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EDITORIAL NOTICE.

The news issues of the Street Railway Journal are devoted primarily to the publication of street railway news and current happenings related to street railway interests. All information regarding changes of officers, new equipments, extensions, financial changes and new enterprises will be greatly appreciated for use in its columns.

All matter intended for publication must be received at our office not later than Wednesday morning of each week in order to secure insertion in the current issue.

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Contents of this Issue

Akron Power House Badly Damaged by Fire

The Northern Ohio Traction Company's new Akron power house was badly damaged by fire July 29. The loss will probably exceed $35,000. The fire started in the boiler room, where an exploding flue in one of the boilers scattered live coals about the room. Waste about an oil tank caught fire and an explosion followed. The boiler and engine room was almost totally destroyed and the generators were badly damaged by heat and water. The plant was installed by the Westinghouse company, and had but recently been turned over to the company by them. The fire tied up the Akron city lines and the Akron, Bedford & Cleveland Electric Railway until power could be secured from the Cuyahoga Falls power house.

The Street Car Float Idea Spreading

The street car float idea seems to have taken hold of the managers in the West. Since the inauguration of this idea during the Mardi Gras celebration in New Orleans there has been considerable talk by the Western managers of making this a feature of carnivals, etc., and since that time the float idea has been used to advantage in Milwaukee. Now it is announced that Wichita is planning to surprise its citizens by utilizing the floats in a coming festival in that city, and that President McGowan, of the Indianapolis Street Railway Company, is arranging to make the floats an important feature of the carnival in that city in October. As the ideas of the Wichita and Indianapolis managements are not known in regard to the design and subjects of their floats, it is probable that we may see some radical changes in both design and subjects.

Chicago Street Railway Questions Likely to be Submitted to the People

It is reported from Chicago that the street railway questions now being considered by the Street Railway Commission will be submitted to the people by an informal referendum if a satisfactory method of reaching the public can be devised. One proposed method of securing the suggestions of the people is to ask citizens to appear before the commission with their opinions. For this purpose a number of representative men will be asked, as the traction companies have been asked, to submit statements of their views for the consideration of the commission. To reach the people more directly and to submit propositions which affect them it is proposed that circulars be used. The questions of municipal ownership, long term franchises, and the terms which should be demanded in granting them, can be stated and opportunity for a statement of opinions given. The expressions thus secured will be formulated as a statement of public opinion.

Disappointments in City Census Returns

The citizens of Washington, Cincinnati and Buffalo, of which official returns as to their population have been made by the census officials, are greatly disappointed at the showing made by their respective cities. From all accounts, the citizens of Washington are deepest in their gloom, and the estimates of the local authorities on such subjects have been shattered. All sorts of estimates had been made regarding the wonderful growth of the city, but they were all destroyed by the official returns, which show no perceptible gain. How is this accounted for? This is the question they have asked themselves, and, after careful consideration, have laid the responsibility at the door of the electric railway, which has worked so many other wonders since the compilation of the last census. The suburban development stimulated by the wide and rapid extension of the electric railway is held accountable for the results. The increase in Cincinnati has been but 9.77 per cent for the ten-year period, and at Buffalo only 37.77 per cent for the same period, as against 64.8 for the period of 1880-1890. These are the first returns of the census officers, and as subsequent reports are made the estimates of population in other cities are liable to receive a serious shock. The electric railways have built up that portion of the country surrounding the cities which in the times of the horse car were inaccessible because of that slow mode of locomotion, and yet were not quite distant enough to build up a steam railroad traffic. In all, it has filled a long-felt want, and the latest reports show that it has even exceeded the expectations of its early champions, who predicted relief for the congested city districts on its advent.

Electricity on the Manhattan Elevated Railroad

General Superintendent W. E. Baker, of the Manhattan Elevated Railroad Company, of New York, has announced that the electrical equipment of the company's lines will be completed by Oct. 1, and that at least one trial train will be operated over its Second Avenue line by that date. The company's new power plant will not be sufficiently advanced to furnish power at so early a date, but the Metropolitan Street Railway Company will supply power temporarily from its new plant at Seventy-Fifth Street and the East River. The new electric trains will consist of six cars, instead of five, as at present, and will run on one-minute headway. They will consist of two motor cars, one front and one rear, and four regular passenger cars. The one additional car will permit of the handling of a considerable number of passengers, and will be especially useful in rush hours. The plans for the electrical equipment also call for the substitution of the gas lighting system now in use on the cars and in the stations with electric lights and the installation of a telephone system connecting all stations. Contracts are now being let for the installation of these systems. The motor cars will each be equipped with four 100-hp motors, thus giving a total of 800 hp to each train.

Collecting Fares on the Brooklyn Rapid Transit

The Brooklyn Rapid Transit Company has ordered that its conductors ring up the fare immediately after the passenger boards the car. This system has long been in use on the Coney Island & Brooklyn Railroad, and its adoption by the larger company is largely due to the apparent success there observed. W. W. Wheatley, general superintendent of the Brooklyn Rapid Transit, states that the new arrangement is not made as an experiment, but that after careful investigation the management has decided that without imposing unreasonable annoyance on the conductor it has a decided tendency toward preventing the "skipping" of fares, and for this reason it has been permanently adopted. Mr. Wheatley asserts that the conductors themselves, especially the older men, appreciate the advantages of the system, and are perfectly satisfied with the change. This is probably partly due to the peculiar sense of honesty with which such a large portion of the traveling public is affected. Many passengers who would attempt to ride free if they thought the railway company only would suffer and do not realize the severity with which "skipping" is looked upon, would condemn as the grossest meanness the cheating of a conductor out of a fare. Another advantage of the system is that dishonest conductors cannot fall back on the excuse of not having collected the fares when questioned by an inspector regarding discrepancies in the number of passengers and the register indications. In case a person boards the wrong car the conductor merely makes a note to that effect on the back of his day card, and is thus relieved of all responsibility. By the adoption of this system the former use of double registers has been necessarily discarded, cash fares and transfers being rung up on the same register.

Plans for a Chicago Subway

On July 25 President John M. Roach, of the Union Traction Company, of Chicago, presented the Street Railway Commission with detailed plans for the construction of a downtown subway system in Chicago. The cost of constructing the proposed subway is estimated at $25,000,000. In drawing the plans for the new tunnel careful consideration was made of the underground systems of London, Boston, Buda-Pest and the plans for the New York tunnel. The plan in general provides for the construction of six distinct loops diverging from a transfer point beneath the heart of the city, and include the construction of about 10 miles of underground road.

The following are the routes as proposed:

Dearborn Street Subway—Enter river tunnel at Michigan Street, to Madison Street, to State Street, to Randolph Street, to Dearborn Street.

LaSalle Street Subway—Enter river tunnel at Michigan Street, to Madison Street to Dearborn Street, to Randolph Street, to LaSalle Street.

Washington Street Subway—Enter river tunnel as at present, to Franklin Street, to Monroe Street, to Dearborn Street, to Madison Street, to Franklin Street, to Washington Street.

