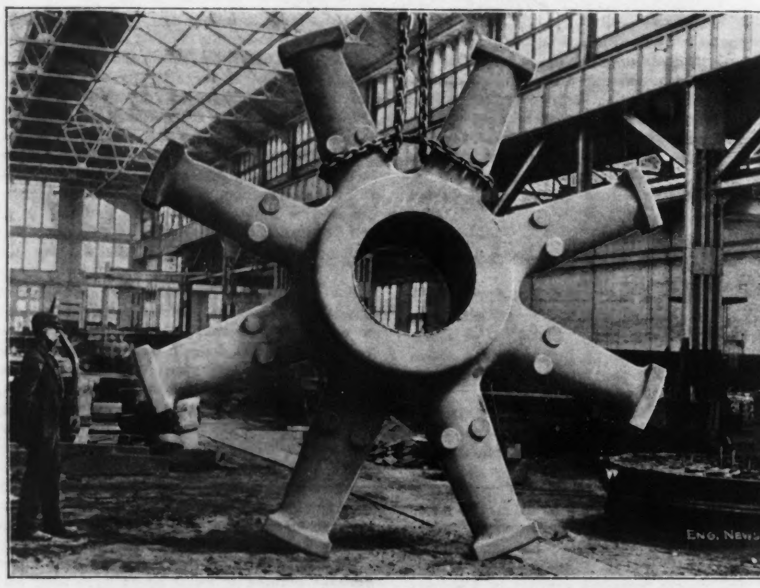
I have to make borings in a river, the bed of which is covered with large gravel and boulders. It seems to me that the boring outfits commonly used, or at least those which have come to my notice, will prove useless for this work, as most of the gravel will stick in the small annular space between the 1-in. inside pipe and the 2-in. caisson pipe. I have seen no larger outfits used except a regular well-boring plant (3-in.), which was expensive. Even with 3-in. caisson pipe I think the large gravel in the river bottom would stick between the pipes. If you can recommend me to any firm making tools suitable for this work, or to any article describing an apparatus suitable, I will be greatly obliged.

With the small outfit, by using expansion bits, we could, of course, drill through the large gravel, but that would be slow and expensive.

We shall be glad to hear from any of our readers who have had experience with similar difficulties.

A LARGE CASTING FOR A 4,000-HP. RAILWAY GENERATOR.

A description of the new iron foundry of the General Electric Co., at Schenectady, N. Y., was given in the issue of Engineering News of April 13. It is our privilege at this time, through the courtesy of Mr. A. L. Rohrer, Electrical Superintendent of the Schenectady works, to present a view of a large casting poured in this factory on March 24 (Eng. News, March 30, 1899) in the presence of a party of editors of prominent technical journals.



CENTER CASTING FOR A 4,000-HP. RAILWAY GENERATOR.
General Electric Co., Schenectady, N. Y., Builders.

This casting will form the hub and spokes of a large railway generator. As shown in the illustration, cleaned and ready for the machine shop, it tips the scales at 37,600 lbs. As will be noticed, the hub is cored out to reduce the weight. When finished the spider will have an immense cast-steel tire, to the outside of which will be bolted the massive pole pieces and bobbins used in the revolving-field type of generators.

The bosses noticed on each spoke are for the bolts which will lock together the engine flywheel and the revolving field. This arrangement is employed to prevent the great torsional strain which would otherwise occur in the engine shaft with sudden changes in the load on the generator.

THE SHIELD USED IN CONSTRUCTING THE ORLEANS RAILWAY TUNNEL, PARIS.

The extension of the Orleans Railway into Paris, along the left bank of the Seine, is being carried out partly by open excavation and partly by tunneling work. The shield and the methods of construction employed are described and illustrated in

"Le Genie Civil" for Feb. 11, and from this article the following brief abstract is made:

The dimensions of the masonry arch are as follows: Span at springing line of arch, inside, 29.52 ft.; from level of rail to springing line, 6 ft.; rise of arch, 10.38 ft.; thickness of side wall masonry, at base and springing line, 2.62 ft.; thickness at crown, 2 ft. The execution of this work presented especial difficulties. The extrados of the arch is but a short distance below the street surface above; and, in places, the foundation is below the normal level of the Seine; the alinement is a succession of curves of large radius, and many sewers are cut by the tunnel. In addition to these conditions, the abutments of bridges and the walls of quays were encountered over great lengths; old masonry and many cellars were met with, and the soil itself was very irregular in character, representing the rubbish of many different epochs. Finally, the contract required that the work should be done without interrupting traffic upon the quays.

These conditions necessitated the shield method of excavation, and the plans of Mr. Chagnaud were adopted, after a somewhat similar shield had been successfully employed in building the Clichy collector. Fig. 1 shows the successive methods of attack, galleries being first driven for the erection of the two side walls of the tunnel. In the Clichy tunnel the shield was supported upon the soil itself; but in this case the character of the soil varied so much that it was deemed safer to support the shield upon the side walls, as was done in the building of the Boston subway. The timbered advance galleries were 6.56 ft. wide at the top, and 8.85 ft. wide at the base, with the roof 2.29 ft. above the springing line of the arch. As these galleries advanced the side walls were built within them. Work was carried on in three shifts of 8 hours each; two being devoted to excavation and the third to the building of the walls.

The shield employed covered the section above the springing line of the arch, and was practically the same as that by which, at Clichy, an advance of 30.5 ft. was made in 24 hours. Two important modifications were made, however, one being the guiding of the shield by lateral rollers, and the second related to the sustaining of the soil behind the shield. This shield, as shown in Figs. 2 and 3, includes a metallic skin, A, made of two steel plates, 20 mm. thick. The forward part forms a cutting edge in form of a hood to protect the workmen. The two beams, B D and B' D' support this skin, and are tied together at their extremities by the horizontal beams, C, resting upon the rollers, b. The ten hydraulic jacks, V—double-action and independent movement, advance the shield, and have an interior diameter of 9⅜ ins. The horizontal beams, H, form the floor of the shield, and the resistance to the jacks is provided for by 40 centers, i, spaced 3.28 ft. apart, and tied together by bracing.

To guide the shield laterally, rollers, C (Fig. 3), are provided which roll upon planks of hard wood, d, covered with sheet steel and attached in advance to the inside of the side wall masonry. This plan was found to be successful; and in figuring the weight of the shield, the earth above and the rolling load on the base, we arrive at a total of 90 to 100 m. tons, or about 43 lbs. to the sq. in. on the side walls, or less than the load of the completed arch.