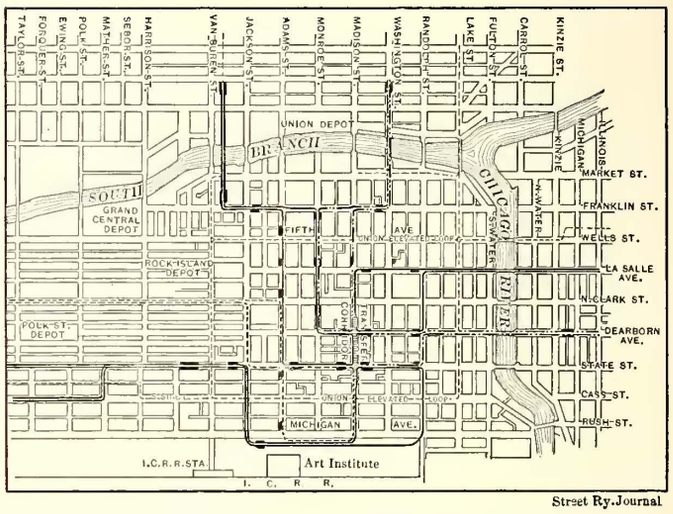
Van Buren Street Subway—Enter river tunnel as at present, to Franklin Street, to Adams Street, to State Street, to Madison Street, to Dearborn Street, to Monroe Street, to Franklin Street, to Van Buren Street.

Clark Street Subway—Enter at Twelfth Street, to Jackson Street, to State Street, to Adams Street, to Michigan Street, to Madison Street, to Dearborn Street, to Adams Street, to Clark Street.

State Street Subway—Enter at Twelfth Street (Wabash Avenue at Hubbard Court), to Jackson Street, to Michigan Street, to Randolph Street, to State Street, to Madison Street, to Michigan Street, to Jackson Street, to State Street.

The plan provides for the issuance of transfers at a station to be located under Madison Street, between Dearborn and State Streets. All loops are to touch this transfer corridor and thus permit of a ready change of cars by passengers.

According to the specifications, the bottom of the tunnel is 32 ft. below the street level. Underground work is provided for, sewer work and gas mains being placed above, instead of below, the transportation tunnel to prevent the escape of gases into the tunnel proper and lessen the danger in case of explosions.



Street Ry. Journal

GENERAL PLAN OF CHICAGO SUBWAY

The tunnel is to be 32 ft. wide and 14 ft. high, separated into two compartments for an up and a down track by a wall of masonry. The tracks are 30 ft. below street level, while the platforms are constructed about 15 ins. higher. Sewage, which in Chicago has proved an obstacle to all subway plans, is cared for by iron pipes on either side of the street, as well as one deeper system below the tunnel proper. Mr. Roach believes the upper sewers will drain surface water from the streets, while the smaller one below will furnish drainage for other wastes.

Between the top of the subway and the street level are conduits for telephone and telegraph wires, electric light cables, all city wires and pneumatic tubes. Compartments 6½ ft. deep and 5½ ft. wide are provided. President Roach has this to say of the plans:

"The plans were drawn hastily and without a study of details, such as I should desire. They embody features that seem to me desirable, and can be used to advantage by the commission. The street railway companies are not ready to make a proposition for the construction of any such system. The Chicago City Railway Company has not worked in the preparation of these plans, and it is likely some outside corporation would like to secure the right."

Special Meeting of the Massachusetts Electric Companies

At a special meeting of the stockholders of the Massachusetts Electric Companies held July 30 it was voted as follows:

"To amend the declaration of trust by changing the dates for the payment of semi-annual dividends of the preferred shares from the first days of June and December to the first days of January and July of each year.

"To approve the purchase of the stock of the Lowell & Suburban (12,000 shares) on the basis of two shares of preferred and one and one-half shares of common stock of the Massachusetts Electric Companies for each share of Lowell & Suburban stock.

"To approve the purchase of the stock of the South Shore & Boston (6900 shares) on the basis of one share of preferred and three-quarters share of common stock of the Massachusetts Electric Companies for each share of South Shore & Boston stock."

At the meeting President Gordon Abbott said in part: "The first fiscal year ends Sept. 30, and before the annual meeting on

Nov. 7 a full report of the year's operations will be sent to all the shareholders; meantime a few figures as of June 30 last may be of interest. When on that date a year ago the trustees organized they received either all or a controlling interest in the shares of thirty-one corporations, two of which were lighting companies. Since then four other companies have been acquired, including the South Shore & Boston and the Lowell & Suburban, whose acquisition you are asked to-day to approve."

He then referred to the consolidation into system of the various roads controlled by the company, and continuing said: "The results of the operation of the companies in which you are interested, excluding as before the Lowell & Suburban and the South Shore & Boston and also the New Bedford, Middleboro & Brockton, which company had not been acquired by the trustees at this time last year, are as follows, comparisons being made with the same period of the fiscal year, 1899:

	1900	1899	Increase	
Gross earnings.....	$3,102,518	$2,809,464	$293,053	10.4%
Operating expenses..	2,132,679	2,087,898	44,781	2.14%

Operating ratio 68.75%.

"For the same period of nine months the net divisible income, after deducting all interest and other charges, has increased by $207,893. These figures do not fully represent in the improvement in the net divisible income, for the following reason: Believing it wise to provide a general fund as an insurance against losses caused by accidents to persons, the companies in which you are interested mutually established such a fund at the beginning of the present fiscal year, and each company now makes quarterly payments of a percentage of its gross earnings. The balance to the credit of this fund on June 30 was $117,000. Inasmuch as damage cases are seldom settled until some months after the accident occurs and inasmuch as only those accidents which happened since the first of last October are properly chargeable to this fund, the companies have been paying a double charge during the last nine months, because while they have been making the payments to the new fund they have been at the same time obliged to settle a number of claims antedating the establishment of that fund; therefore, in making a strict comparison of the results it would be proper to add the balance of this accident fund to the increase in net divisible income, making the total increase $324,893."

The Utilization of Water Power for the Electric Railway System of Minneapolis and St. Paul*

BY EDWARD P. BURCH, CONSULTING ELECTRICAL ENGINEER

It is well known that within a few years a new dam has been constructed in this city across the Mississippi River just below St. Anthony Falls, that electricity has been generated by the power produced at the dam, and that the power has been utilized for the electric railway system of Minneapolis and St. Paul. It is the purpose of the lecture to review the engineering which has recently been accomplished in the utilization of this power.

THE MISSISSIPPI RIVER

The source of power is the upper Mississippi River, a peculiar stream; generally quiet and governable, yet at times of flood apparently beyond control. The flowage characteristics have been averaged year after year until we are certain of the general nature of the annual changes. By providing liberal margins we can predict with fair accuracy the amount of water which can be depended upon. These characteristics are given in Fig. 1, which shows the months of the year along the base line and the flowage in cubic feet per second vertically.

The flowage changes materially during the different seasons. During the first months of the year the lakes and great swamps in the northern part of our State freeze so solid that the flowage is greatly diminished. As warm weather comes on in April, the melting ice and snow invariably produces a flood, so that within a week of a spring break-up the volume may increase ten-fold. The summer flowage is several times greater than the winter flowage. There is commonly a second flood in September, after which the amount of water gradually decreases as cold weather comes on.

These characteristics of flowage are changing quite materially. The United States Government is constructing permanent dams at the outlets of the great swampy lakes on the upper Mississippi, thus forming immense reservoirs. The object of these reservoirs is to collect surplus water, principally in the spring and fall, which may be systematically released, especially in case of drought in midsummer or late in the fall. This storage capacity may ultimately become 100,000,000,000 cu. ft.

* Paper read before the Northwestern Railway Club, April 10.

Not only is the intensity of the spring and fall floods thus reduced, but navigation is facilitated and a more equitable distribution of water for power results. As this immense reservoir system grows, the curves of flowage become more nearly flat. At present the general mean minimum flowage in February is about

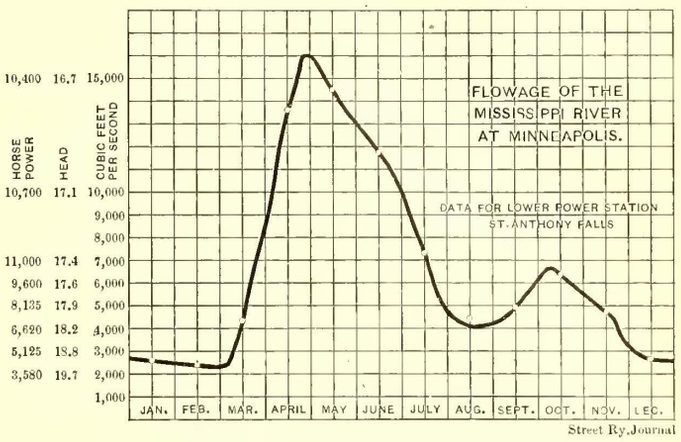


FIG. 1.—FLOWAGE OF RIVER AT MINNEAPOLIS

2500 cu. ft. per second, the spring flood commonly reaches 15,000 cu. ft. per second, and the summer flowage at least 6000 cu. ft. per second. By utilizing local storage the amount of power available may be increased 10 per cent at times of heavy demand.

ST. ANTHONY FALLS

Within the limits of the Twin Cities the Mississippi has a fall of over 110 ft. Just above the city limits there is what is known as Coon Rapids, where there is a fall of 20 ft. This power has not been developed. Between the Minneapolis Western Railroad bridge at Eleventh Avenue South in Minneapolis, and Fort Snelling bridge in St. Paul, there is a fall of 40 ft., along which the government has laid out and is now constructing locks and dams.

The main St. Anthony Falls, with a fall of 50 ft., have been utilized for forty years. With normal summer flowage, 6000 cu. ft. per second, about 25,000 mechanical hp are available and are used, largely for flour manufacturing.

CONSTRUCTION OF THE NEW DAM

St. Anthony Rapids, just below the main falls, has been developed within the last few years. The construction of a dam below what was formerly known as the "rapids" (now known as the lower power) had been in the minds of capitalists and engineers for many years. With normal summer flowage it was estimated that a dam giving a 20-ft. fall could develop 10,000 hp.

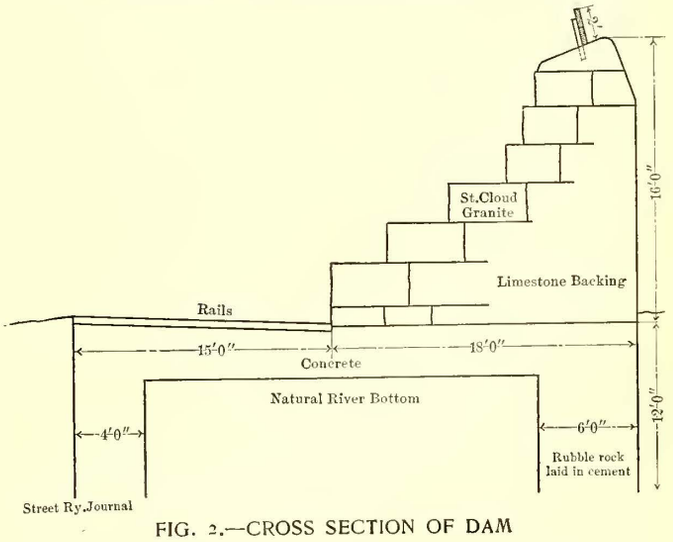


FIG. 2.—CROSS SECTION OF DAM

The riparian owners, St. Anthony Falls Water Power Company, having procured ample English capital, their hydraulic engineer, William de la Barre, started the construction of this new Lower Dam at St. Anthony Falls in May, 1895. The work was finished and turned over to an operating company Jan. 1, 1898. Fig. 2 shows a map of the upper and lower power at St. Anthony Falls.

In the construction of the lower power the general plan carried out was to build a dam directly across about two-thirds of the main river, then making an obtuse angle, run diagonally across toward the east bank to a power station at the foot of the canal or

head race thus formed. This plan of construction was a most advantageous one. The walls of the canal were built first, and on the dry east bank the great waste gates were installed and the power station foundations were completed, all during the first season.

The second year, 1896, the water of the entire river was de-

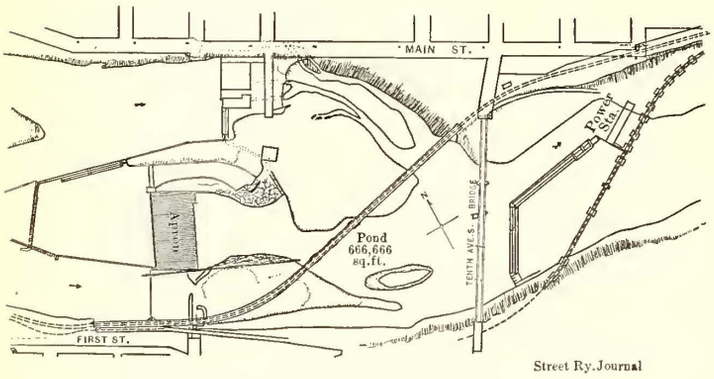


FIG. 3.—MAP OF UPPER AND LOWER DAM

flected from its old bed into the new canal and sent through the waste gates and also under the power station. A coffer-dam was then built across the old bed of the river. The main dam, located 2000 ft. below the upper falls was then started, and was nearly completed during the second year. At the beginning of the third year, the spring of 1897, a most disastrous flood, amounting to 60,000 cu. ft. per second, swept away the coping and other portions of this section. In repairing this break, a rock-filled, timber-framed approach, lined with steel plate was built in front of this section of the main dam, in order to ease the battering which piers, logs and ice give the structure.

Examining the plan as a whole, note that the great length of the dam allows the water to fall over a very long crest of the dam during a flood, thus lessening the wear and tear of the fall by distributing it over a greater surface. A cross-section of the main dam is shown in Fig. 3.