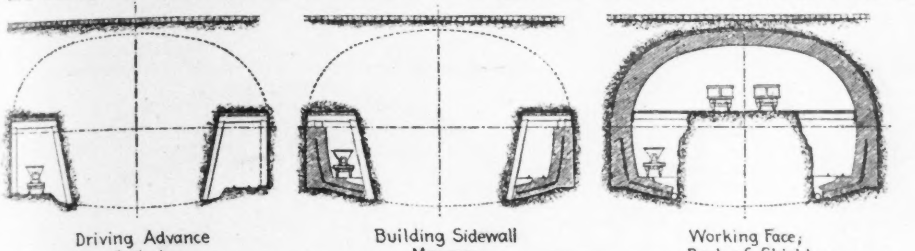


FIG. 1.—THREE STAGES OF PROGRESS IN THE EXCAVATION OF THE ORLEANS RY. TUNNEL, PARIS.

To sustain the earth behind the shield, the following plan was adopted: Latticed beams, E (Fig. 5), were placed longitudinally upon the centers, resting between angles fixed upon the centers and forming guides. These beams carried a series of small hydraulic presses, u, with the upper end of the piston buried in a timber, f, about 8 ins. thick and covered with sheet steel next to the soil. This arrangement kept the soil above in place and stopped all "runs" behind the shield. The small screws, g (Fig. 2), were used in separately pulling forward the timbers, f, and the beams, e, the latter slipping between the angle-iron guides. There was very considerable friction involved in this operation, and it constituted the one very serious difficulty in putting this method into practice. In any similar plan it will be very important to carefully calculate the power required, depending upon the dimensions of the shield, and the nature and weight of the soil.

The beams, e, are of different lengths, corresponding to the different stages of construction in the arch masonry. The longest, at the key, are 26.24 ft. long, and the shortest are 9.84 ft., at the springing line. Notwithstanding the difficulty in handling the beams, e, the system is believed to possess important advantages as compared with building the masonry under a solid shield. All openings in the arch provided for are easily made, though this is impossible in the other method; there is no danger of the displacement of the masonry by the forward movement of the shield; and, lastly, we have no voids between the masonry and the soil, which may be nearly 4 ins. in the case of a rear-shield.

The centers, l, which support the beams, e, are made of beams with a rectangular section, and they are constructed in two parts weighing not more than 1,320 lbs. each. Fixed hoisting tackle attached to the exterior skin facilitate the raising of these center members. These centers rest, through a shoe, on wooden sills, J, covered with thin steel; under the sills are ordinary wooden wedges, K, and a second sill, l, resting on posts, m, braced to the side walls.

The ten hydraulic jacks used in forcing the shield forward exercise a force of 1,000 metric tons, and it is necessary that their point of support upon the first center should be as large as possible, and the same caution applies to the bracing, h. The pumps and the dynamos which operate them are placed in the space, q, Fig. 3. Two dynamos and two batteries of pumps are employed, the one of three and the other of six elements. A reservoir of water is placed in the space, r, Fig. 3, raised above the pump level. An arrangement of copper pipes and three-way valves, permits the application of the power, either together, or upon a single jack.

When the shield has advanced its length under the push of the hydraulic jacks, V, the pistons are withdrawn, and the next step is prepared for. This consists in placing the rollers, b, under the forward end of the beam, C, and laying the sills and wedges for the next center. The pistons of the hydraulic presses, V, take their support from this new center, when in place, to advance again; at the same time the small hydraulic presses are operated to raise the beams, e, and fill up the space left by the rear of the shield. The masonry is built as the timbers, f, advance; and on the haunches of the arch this masonry is built in front of a thin sheet of steel extending from one rib of the center to the other. This latter arrangement ensures a clean, regular arch. The arch itself is made of beton blocks, molded at Vigneux, and delivered on boats. The proportions are: 225 kilos. of Portland cement to 0.9 cu. m. of pebbles, and 0.6 cu. m. of sand.

The masonry was laid continuously, day and night, requiring the work of ten masons on the sides and one at the key. Tracks of 2-ft. gage carry tip cars of 1 cu. m. capacity, or platform cars of 3 m. capacity; these are used in conveying away the material excavated, and the trains are hauled by a small 8-ton compressed air locomotive of the Mekarski type, which will haul 40 tons up a considerable grade at a speed of 3.6 miles per hour. For five advances of the shield in 24 hours about 4½ hours are necessary for carrying away the material. Three workmen at one time are employed at the front of the shield, and about 82 cu. yds. are taken away at each advance. The contract price for this work is 1,070 francs per lineal meter, or $65.24 per lineal foot. The arrangements adopted permit the keying of the arch about two days after the advance of the shield; the centers are removed from 4 to 5 days after the keying, and the working force at all the different points includes two shifts of about 200 men each.

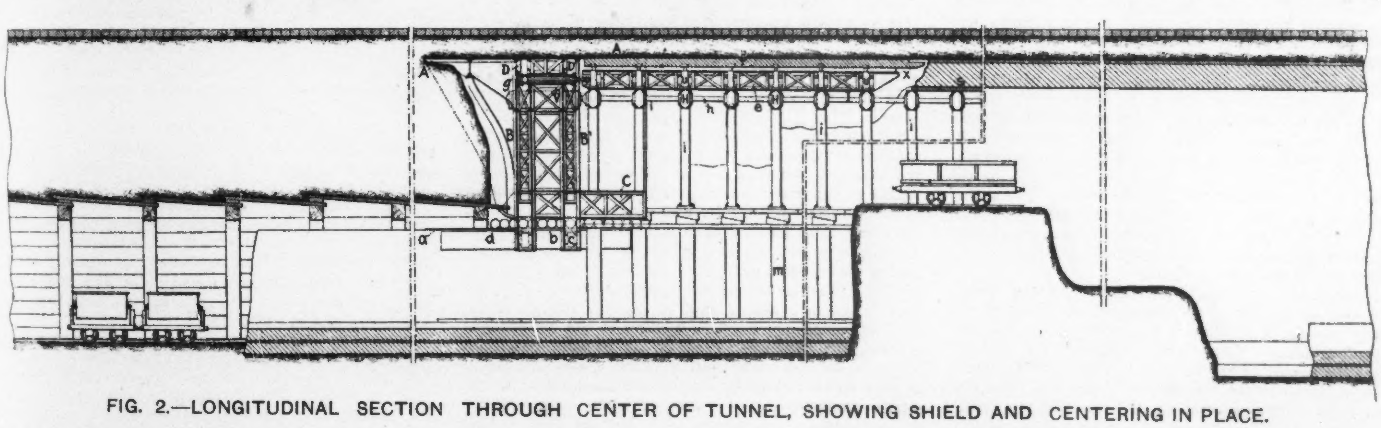


FIG. 2.—LONGITUDINAL SECTION THROUGH CENTER OF TUNNEL, SHOWING SHIELD AND CENTERING IN PLACE.