The dams are 1085 ft. long. The height of the dams is from

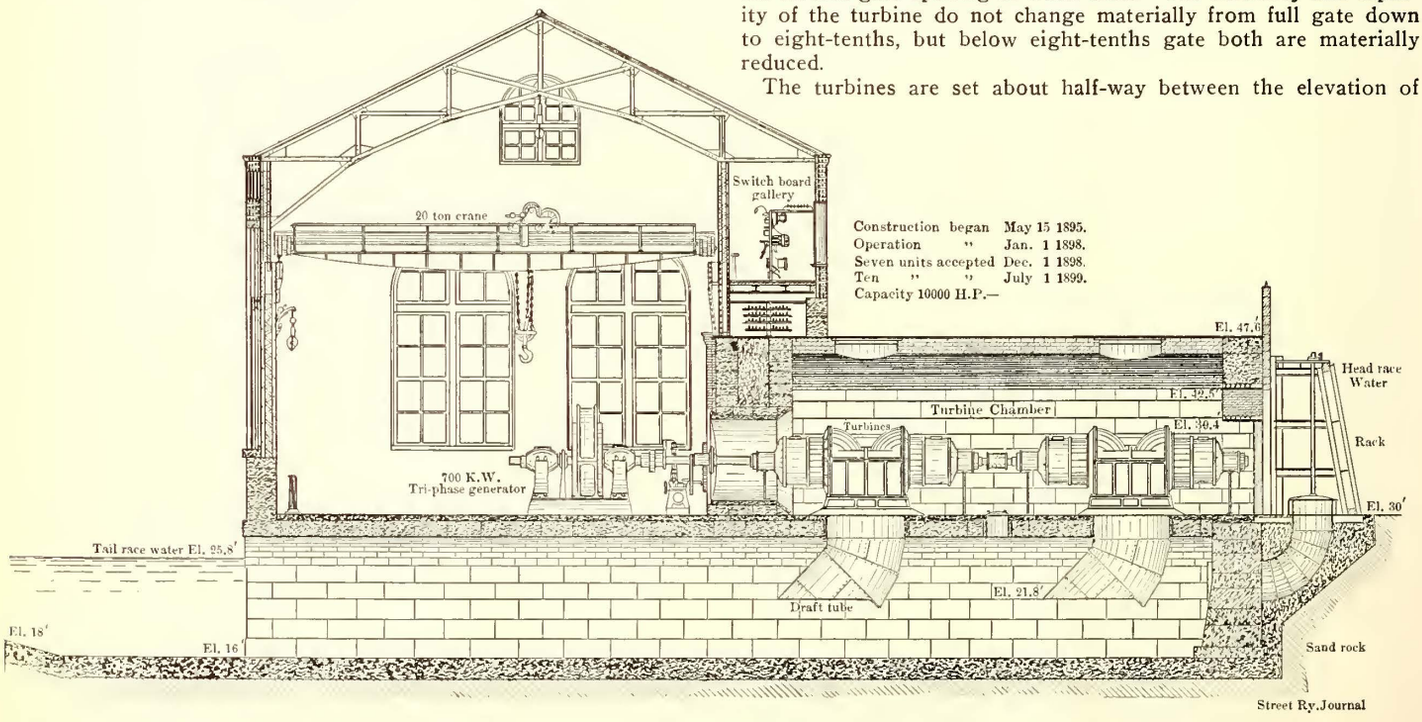


FIG. 4.—CROSS SECTION THROUGH LOWER STATION

14 ft. to 16 ft. above the river bed. Below the superstructure there is a 3-ft. base of concrete, 33 ft. wide. This base is especially well reinforced by a rubble rock and concrete dyke construction in the sand rock below the crest line of the dam and again at the toe of the dam. This will prevent undermining. The face of the dam is perpendicular. The down-stream side is so shaped or sloped as to ease the momentum of the water and discharge it horizontally, thus preventing an undertow which might prove fatal to the structure.

The main structure is of limestone from the quarries on the east bank of the river. The facings are of St. Cloud granite. The coping is lined with skeleton steel plate and the base of the dam with steel rails in 15-ft. lengths laid side by side in cement. These rails are laid with their outer ends 6 ins. higher than the end next to the dam—thus a pool of water is formed which acts as a cushion and protects the concrete work from erosion.

THE STATION

The power station forms 200 ft. of the dam. Inside, it is one large room 250 ft. long, from 45 ft. to 55 ft. wide, and 50 ft. high inside. The station is heated by electric heaters; a 20-ton traveling crane is provided.

The station, shown in section, Fig. 4, is built on solid sand rock. First, a concrete base, the present tail-race floor and foundation for tail-race arches, was laid 2 ft. thick under the power station. The top of ten tail-race arches forms the floor or substructure of the station. The turbine chambers and the tail-race arches are spaced horizontally 20 ft. apart from center to center. Large sulice gates allow a by-pass for the water in front of the chambers to the race below. In front of the entrance to the turbine chambers, a structural steel framework is formed to support the racks—a steel screen of ¼ in. iron, 3½ ins. wide and spaced 1 1-3 ins. apart, to prevent the entrance of floating logs, bark and ice.

THE TURBINES

In the water chambers ten large turbine units were installed. The capacity of each unit is approximately 1150 hp on 20-ft. acting head at 130 r. p. m. The capacity of the turbines varies as the square root of the cube of the acting head. There is one speed on any given head at which they run at highest economy, this speed varying with the square root of the head. Thus, on 17½-ft. head the horse power would be

$$1150 \times \sqrt{\left(\frac{17.5}{20.0}\right)^3} \text{ or } 940,$$

and the most economical speed 121.6. If a higher or lower speed is used on 17½-ft. head, the horse power capacity of the turbine is materially less. At 190 r. p. m. the horse power capacity is naught.

The object of the turbine governor is to provide a speed of 130 revolutions, given any head and any load which may be on the generator. This is done by a centrifugal governor which controls the turbine gate opening or water inlet. The efficiency and capacity of the turbine do not change materially from full gate down to eight-tenths, but below eight-tenths gate both are materially reduced.

The turbines are set about half-way between the elevation of water in the head and tail-race. The pressure above the turbine runner and the suction from the draught tubes together form the head on the turbine. Should the normal elevation of water in the head race increase 2 ft. during a common spring or fall flood the normal elevation of water in the tail-race would make a corresponding increase in elevation of 5 ft., or even above the floor of the power station should the flowage amount to 30,000 cu. ft. per second. The result is that during a flood there is a smaller quantity of water per turbine and a much lower acting head. Therefore, the capacity of each unit and of the power station is

always the least when the quantity of water in the river is greatest and vice versa. Floods as well as droughts are thus undesirable.

The acting head on the turbines is nearly 1 ft. less than the fall of water produced by the dam. This is due to friction losses

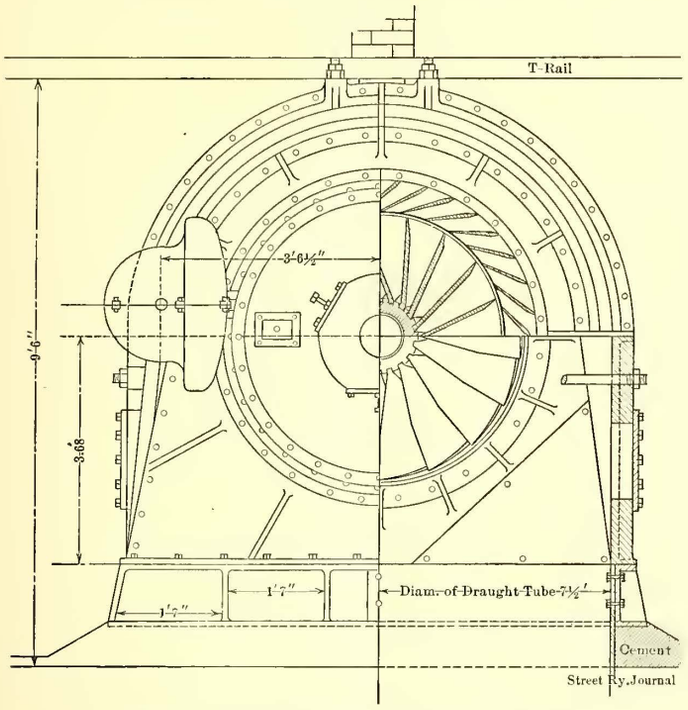


FIG. 5.—CROSS SECTION OF 46-IN. TURBINE

past booms, through racks, eddies in the turbine chamber, and the piling up of the water discharged by the draft tubes.

Drawings of the turbines are given in Figs. 5, 6 and 7.

Each 1150-hp turbine is directly connected to a 1000-hp electric generator, the turbine shaft passing through a water-tight flume cover into the generating room. Ten 1000-hp and two 150-hp generators have been installed. The generators are of two classes or types, well adapted to the work of distribution to be referred to later. The power, after being converted into electricity, is sent to the switchboard in the gallery, where it may be controlled and distributed.†

THE TWIN CITY RAPID TRANSIT COMPANY'S ELECTRIC RAILWAY SYSTEM

The power service is now ready. One of the corporations to whom propositions were sent on the sale of the power, was the Twin City Rapid Transit Company. This company has an electric railway franchise, owns and operates the entire electric railway system of Minneapolis and St. Paul. It has 240 miles of track in service. Its annual revenue is over $2,500,000, coming nickel by nickel from 50,000,000 passengers. Its annual car mileage is 13,000,000. The maximum number of cars in ordinary daily service is about 400; in maximum service, 550.

From 1891 to 1897 it had four steam plants with a capacity of 11,500 hp, equipped with modern boilers and engines and fairly modern generators. These plants were distributed as shown.

By a consolidation into one large power station, many savings due to the cheap water power, decreased labor, repair expenses and distribution losses were apparent.

A forty-year lease of all the power produced by the dam was effected by the railway company about Jan. 1, 1897. The choice of generating machinery, transmission and distribution plans and equipment was left to the railway company.

TRANSMISSION AND DISTRIBUTION

Without detailing the investigations made by the company, we can say briefly that exhaustive study was made of the most modern electric plants in the country, of most improved methods of transmitting and distributing large blocks of power over long distances.

Given 10,000 hp at the dam, the problem was to convert this power into electrical energy and distribute it to 500 cars scattered over two cities. About sixty of the heavier cars were within a mile of the station. The generation and transmission of 2000 hp for these sixty cars was planned and carried out by using low voltage direct current. This low voltage, 600 volts, is adapted only for short transmissions. It was necessary to send 3000 hp to No. 1 steam station, now known as a sub-station. The distance from the water power station to this sub-station is 1½ miles. For this transmission it was necessary to employ alternating currents and to use a pressure six times as high as that used for the short and ordinary transmission just referred to.

Similarly, 100 hp is sent to No. 2 steam station, now a sub-station. For St. Paul 2000 hp was sent to No. 3 sub-station, formerly the old steam plant, and 2000 to sub-station No. 4, a building and location especially selected for the purpose.

Alternating current apparatus is necessary for economical and structural reasons when we will transmit large blocks of power over long distances. High pressures are necessary in order to reduce the first cost of apparatus and in order to decrease transmission losses.

If you were going to transmit a million gallons of water 1 mile per day, a small-sized pipe and moderate pressure, 60 lbs. per square inch, would be used. If you were to transmit a greater quantity of water and several miles, you *could* increase the size of the main, reducing the friction loss materially. A better plan, however, one involving less first cost, might be to use the small pipe and raise the pressure to, say 1200 lbs., as oil is transmitted in Ohio.

Similarly, in transmitting large blocks of electric power over long distances, good engineering calls for small conductors and high pressure.

The two transmissions to St. Paul were especially long, 7 and 9 miles. It was necessary to use 12,000 volts, an extraordinarily high pressure, in order that the cost of cables and the losses in transmission might be reduced. Twelve thousand volts was the highest pressure heretofore carried for heavy power distribution

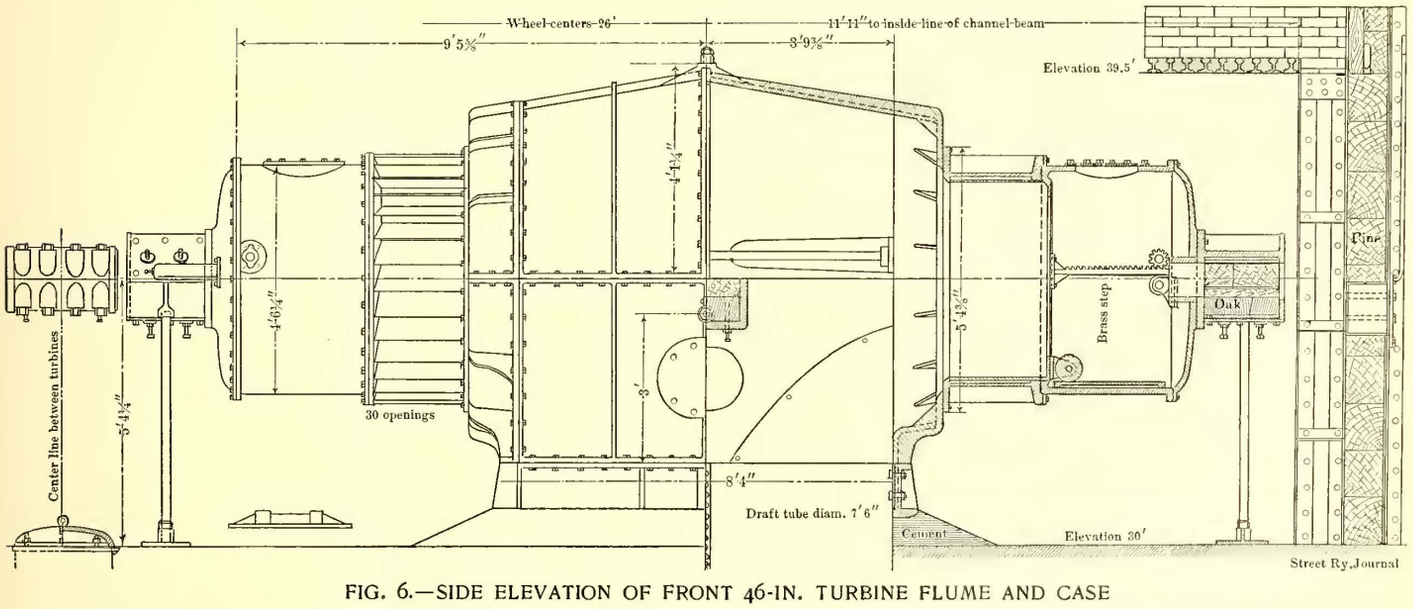


FIG. 6.—SIDE ELEVATION OF FRONT 46-IN. TURBINE FLUME AND CASE

† Additional notes on station and other equipments will be found in *American Electrician*, May, 1898; *Street Railway Review*, February, 1899; STREET RAILWAY JOURNAL, June, 1897; *The Electrical World*, Oct. 8, 1898.

in underground cables, and many were the prophecies of failure. One cable, 2 ins. in diameter, was used for each 2000 hp transmitted. Each cable contains three wires, each .4 in. in diameter, separated and insulated from each other and from a lead sheath by common manilla paper impregnated with resin oil, linseed oil and other insulating compounds. The cable is drawn in cement conduit

An attendant is required to supervise the transforming and converting apparatus at the sub-station and to care for the low tension railway distributing switchboards. Copper feeders distribute the power from these switchboards to the different trolley seetions. Over 1,200,000 lbs. of copper are required for these local distributions. The current at the car is under the control of the