GENERATING AND DISTRIBUTING ELECTRIC POWER FOR THE GLASGOW CORPORATION TRAMWAYS.*

By H. F. Parshall, M. Am. Soc. M. E.†

(The following report, while pertaining particularly to Glasgow, Scotland, contains a statement

*Abstract of a report presented by the author to the Tramway Committee of the City of Glasgow; printed in "Engineering" of March 24, 1899.

†83 Cannon St., London, E. C., England.

of current electric railway practice which is of general interest and application. The expression of opinions by Mr. Parshall is also noteworthy, as he is one of the foremost electrical engineers of England.—Ed. Eng. News.)

At present the Glasgow tramway system operates 380 cars by horse and 27 by electric traction. Extensions and the usual growth accompanying the conversion of horse traction systems into electric traction systems will call for about 600 cars, for which generating and distributing arrangements must be made. In the city of Boston, which is of somewhat less population and of not greater area than the city of Glasgow, double this number of cars is being operated at a profit.

Capacity of Generating Plant.—The consumption of power per car-mile varies in different cities with the conditions of the permanent way, frequency of stops, gradients, etc. In Glasgow the track construction adopted is admirably suited for electric traction, since the rails are of the best possible cross-section and of ample weight. The policy of charging low fares increases the number of passengers carried per car-mile as well as the number of stops, the result being that the amount of power which would be consumed in Glasgow is greater than that which is consumed in many other cities.

From actual measurements taken on your present electric traction works, your average consumption of power at the car is 7.2 K-W., or 9.65 HP.

Taking, therefore, 600 cars, the amount of power to be delivered to the car for average working conditions is 5,800 HP. In traction systems the ratio of the average to the maximum load varies greatly at different hours of the day, on account of the stops for passengers and the number of passengers carried, also on different days according to the weather and other conditions. For this reason 60% should be added to the average working load to provide for the maximum load that would occur under normal working conditions. This means that the capacity of your machinery must be such as to deliver 9,250 HP. to the cars, or, allowing for loss in transmission and distribution, approximately, 11,500 electrical HP. must be generated, as a maximum working load at the power station. Taking 85% as the ratio of electrical HP. at the busbars to the indicated HP. of the engine, the engine capacity for the maximum working load would amount to, approximately, 13,000 HP. Allowing a safe margin for spare plant, an aggregate of 17,000 indicated HP. will be required in the generating station.

Conditions of Electrical Distribution.—Having determined the amount of power required for working the tramway system, it remains to be decided, having regard to the distribution of cars and frequency of service, whether the supply of energy to the cars can be the more efficiently controlled and economically supplied from one central point or from several points. To meet the conditions obtaining in Glasgow would require several centers of distribution, for the following reasons: 1. The distances to which energy has to be conveyed are so great and varied as to preclude an economical supply at 500 volts. 2. The maintenance of property in gas and water mains, and the conditions to be complied with in regard to difference of potential on the rails specified by the Board of Trade, would entail in the case of a single center of distribution an elaborate and complicated return system, involving great outlay in cables and machinery, which would necessarily require subdivision into several comparatively small units in order to meet the varied conditions and the distances to which the cables would need to be carried.

The amount of current that would be returned through your rails in Glasgow to a central point would be sufficient to eat away 50 tons of iron per annum from the pipes, which is a sufficient demonstration that the earth return is a point of primary consideration in determining the nature of your distributing system. This becomes more evident when we consider that the maximum voltage drop allowed by the Board of Trade is 7 volts, and that in some of the central streets in Glasgow, with the increased traffic contemplated, the drop would amount to 15 volts per mile, or double that which is allowed by the Board of Trade. Practice has demonstrated that, under such conditions as those existing in Glasgow, a maximum voltage drop of not more than one-half of that permitted by the Board of Trade, namely, 3½ volts, is all that should be entertained. In other words, having reference to the safe conditions to be maintained in the track and return, in many cases in Glasgow the current should not be taken for more than half a mile from any point of distribution.

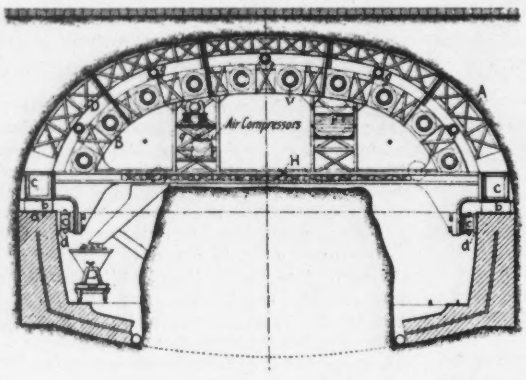


FIG. 3.—CROSS-SECTION OF TUNNEL BACK OF THE SHIELD.

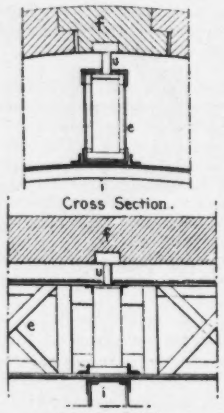


Fig. 5.—Details of Temporary Lagging with Supports.

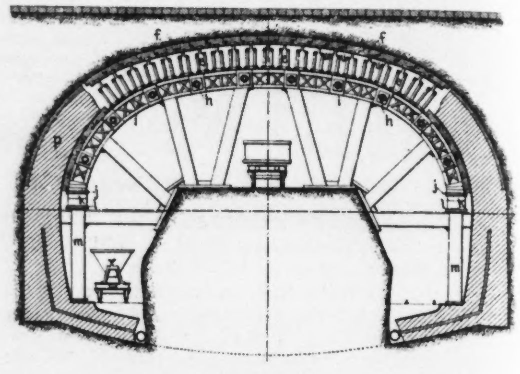


FIG. 4.—CROSS-SECTION OF TUNNEL SHOWING PLACING OF MASONRY ARCH.