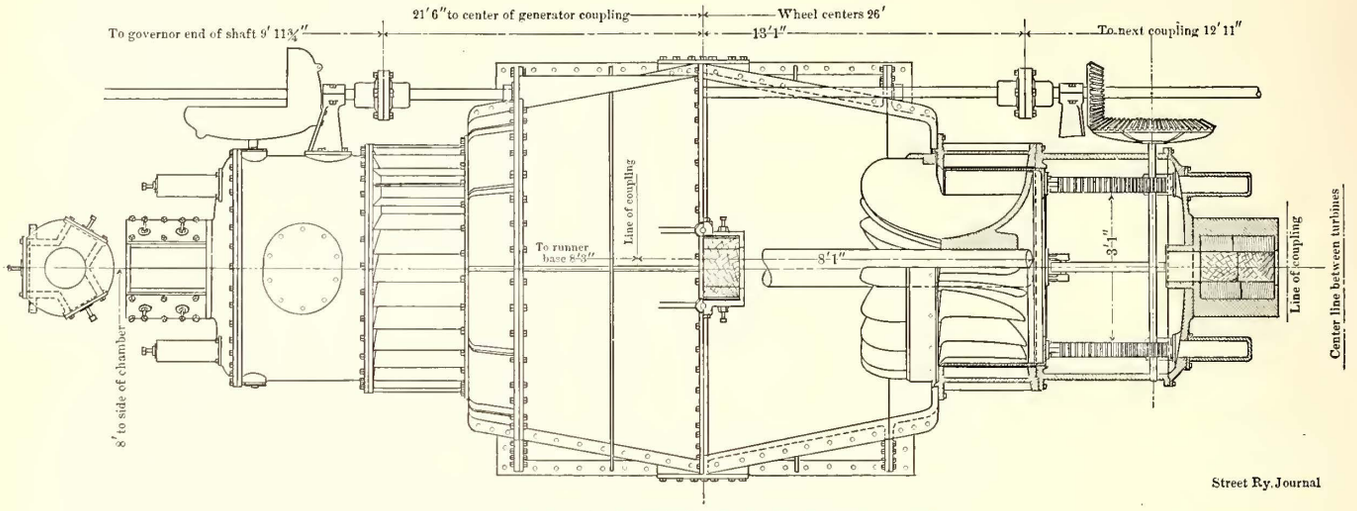


FIG. 7.—REAR 46-IN. TURBINE FLUME AND CASE

ducts 3 ins. in diameter. These ducts are protected by concrete and are laid about 3 ft. below the roadbed. Manholes are located every 500 ft. for the purpose of drawing the cables in the duct, making cable splices and for inspection and repairs. Drawings of cables and splices are reproduced in Fig. 8.

SUMMARY

Reviewing the complete cycle, let us start over again with the water which formerly tumbled down the rapids below St. Anthony Falls. It has been dammed, a pond formed and a fall of 18 ft. produced. The falling water, in passing through the turbines, develops 10,000 hp, which is converted into elcctric power by the generator attached to the turbine. Direct current of low pressure is provided by two of the 1000-hp generators, while alternating current of moderately high pressure is generated by the remaining eight generators. All the electric power is first carried to a switchboard in the gallery. The operating electrician can start the generation of current, vary the amount, and read from the meters the amount developed. By means of switches, varying amounts are sent to the different sub-stations to meet the changing conditions of load and service. The low voltage direct currents are sent to the nearer lines, especially for the heavy interurban service. Medium pressure alternating currents, at 3500 volts, are sent to the Minneapo.is sub-stations, and the extremely high pressures, 12,000 volts, are sent to the St. Paul sub-stations.

It may be interesting to state that the transmission of 2000 hp cver 9 miles to the further St. Paul sub-station, at 12,000 volts pres-

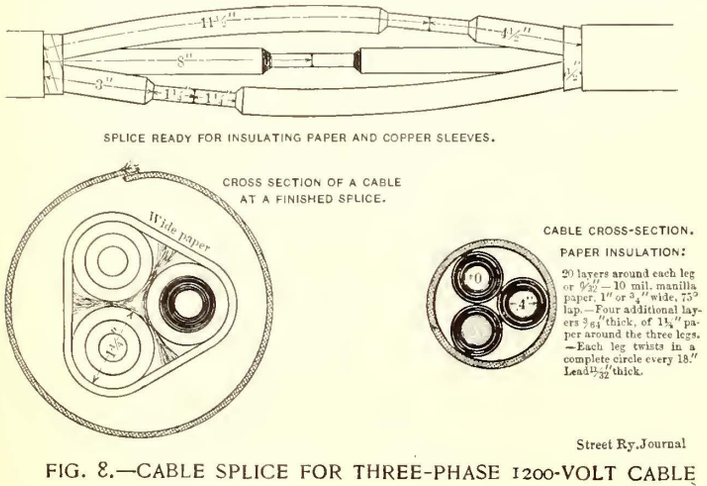


FIG. 8.—CABLE SPLICE FOR THREE-PHASE 1200-VOLT CABLE

sure, is accomplished with a cable loss of but 5 per cent of the power so transmitted.

At the sub-station the alternating current is reduced in pressure and converted into direct current, after which the sub-station operator sends the power through his local distributing switchboard.

motorman, who uses it for the motors on the trucks beneath the ears.

In this railway system there are three interurban lines; the longest, 22 miles long, between St. Paul and Stillwater, has on the car equipment air brakes, air whistles and are-lamp head lights. It makes 44 miles per hour, maximum speed; has a schedule of 22 miles per hour. Each car has a telephone used for dispatching cars. Long 10 per eent grades are mounted. All interurban cars are double truck, 44 ft. long, weigh from 18 to 22 tons, and seat fifty-two passengers.

The efficiency of the whole power system is very low. There is a 5 per cent loss due to booms, racks, eddies, etc., near the station, so that we may say the efficiency of the falls is 95 per cent.

	Maximum per cent	Ordinarily per eent
The efficiency of the turbines	80	78
The efficiency of the generators	95	94
The efficiency of the station distribution	92	90
The efficiency of the conversion to direct current	94	91
The efficiency of the local distribution	90	92
The efficiency of the railway motors	80	70

So that of the 10,000 hp developed by the turbines, the railway motors could not get 5900 mechanical horse-power at highest efficiency and not over 5000 hp during ordinary operation. Moreover, 50 per cent of all the power delivered to the motors is spent in acceleration, only to be destroyed in the same block by braking. The motor tractive effort is very high, 25 lbs. per ton, compared with 5 lbs. per ton in steam railroad service.

The cost of the entire power service on this system is but 14 per cent of the total cost of operation of the system.

In closing the lecture, let us eonsider for a minute the application of an entirely similar system for *steam* railroad service.

The amount of the steam railroad business in this country is not large. The Twin City Rapid Transit Company's passenger service was $2,500,000 last year, while the entire steam passenger service of the country during 1899 is given by one authority as $330,000,000. A far greater problem for the engineer's consideration is the freight business, amounting to $880,000,000 per annum.

The power might be generated by steam or gas engines if water power was not available, but the general plan of the station, the polyphase generators, the transmission, the sub-station and utilization could be quite similar to the system above described.

Many of the steam railroad systems in and radiating from the Twin Cities present quite favorable conditions for the substitution of electricity for steam. This is particularly true where the public appreciates and will use better transportation facilities. By better, we mean faster service, lower fares and more frequent train service. Where these conditions can be worked out, the motive power can be changed from steam to electricity with a resultant deerease in operating expense per passenger earried.

The heavy service on lines in thickly settled districts and between our cities and towns will adopt electrieity first, after whieh the main trunk lines, with their light passenger service, and later

the heavy freight trains will follow, when the management finds electric service is satisfactory as a motive power and in financial results.

The first few years of the coming century will see rapid progress along these lines. Some of the members of the Railway Club will be found engaged in this development.

DISCUSSION

Prof. G. D. Shepardson—Mr. President, there are about three points that I could speak of in which the Twin City Rapid Transit Company has been one of the pioneers.

One is the general adoption of electricity for power. I believe that when the horse cars were finally dropped in the Twin Cities this was the largest electric street railway system in the world. Since that time some of the Eastern cities have exceeded these cities in the number of cars and number of miles of track. This system also I believe is one of the first of the interurban roads, that is, in connecting neighboring cities. Nowadays it is nothing at all uncommon to find electric railway lines connecting neighboring cities. I think at present the longest continuous line in operation is one between Detroit and Ann Arbor, Mich., where there are 40 miles in one stretch. But at the time the interurban road was put in between Minneapolis and St. Paul I believe that was the longest electric railway line in the world.

The other point in which the Twin City Rapid Transit Company has been a pioneer is in the transmission of power at a high pressure for a considerable distance under ground. The speaker of the evening mentioned to-night the difficulties which were expected to arise, but I believe this is the first case where energy has been transmitted so long a distance, at such a high pressure, under ground.

It is a point of considerable interest to know that the telephone people were terribly disturbed lest the high pressure alternating current which was being sent under ground should be a disturbing factor on their telephone lines. This was the only place in the country where they could examine the matter, and the telephone engineers came here from Boston, New York and other Eastern places to examine the system.

So, in at least three particulars, the Twin City Rapid Transit Company has been a pioneer.

I suppose I might add a fourth way, which is not, perhaps, so favorable to railway people, and that is that the vigorous competition between the trolley roads and the steam roads had its effect, and the short line trains were gradually abandoned. That experience has been duplicated in other places since, but I believe that this is the first place where the trolley cars successfully competed with the short line steam roads.

It is interesting to notice that the steam railroad people have adopted the very means which have taken from them a great deal of business, and in quite a number of cases the steam roads have adopted the practice of trolley service on their short lines, with a marked diminution in running expenses and a marked increase in profits. As the speaker said, when we increase the frequency of the service we increase the amount of travel.

The Twin City Rapid Transit Company has been one of the pioneers in other improvements than those already mentioned. About the first instance where street railway feed wires were placed under ground was on Nicollet and First Avenue South in Minneapolis. The "jumper system" of connecting the different sections of the conductors by means of fuses around the circuit breakers was worked out in Minneapolis, the idea having been proposed, I believe, by Mr. Burch; this plan has since been adopted by many large roads, since it reduces the fluctuations of load on the individual feeders as well as upon the power house; it maintains a better pressure upon the lines and thus enables a higher speed to be secured; it reduces trouble at the switchboard and at the power house as a result of the less fluctuation of current, and it is of especial value in case of congested traffic at unusual points. The series-parallel controller, in universal use at present, is the result of the experience of many roads and many men, and it is a matter of some pride that two members of this club, Mr. Burch and Mr. F. W. Springer, of the University of Minnesota, are entitled to the credit for designing the controller which has been in use for a number of years on the Twin City lines and which was practically the first one that proved to be a really successful device; this effected a saving of fully 20 per cent of the power formerly required for operating the cars. I may be pardoned for mentioning in this connection that I had the honor of being the first to discover the true explanation of the curious phenomenon known as "bucking," in which a car suddenly and violently stops as if by a collision; this had been previously considered as a mysterious visitation of Providence that was inexplicable except in a very few cases; by careful examination of a number of cases occurring in this State, the speaker finally located the invariable conditions which caused the trouble and was able to demonstrate a method for making such accident impossible. The safety gates, now so common, were first applied to street cars in Minneapolis, although somewhat similar to those on the elevated roads.

Secretary Foque—Mr. Burch spoke of the generator shaft being extended 2 ft. beyond the bearings, the idea being to eventually put on a vertical direct-connected engine. Is that in case of the failure of the water power?

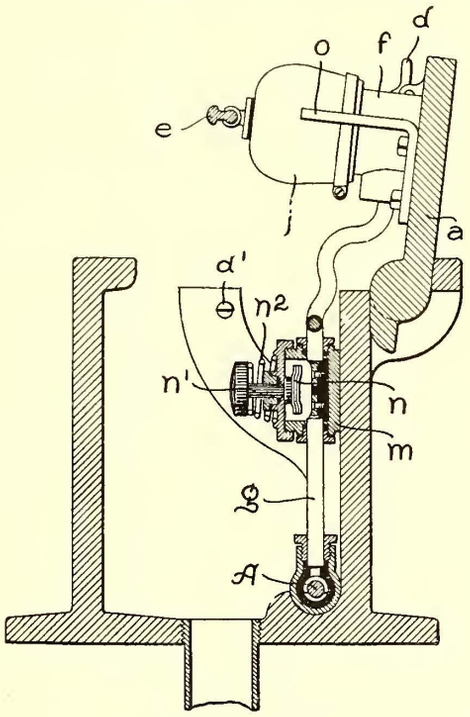
Mr. Burch—When the electric railway traffic and load grow beyond the capacity of the river in winter, reserve engine capacity is needed. The original plan was to have this equipment at the station. It is not probable that this plan for reserve or for additional capacity will be carried out in this way.

Street Railway Patents

[This department is conducted by W. A. Rosenbaum, patent attorney, 177 Times Building, New York.]

UNITED STATES PATENTS ISSUED JULY 31, 1900

654,586. Conduit Electric System; F. M. Ashley, New York, N. Y. App. filed Feb. 26, 1898. The invention in general consists of a conduit provided with a removable plate to which the main portions of the working mechanism inside of the conduit are attached. The construction is also such that when the cover



PATENT NO. 654,586

is removed the circuit between the main and sectional conductor is open.

654,868. Electric Railway; G. A. Lyncker, Munich, Germany. App. filed April 23, 1900. This is a sectional conductor system in which the magnets which close the branches between the main conductor and the sections are energized by a battery carried on the car.

654,670. Snow Plow; M. Perreault, St. Thomas de Joliette, Canada. App. filed April 7, 1900. This plow is adapted to lift the snow from the track, divide the mass of snow in two parts and separately discharge the divided mass on opposite sides of the track. The invention relates particularly to the construction of the framework and to the devices for raising and lowering the edge of the plow.

654,803. Trolley Wheel; S. G. Reynolds, Easton, Pa. App. filed Dec. 11, 1899. The wheel consists of a center cored out to receive a felt packing, and removable side discs, the center and discs having interlocking parts and the whole provided with an axial pin adapted to be locked by means of cotters, or otherwise within the jaws of the fork at the upper end of the trolley pole.