High-Tension Generating Station, with Sub-Stations, versus several 500-Volt Generating Stations.—Having determined the probable increase in traffic, the amount of power necessary to meet the demand, and that at least five centers of distribution are necessary, it remains to decide whether the energy can be the more economically supplied from a single station generating polyphase currents at high voltage, to be transformed into continuous currents at 500 volts in a number of sub-stations, or from the same number of generating stations, suitably located, and generating continuous currents at 500 volts.

The following is a summary of the advantages of the three-phase system over the other:

(a) Less capital expenditure in buildings, generating plant, and in real estate investments.

On the one hand, you have to provide a site for a generating station, in the choice of which there is a considerable latitude, inasmuch as there are several sites available at such a distance from the center of Glasgow that the power can be economically transmitted at moderate cost in transmitting mains, and where you will be able to obtain the advantages of good coal delivery by more than one railway system, and also to provide for extensions.

On the other hand, the separate generating stations scheme would involve the purchase of four or five sites, the choice of which would be limited, if fixed with due regard to the proper working of the tramway system and suitable railway sidings for coal supply.

(b) The three-phase system has the advantages of less working cost and repairs. On the other hand, there is a skilled staff at the generating station, together with the unskilled labor at the several sub-stations. On the other hand, there is a skilled staff at each of the generating stations, which are equal in number to the sub-stations. It has been conclusively shown at Niagara and other places which have now been working a sufficient length of time so that reliable conclusions can be drawn, that rotary converters require less attention than ordinary 500-volt railway generators, and that no skilled labor is required.

There will also be a saving in supplies and repairs, owing to the use of a few large steam generating units instead of numerous smaller ones. The concentration in load also effects a saving in fuel and water. Also better facilities as to coal-handling arrangements can be afforded in a single large station than in several smaller ones.

(c) The three-phase system has greater flexibility, and is better adapted to the requirements of future extensions. Should your lines extend further in any direction into the country, sub-stations can be installed at any convenient point or points. These sub-stations do not require special buildings; the 2,500-HP. stations of the Central London are contained in two vertical cylinders, each 22 ft. in diameter and 100 ft. below the surface of the ground.

(d) In considering the transition from horse to electric traction the question of time is of great importance. The single generating station can be installed and put in working order more quickly than several stations.

Recommendations as to the Nature and Arrangement of Plant in Generating Station.—Owing to the small ratio between the average and maximum load—that is, to the load factor common to traction systems—the 26,000,000 K-W. hours of electricity per annum could be generated in a plant of nominal capacity of not more than one-third that at which it could be generated in a lighting station, owing to the machinery working at its full capacity for many hours per day. Glasgow would be working the cars, approximately, 16 hours per day, at full service, and four or five hours per day additional at one-third service. This distribution of load for so many hours per day would be very satisfactory, in that the generating station could be designed with but few units working at the best economy during all hours in the day. Four generating sets would give the best result—three of these to be worked during normal conditions of load, and the fourth unit to provide for abnormal conditions and emergencies.

Three-crank tandem compound engines would give best results. These should be provided with massive fly-wheels so as to give a uniform turning moment, and to provide the maximum effort for fluctuations of load. In order to obtain the best results these engines should not work beyond 75 revolutions per minute, and should be specially constructed, having in view the nature of the load and the conditions peculiar to an electric traction system.

The engines should be direct-connected to three-phase generators of the fly-wheel type, with rotating magnets and stationary armatures. Machines of this type have been constructed, with entirely satisfactory results, for as high a working pressure as 13,000 volts. Having reference, however, to the comparatively short distance of transmission, and the small investment in copper required, 6,500 volts is a satisfactory working pressure, all conditions considered.

The station should be provided with a coal conveyor, so that the coal would be automatically conveyed from the railway trucks, or other means of transport, and distributed to different boilers or stored in bunkers.

The station should be designed with electrically driven auxiliaries throughout, thereby securing the greatest possible economy. The switching arrangements in the generating station would be comparatively simple, owing to the small number of generating units, and to the feeders being comparatively few in number, depending on the number of the sub-stations.

The method already adopted in Glasgow, namely, drawing cables into ducts with manholes approximately 100 yds. apart, represents the best practice in electric traction. With a density of from 400 to 600 amperes per sq. in., according to the distance, high-tension cables can be run through the same set of ducts, but where they enter the same manhole, the manhole should be of ample size, so that the high-tension cables could be carried on one side, and clear the low-tension cables.

Comparison of Lighting and Tramway Plants.—It is scarcely possible to avoid reference to the question of joint supply of electricity for the two purposes of traction and lighting. On a large scale the two systems can be kept separate with advantage, owing to the difference in the nature of the plant and in the supply of power. The following are points which militate against a joint supply from lighting stations:

(1) On many days in the year the maximum load in lighting, and that in traction, occur at the same time, so that the same maximum total capacity in plant has to be provided, whether or not the supply is from a common station.

(2) Owing to the difference in the nature of the loads, the capital cost for a given watt-hour production is three or four times as great for lighting as it is for traction. In other words, the traction plant is worked at its greatest capacity three or four times as many hours in the year as the lighting plant; consequently it can be of a more substantial type with advantage.

(3) Machinery of a different type is commonly used for lighting, and the switching appliances are absolutely different. In the Glasgow lighting stations numerous small high-speed engines are in use; such engines are unsuited for the generation of current for electric traction purposes.

(4) The electrical arrangements for electric lighting are necessarily much more complicated and elaborate than is the case for electric traction. Electric lighting has to be carried on with reference to the delicacy of the human retina; in other words, the voltage at the point of consumption has to be regulated to a nicety. In electric traction the same conditions do not obtain, since uniform acceleration and speed of the car can be obtained within a much greater range of voltage.

(5) From a business point of view the different conditions in electric supply are sufficiently shown by the difference in cost of energy between electric traction and electric lighting. The cost of energy for electric traction owing to its better load factor, would not be more than 25% of that for lighting. The present cost of electric lighting in Glasgow is 2.52 cts. per K-W. hour, which compares favorably with that of lighting for other cities. This figure is 4.8 times as high as would be expected in the traction service outlined.

(6) It has been suggested that economy in staff will be gained in a joint station. This does not apply provided the tramway business is attended to as a business by itself. In the station outlined this staff will, as I have said, be regularly employed during 16 hours of the day at practically full load, and for five more hours at one-third load, so that the staff would be fully occupied during the hours of working. Owing to the difference in the nature of load, a different class of attendants would be required for the two classes of work.

Having regard to the nature of the tramway system as a whole, a single generating station, with high-tension multiphase transmission to sub-stations located in some existing car-sheds and stables, will be found the most economical to work, involving less capital outlay, taking less time to install, lending itself to compliance with the Board of Trade requirements and to the safety of property in gas and water mains, and being of a type least likely to be superseded when further demands are made, either as an increase in the area to be served, or increase of traffic over the existing system.

Comparative statement of cost, in pence, per K-W. hour, delivered to cars on the basis of 600 cars running for 16 hours per day, with 200 of these running between four and five hours additional per day, taking an average of 7.2 K-W. per car.

(a) A Three-Phase Generating Station Containing Four 2,500-K-W. Units, with Transmission at 6,500 Volts, and Five Sub-Stations Containing 500-K-W. and 800-K-W. Units, and Located in Present Car Depots.

	Generating station. Cts.	Sub-station. Cts.	Generating and sub-stations. Cts.
Power expenses:			
Coal, delivered & handled	0.2480	....	0.2480
Water, 8 cts., 1,000 galls.	0.0164	....	0.0164
Oil, waste and supplies..	0.0176	0.0106	0.0282
Labor	0.1000	0.0720	0.0172
Total power expenses.	0.3820	0.0826	0.4646
Maintenance	0.0514	0.0056	0.0570
Fixed charges:			
Depreciation, interest, insurance, rates and taxes	0.4162	0.1232	0.5394
Total	0.8496	0.2114	1.0610

To the above figures must be added the cost of maintenance, depreciation, and interest upon the high-tension cables for connecting the generating station to the sub-stations, amounting to .038 cts. This makes the total cost of the three-phase scheme 1.0990 cts.

(b) Five Generating Stations Containing 500-Volt Railway Generating Plant.

	Cts.
Power expenses:	
Coal, delivery and handling	0.3100
Water, at 8 cts. per 1,000 gallons	0.0206
Oil, waste and supplies	0.0220
Labor	0.4000
Total, power expenses	0.7526
Maintenance	0.0700
Fixed charges: Depreciation, interest, insurance, rates and taxes	0.7508
Total	1.4734

Note.—The above figures do not include interest on the cost of sites and railway connections. The difference as between 1.0990 cts. for the single multiphase station, and 1.4734 cts. for the five 500-volt stations, based on 600 cars, amounts to $101,400 per annum as the saving in working costs in favor of the single multiphase station.

OWNERSHIP OF THE DRAINAGE AREAS, either wholly or in part, from which English surface water supplies are impounded, now prevails or is proposed in a number of instances. Torquay has received authority to expend about $200,000 for the purchase of the whole drainage area from which its supply is derived. Dublin will buy 9,000 acres of land forming the drainage area of a new source of supply. Birmingham has authority to buy the 45,562 acres embraced in its new rivers Elan and Claerwen scheme, and has bought some, although the population in the drainage area is only 362. Bolton owns 1,983 out of 3,166 acres. Edinburgh has bought 6,000 acres connected with a new source. Manchester has bought the 11,000 acres from which the supply of its new Thirlmere works is gathered, and owns 1,400 out of 19,300 acres of its original gathering grounds. Liverpool owns nearly all the drainage area of the Lake Vyrnwy supply. These figures are from a report by Mr. W. Ingraham, Assoc. M. Inst. C. E., Water Engineer to the Torquay Corporation. From this report, published in the London "Surveyor," of Feb. 24, it appears that of 44 municipalities in Great Britain and Ireland 2 now propose to acquire their whole drainage areas; 4 already have from 40% to 60%, or more; 6 own from 10% to 15%, and some 10 or so own under 10%. In general the percentage of cultivated land in these drainage areas is small and the inhabitants few and far between.

ASPHALT FOR JOINTS IN VITRIFIED SEWER PIPE is being used quite extensively in Germany, and evidently with satisfactory results. A long paper on the subject, in which the objections to clay and cement joints were reviewed, appeared in "The Contract Journal" for Jan. 18, 1899. The paper was prepared by Mr. A. Unna, City Engineer of Cologne. The materials used are either a compound of pure Trinidad Goudron and mastic asphalt or pure Trinidad with "a suitable bulking addition." Mr. Lindley, of Frankfort-on-Maine, recommends 2 parts Goudron to 1 part Vorwohler mastic asphalt, but Mr. Unna prefers 1 to 1 of the same materials. The preliminary step in the calking process is the use of tarred rope, great care being taken that no holes are left through which the asphalt can pass to the interior of the pipe. The asphalt is reduced to a fluid state and poured into the joint with the aid of a collar. In Cologne the asphalt joints cost as much as cement for the smaller sizes of pipe, but less than cement for the larger, owing to the diminution in the relative cost of the fuel as the sizes increase. The claims for the asphalt joints made by Mr. Unna are as follows: Complete imperviousness to liquids; perfect adhesion to glazed surfaces; elasticity; adaptability to all climatic conditions, and to temperatures up to 50° C.; proof alike to acids and alkalis; permits immediate use of sewer if desired, and obviates necessity of bailing or pumping out water after joint is once made; asphalt joints may be melted by blowpipe flame and the pipe reclaimed for subsequent use.

A WATER POWER PUMPING PLANT is being installed in the power station of the Niagara Falls Power Co. for the Niagara Falls Water-Works Co., which is associated with the power company. The plant will include two 6,000,000-gallon duplex Riedler pumps, ordered from Fraser & Chalmers, of Chicago. The pumps will be direct-connected to Pelton wheels, under a head of about 120 ft. The pumps will be arranged for operating one side only. The water will continue to be taken from the Niagara River and filtered before passing to the pumps, as is now the case. The new plant will be in operation by the end of the year, when the steam pumping plant will be abandoned, the space gained becoming available for the addition of more mechanical filters. The company supplies a part of Niagara Falls, N. Y.

ONE HUNDRED TONS OF CALCIUM CARBIDE per day is the estimated output of the new plant of the Union Calcium Carbide Co., now being built at Niagara Falls, N. Y. This new factory is located on the lands of the Niagara Falls Power Co., east of the industrial village of Echota and north of the tracks of the New York Central and the Erie railroads. In raw material and product the company expects to handle between 30 and 40 cars every day. When the facilities of this plant are fully developed it will use 25,000 electrical HP., the output of no less than five of the great 5,000-HP. generators in the central station of the Niagara Falls Power Co. In order to supply the Carbide Co. with this amount of electric power, the Niagara Falls Power Co. is now laying a new cable conduit, which consists of 36 3¼-in. vitrified tile ducts, laid in a nest, and sheeted with cement. A drain is laid beneath the conduit tile. The length of this conduit will be 12,000 ft., and the work is being done by Thomas Dark & Son, of Buffalo. The contract for the building is in the hands of Wentworth & Taylor, of Niagara Falls. There will be an office building and two buildings for factory purposes. The first of the factory buildings is 864 × 75 ft. on the inside. Brick and iron are the principal materials used in their construction. The front section of the first building or pulverizing department is three stories high, 132 × 75 ft. Next comes a two-story section 30 × 75 ft., to be used for dust collecting, and in the rear of this is the furnace room, which is 395 × 75 ft., and on each side of it are three small rooms to be used as transformer rooms and distributing points for the current. The rear end of the building, a section 300 × 75 ft., will be the packing and shipping department. There will be about 3¼ miles of railroad track in and about the plant. With the exception of the three-story front, the second building will be a duplicate of the first. The iron for the structural work is supplied by the Berlin Iron Bridge Co., while the Penn Bridge Co. will furnish the storage bins, and the Jeffrey Manufacturing Co., the elevator and conveying apparatus. Contracts for the electrical installation of this plant has been made with the Wagner Electric Manufacturing Co., St. Louis, Mo., for seven static transformers of 2,000-HP. output each, and two static transformers of 500-HP. output each, all complete with switchboards and apparatus ready for operation. With the Westinghouse Electric & Manufacturing Co. the Union Carbide Co. has contracted for about 10,000 HP. in transformers, while the Niagara Falls Power Co. has contracted with the same company for seven 2,500-HP. transformers, which will involve the largest units ever manufactured. These transformers will be of the Westinghouse standard oil insulated, water-cooled pattern. In these machines the cooling is to be effected by the circulation of water through coils of brass pipe immersed in the oil. They will be used for stepping-up the two-phase, 2,200-volt current as it comes from the generators in the power house to the three-phase, 4,400-volt current for the use of the Carbide company. The company's superintendent at the Falls is Mr. E. F. Price.

THE PARIS EXPOSITION AUTHORITIES have granted to the United States an additional allotment of space, amounting to 56,000 sq. ft. This space is located in the Vincennes annex, and will be used by the U. S. transportation and machinery exhibits. The plans for the five U. S. buildings in the main grounds have been submitted and approved. Dr. Tarleton H. Bean, late Chief of the Division of Fish Culture, in the government service, has been appointed Director of the Forestry and Fisheries Department of the American exhibits.

THE OMAHA GREATER AMERICAN EXPOSITION will open its gates on July 1, 1899, and keep them open for four months in the grounds of the Trans-Mississippi Exposition of last year. The chief exhibits are intended to illustrate the peoples, manners, customs, products and capabilities of the insular countries acquired by the United States through the late war with Spain. The managers of the Exposition says that the material is already in hand to insure success, and applicants for space are already receiving short allowances.

AN ELECTRICAL EXPOSITION will be held at the Madison Square Garden, New York city, in May. Special attention will be devoted to automobiles, wireless telegraphy, electrotheraphy and a government exhibit, which will contain models of the apparatus used by the United States army, navy and light-house service. Mr. Marcus Nathan is general manager for the Electrical Exposition Co., whose offices are at the Madison Square Garden, New York city.

ILLUMINATING SHELLS for lighting up large areas of ocean in life-saving work, or to obtain the range of the vessels of an enemy are proposed by the American Illuminating Shell Co., of Baltimore, Md. The shell used is a hollow cylinder made of steel tubing, and charged with calcium carbide, which, coming into contact with water, generates acetylene gas. The end of the shell remains above water, and at this end are burners lighted by an electric device contained in the shell. It is claimed that the light produced is of 1,000 c. p. and cannot be extinguished by water. The shell is to be shot from a gun to a distance of two miles, and floats with one-quarter of its length above water.

A VELOCITY OF 3,000 FT. PER SECOND was recently recorded in the late tests, at Indian Head, of the new 45-caliber 6-in. U. S. naval gun. This is claimed to be the best record made by a gun of this class. The Krupp 15-cm. (5.87-in.) and the 16-cm. (6.3-in.) use projectiles weighing 88.2 and 110.2 lbs., respectively; but the highest muzzle velocity recorded for these is 2,635 ft. seconds. These guns are 50 calibers long. The Krupp 21-cm. (8.24-in.) uses a projectile weighing 238.1 lbs., and is credited with a muzzle velocity of 2,822 ft. seconds; and the same velocity has been obtained with a Krupp 24-cm. 9.45-in.) gun, with a projectile weighing 352.7 lbs. The nearest French gun in type is the Schneider-Canet quick-fire, 5.91-in. caliber, using a projectile weighing 88.2 lbs. With lengths of 45, 50 and 60 calibers this gun shows velocities of 2,625, 2,756 and 2,953 ft. seconds respectively. The 60-caliber length is an experiment, and the 45-caliber is the one to be compared with the American gun. The 6-in. Elswick guns of 50-calibers claim a velocity of 2,940 ft. seconds, but the British naval authorities say that the velocity is not desirable, owing to the great wear on the gun. The American full tests are not made public; but it is claimed that the results were due to a new smokeless powder recently adopted by this government.

THE PROPOSED CORPS OF ENGINEERS for the Second Brigade, New York State Militia, has progressed to the point of applying to the Governor for authority to organize. The scheme has the approval of Col. Gillespie,

U. S. Engr. Corps, and Col. Griffin, late commanding the First Regiment of Engineers, U. S. V. The three officers already selected for the proposed corps are First Lieut. Austin E. Allen, Second Lieut. W. D. Farrington and Second Lieut. L. H. Conklin. Applications for membership have been received from 44 persons, 10 of whom are practicing engineers, and 15 are engaged in technical pursuits. This Engineer Corps has temporary headquarters at the 3d Battery Armory, 165 Clermont Ave., Brooklyn.

BOOK REVIEWS.

EXAMINATION OF WATER.—Chemical and Bacteriological.—By Wm. P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 5 x 7½ ins.; pp. 127; illustrated. Price, $1.25.

This is an excellent little guide to the sanitary examination of water by the aid of chemistry and bacteriology. Knowledge of quantitative chemical analysis is assumed and no attempt is made to indicate the steps to be taken in the differentiation of species of bacteria. The interpretation of analyses is clearly presented. The author believes that for the present bacterial studies of water have little or no practical value except in so far as they relate to numbers present, but in this respect they may be classed with chemical analyses in importance.

HISTOIRE DE L'ARCHITECTURE.—By Auguste Choisy. Paris: Gauthier-Villars. Paper; 6 x 10 ins.; two volumes; pp. 642, 800; 866 illustrations in the text. Price, in France, 40 francs.

The author has aimed to show the development of ancient and modern architecture in relation to the social development of the several peoples in question. The subject is therefore taken up largely by countries and periods. The order followed, in a number of sections, is to discuss methods of construction, forms, proportions, decorations and special features, concluding with a general historical sketch for each country. The very numerous illustrations aid greatly in conveying a clear idea of the subject. Many of them combine in one diagram a plan, section and view, all isometric.

HOW TO DO BUSINESS AS BUSINESS IS DONE IN GREAT COMMERCIAL CENTERS.—By Seymour Eaton, Director of the Department of Industry and Finance, Drexel Institute, Philadelphia, Pa. Philadelphia: P. W. Zeigler & Co. 8vo., cloth; pp. 324; illustrated. $2.00.

This book is calculated to fill a real need. The methods and customs of modern commercial life are not taught systematically either in high schools or colleges, and the young man entering business or professional life has to pick them up as best he can. Oftentimes he is ashamed to display his ignorance by asking questions concerning some simple matter of business or accounting, and his lack of knowledge may sometime cause him a loss. This book is designed to give to the reader a clear understanding of the methods upon which business is conducted at the present time. It is written in so elementary a style as to be easily understood, and yet is complete enough and covers a broad enough field to make it of use to men even of considerable business experience. We are inclined to advise professors in engineering schools to obtain and examine this book, and consider the plan of giving some elementary instruction of this sort to the pupils in their classes. We are far from being sure that this book as it stands would be at all suitable for a text book; but it may at least point the way in which instruction in a new field can be profitably imparted. In its general mechanical make-up the book deserves severe criticism. It contains neither index nor table of contents, and in many respects its treatment of its subject is inadequate, while there is much matter in it that is more curious than useful. Yet it contains enough information of value to be well worth its price to any one desiring to inform himself as to modern commercial customs and usages.

GOOD CITY GOVERNMENT.—Proceedings of the Indianapolis Conference for Good City Government and Fourth Annual Meeting of the National Municipal League, held Nov. 30, Dec. 1, 2, 1898. Clinton Rogers Woodruff, Editor. Philadelphia: National Municipal League. Cloth; 6 x 9 ins.; pp. 273. Price, $1.

This volume is devoted almost wholly to a presentation and discussion of the Report of the Committee on Municipal Program, appointed in 1897. The committee submitted a model charter, which was reviewed at length in our issue of Dec. 1, 1898. The principles involved in the program were elaborated in the report by Messrs. Horace E. Deming, Frank J. Goodnow, Albert Shaw and Chas. Richardson, each of whom presented separate papers. At the Indianapolis meeting a large number of municipal officials and reformers presented written and oral discussions. Practically all the speakers were in sympathy with the program, but, as would be expected, adverse criticism was made of some details. Altogether the volume is a most valuable contribution to the discussion of the essential features of city charters, and the whole question of the best form of municipal government. The committee recommended a cessation of legislative interference in municipal affairs; large powers for the mayor, including the appointment of nearly all officials outside the city council; a great extension of civil service principles; short term franchises; and freedom for cities to acquire and operate all public utilities, if they see fit, bonds for investments yielding a revenue to be outside the debt limit. The report should be secured by all persons who are trying to frame or secure the adoption of new charters and by students of municipal government in general.

MUNICIPAL FUNCTIONS.—A Study of the Development, Scope and Tendency of Municipal Socialism. By Milo R. Maltbie, Ph. D. Vol. II., No 4 (Dec., 1898), of "Municipal Affairs." New York: Reform Club, Committee on Municipal Administration, 52 William St. Paper; 6 x 9 ins.; pp. 223. Price, 50 cts.

This is a most excellent summary of the extent to which the cities of the world have assumed control of the various services upon which the health, comfort, convenience and recreation of their citizens so largely depend. Police, Fire Departments, Charities, Education, Recreation, Street Facilities and Industrial Functions are some of the main chapter headings. Under "Street Facilities," streets, sidewalks, sewers and bridges are some of the subjects discussed. Cemeteries, markets, water, lighting and street railway plants are some of the most important topics under "Industrial Functions."

An occasional slip, or at least the conveying of a partial or wrong conception, occurs in a few instances where technical subjects are being discussed. Thus, under Garbage Disposal, it is stated that "most large American cities have garbage cremators," while, as a matter of fact, nearly all our largest cities that have any improved system of garbage disposal employ one of the reduction processes. Sewage disposal works, "in a large number of British and some inland German cities," are defined, in short, as chemical precipitation plants, after which the author speaks of broad irrigation and filtration. He also says, in speaking of the works now being constructed by Providence, that the sludge will "meet part of the cost of operation." This would be good news to Providence. Such slips, though to be regretted, do not greatly impair the usefulness of the monograph, which is designed to show what public services are now being performed by municipal corporations in all countries, rather than in what manner the work is being done. With this in mind, the study may be pronounced both unique and eminently successful.

MUNICIPAL MONOPOLIES.—A Collection of Papers by American Economists and Specialists. Edited by Edward W. Bemis, Ph. D., Professor of Economic Science in the Kansas State Agricultural College. New York: Thos. Y. Crowell & Co. 8vo., cloth; pp. 680; illustrated. $2.50.

It has come to be generally understood by intelligent men everywhere that certain classes of industries are, and of necessity must be, carried on without competition, and hence cannot be subjected to the same economic or statute laws as ordinary commercial industries. One important class of these natural monopolies, as they are frequently called, consists in supplying the inhabitants of towns and cities with water, drainage and light, and with facilities for passenger travel and for telephonic communication.

The book before us is an extended discussion of the experience of American cities, and, to some extent, of European cities also, in connection with these municipal monopolies, and of the legal and economic principles which underlie their treatment. It is the work, not of one author but of several, each one writing a chapter on a special subject. The titles of these chapters with their respective authors are as follows: "Water-Works," by M. N. Baker, of the editorial staff of Engineering News; "Municipal Electric Lighting," by Prof. John R. Commons, of Syracuse University; "The Latest Electric Lighting Reports," by Professor Bemis; "Validity of Electric Light Comparisons," by Prof. F. A. C. Perrine, M. Am. Inst. Elec. E., of Leland Stanford, Jr., University; "The Telephone," by Frank Parsons, Esq., of the Boston School of Law; "Municipal Franchises in New York," by Dr. Max West, of the Agricultural Department; "Legal Aspects of Monopoly," by Frank Parsons, Esq., and three concluding chapters on "Street Railways," "Gas," and "Regulation or Ownership," by Professor Bemis.

Electric lighting is given more attention than any other topic in the book, as is natural in view of the extent to which cities in this country have undertaken to supply themselves with electric light. One of the very best chapters in the book is the concluding one, in which the author discusses the relative merits and demerits of public regulation or ownership of these monopolies. His discussion is a fair and comprehensive one, and cannot fail to interest as well as instruct the reader. The chapter on the "Legal Aspects of Monopoly," is also deserving of especial commendation.

We cannot too strongly urge upon our readers to obtain and study this book. Its subject is one on which not only every engineer in the least interested in municipal work, but every intelligent citizen as well, needs correct information. It should be at least in the library of every engineer's club, in every public library, and in the library of every city official. The questions it discusses are bound to attract even more attention in the next decade than they have in the past one, and the engineer who engages in municipal work and neglects to inform himself on these much-discussed questions is likely to have occasion to regret his ignorance.

LIQUID AIR and the Liquefaction of Gases. Theory, History, Biography, Practical Applications, Manufacture. —By T. O'Conor Sloane, Ph.D. New York: Norman W. Henley & Co. 12mo.; cloth; pp. 365; illustrated. $2.50.

The "liquefaction of air" has become a popular fad. The newspaper, the magazine and the lecture platform have familiarized the public with this new wonder, until it has become as great a topic of interest as the X-rays were a few years ago. Now, when anything becomes a popular fad, all sorts of exaggerations concerning it become current, and are accepted as truth by the public, which, in technical matters, is generally unable to tell the true from the false. All sorts of ridiculous claims were made a few years ago for the X-rays. They were to be applied to a score of uses, where later and fuller knowledge has shown them to be wholly inapplicable. The same thing is being repeated in the case of liquid air. The popular lecturer or magazine writer who tells the public about liquid air wants to bring forward something big to interest his audience, and he generally leaves them with the impression that in some way or other liquid air has a great commercial future before it. Perhaps it has; but it is yet to be proved. At present it is a scientific toy, and investors in the stock of liquid air promoting companies should part with their money with the full understanding that its commercial value is at best problematical.

The book before us is the first upon its subject which has appeared, and it will doubtless attract a wide circle of readers. It is written in an entertaining style, its discussion is designed to be intelligible even to those who are not technically educated, and it brings together a mass of historical matter which was buried in pamphlets and proceedings of scientific societies. Notwithstanding these merits, the book is one to be used with the utmost caution. The reader does not finish the author's first chapter on elementary physics before he discovers that the author is writing upon a subject which he has not mastered. And thereafter, if he be wise, he will read with caution and keep a sharp lookout for other statements that will not bear critical analysis, and which, if accepted, would lead the reader far astray. For example, take the following definition of entropy:

> The world's energies which can be utilized by man are called available energy, or entropy. The world's coal is being burned up, its forests are being destroyed, machinery is adding to the irreclaimable energy of the world, and by the doctrine of the conservation of energy, is destroying that same quantity of available energy, hence the entropy of the universe is becoming smaller, day by day.

The author then proceeds to explain what he calls "a popular paradox." This is the old conundrum, "What becomes of the energy stored in a steel spring if it be placed in tension or wound up and then dissolved in acid." Our author suggests that there is no energy stored in such a spring. He puts forward the idea that the energy used in winding the spring is all transformed into heat, and that the reason it can do work after winding, is:

> As it drives the clock it gets cool, and the energy required to drive the clock is represented by this cooling. As air circulates around it, it recovers immediately any loss of temperature. But the clock is driven primarily by the heat of the air.

Such statements as the above would do credit to that once famous work, "Steele's Natural Philosophy," which misled many thousand school children a generation ago.

It may be said: What has all this to do with liquid air? It has everything to do with it, for the author uses this to build a foundation on which to harmonize Tripler's famous power-multiplication claims with modern science. Listen:

> The liquefaction of air has in it a germ, dimly recognizable, which may enable us to utilize the low forms of energy with which nature is charged. * * * * *
>
> Clerk Maxwell saw the possibilities of the utilization of the unavailable energies of the universe. It is provoking to know that our great ocean of air is pulsating with molecular energy which we do not utilize. Yet we do utilize it in a sense in compressed air motors, we call upon it in liquid air work, and Clerk Maxwell's dream of the utilization of the lost energies of the universe may yet come true by the application of liquid air and liquefied gases to motors.

Again, on pp. 288, 289, he has the following to say concerning Tripler's work:

> The key to his life's work has been the effort to use gases for motive power, Carnot's cycle giving the clew to what he has desired to accomplish. He desired to use the heat of the sun. If the first chapters of this book have been followed out to their conclusions, it will be seen that the utilization of the low grade heat energy of the universe, in accordance with Clerk Maxwell's dream, presents nothing of the essentially impossible. This heat Tripler hopes to utilize. If it is utilized, there will be a further demand made upon the heat of the terrestrial system, which will involve a reduction of temperature due to the conversion of low grade heat energy into mechanical energy. This involves a theoretical loss of temperature by the earth and its atmosphere from self-contained causes, and the loss would have to be replaced by heat derived from the sun.

It was a pity to drag in the honored name of Clerk Maxwell to holster up a perpetual motion delusion of the present day.

The book is well printed, and has a good index. We notice that several of the cuts have been reproduced direct from this journal, but its name has been cut off and the customary acknowledgment is omitted. The book contains a good deal of matter concerning the history of the liquefaction of gases, which would be interesting if one could rid one's self of the recollection of the serious breaks which are quoted above. The description of the apparatus used by Dewar, Pictet, Hampson, Linde, Tripler and others is good as far as it goes, which is not very far.