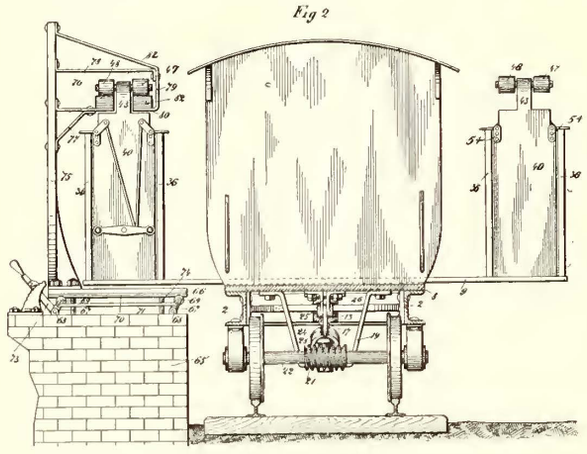
654,805, 654,806, 654,807, 654,808, 654,809. Automatic Brake Shoe or Block; W. H. Sauvage, Denver, Col. Apps. filed Oct. 30, 1899, and Nov. 13, 1899. These inventions are all modifications of the one idea of utilizing the rotary movement of the wheel to apply the brake, the invention consisting specifically of the details of construction of the brake shoe and the rigging.

654,820. Railway Cross Tie; W. M. Woodworth, Sycamore,

Ind. App. filed Feb. 20, 1900. The tie consists of a flat plate having wooden blocks strapped to it, upon which the rails rest.

654,825. Device for Transporting Passengers from and Onto Moving Cars; E. F. Böttcher, Lengenfeld, Germany. App. filed June 10, 1898. The car carries a rotary platform on which rests a number of small cabs. A person or persons desiring to leave the car at a station will step into one of the cabs, whereupon the platform is rotated to swing the cab into line with a receiving rigging built on the station platform. This rigging lifts the cab from the platform while the car is in motion.

Fig 2



PATENT NO. 654,825

654,854. Car Fender; G. D. Smith, Paterson, N. J. App. filed March 30, 1900. The net is supported in such a way that a body falling into it will cause it to assume a basket shape to retain the body and prevent its rebounding.

PERSONAL MENTION

MR. JOHN SCULLIN, the St. Louis street railway magnate, has just been elected president of the Wetmore Tobacco Company, to succeed Mr. Moses C. Wetmore.

MR. E. S. REILLY, manager of the West End Traction Company, of Pittsburgh, has started for Europe, where he intends to sojourn for about two weeks. Mr. Reilly intends to visit the Paris Exposition.

MR. E. C. FOSTER has not been appointed general manager of the Massachusetts Electric Companies, as reported in the Street Railway Journal for July 28, but has had his duties increased so that he is now manager of the individual companies controlled by the Massachusetts Electric Companies.

MR. GEORGE L. COOKE, who has been in charge of the Interstate Consolidated Street Railway system for the past six years, has been advanced to the position of superintendent of the Pawtucket Street Railway, and will, in addition, have entire charge. Mr. Cooke succeeds Mr. Charles F. Luther, who was connected with the Pawtucket corporation for more than a dozen years.

MR. CHARLES OLIVER, Chief Railroad and Tramway Commissioner of New South Wales, who has been making his headquarters while in New York with R. W. Cameron & Company, 23 South William Street, expects to sail on Aug. 11. By that time Mr. Oliver hopes to have completed the awarding of contracts for the extensive work being done on the Sidney railway system. The General Electric Company has undertaken the contract for supplying the equipment of the main power station, and it is stated that nearly all apparatus, engines, material, etc., will be furnished by this country. The work is expected to continue for at least two or three years, so that it is quite possible that Mr. Oliver may favor the United States with another visit in the near future.

NEWS NOTES

[*News notes for this department are solicited.*]

DERBY, CONN.—The Derby Street Railway Company has decided to abandon Lake Housatonic Park as a pleasure ground.

BRIDGEPORT, CONN.—The stable of the Bridgeport Traction Company was destroyed by fire Aug. 1. Seven horses were burned to death.

NEW HAVEN, CONN.—At the annual meeting of the stockholders of the Winchester Avenue Railroad Company, July 30, Israel A. Kelsey was deposed as director of the corporation and at a subsequent meeting of the directors Mr. Kelsey was deposed as vice-president, Samuel Hemingway being elected to both positions. Mr. Hemingway is also vice-president of the Fair Haven & Westville Railroad. Henry S. Parmelee was re-elected president, Henry F. Spencer secretary, and Albert E. Pond, treasurer and superintendent. The following directors were elected: Henry S. Parmelee, S. Harrison Wagner, Albert E. Pond, Henry F. Spencer, Samuel Hemingway, John B. Carrington, E. Hayes Trowbridge, George D. Watrous, James S. Hemingway.

WASHINGTON, D. C.—The Washington Traction & Electric Company has just completed the extension of its lines from North Capitol Street via Michigan Avenue to the Catholic University, where connection is made with the old Brookland Street Railway. The cars are now run from Penn Depot to Brookland over the new route, and its city lines. The use of the tracks from Albany Street to the Catholic University has been discontinued at least for the present. Work is rapidly progressing on the rebuilding of the Washington Traction & Electric Company's tracks in Eckington.

SAVANNAH, GA.—It is said that the Savannah, Thunderbolt & Isle of Hope Railway Company will shortly make application to the City Council for permission to lay a second track on Barnard Street, and two switches on Whitaker Street. This action will be preliminary to a change in the operation of the lines.

CHICAGO, ILL.—While going north in Superior Avenue, South Chicago, a few nights ago an electric car of the South Chicago City Railway left the track and ran on the sidewalk in front of 8421 Superior Street, demolished the car and injured two passengers.

CHICAGO, ILL.—Traffic on the Metropolitan Elevated during July showed a daily average of 73,790 passengers, as compared with 67,498 during the corresponding month of last year. This is a gain of 6292. The gain is small, and this is due to the labor troubles, which have had a severe effect on West Side travel. The traffic by months, with a comparison for 1899, follows:

	1899	1900
January	72,338	88,585
February	75,344	92,618
March	79,243	94,508
April	77,464	90,430
May	75,890	86,288
June	72,433	82,206
July	67,498	73,790

CHICAGO, ILL.—The Appellate Court has sustained the decree of the Circuit Court, made in July, 1897, ordering the sale of the Alley L elevated road and its appurtenances and the division of the proceeds between the two mortgages. There were no new legal points covered, and the decision is of importance only to the stockholders of the company operating the road, whose title is strengthened. The Chicago and South Side Rapid Transit was built in two sections, the first section extending from Congress Street to Sixty-Third Street, and the second section from Calumet Avenue to Stony Island Avenue, along Sixty-Third Street. To pay for the construction of the first section bonds to the amount of $7,000,000 were issued, and secured by a trust deed on the section, made to the Northern Trust Company as trustee. To pay for the construction of the second section bonds to the amount of $3,000,000 were issued, and secured by a trust deed on both sections, made to the Illinois Trust and Savings Bank as trustee. On default of interest the Northern Trust Company asked foreclosure of the first mortgage on the first section, and the next day the Illinois Trust and Savings Bank filed a cross bill for the foreclosure of the blanket mortgage on both sections. The court ordered the property sold, the proceeds to be divided between the two sets of bondholders, in the proportion of 75-93 to the first set and 18-93 to the second set. The property was bought in by the bondholders and divided between them in that proportion. The stockholders of the original company claimed that the whole bond issue was void; that the franchise forbade any company but the original one ever to own the road, and that the practical result of the foreclosure was to wipe out and destroy the property interests of the stockholders in the original company.

CHICAGO, ILL.—South Side Elevated traffic during July showed a daily average of 60,972 passengers, as compared with 52,644 for the corresponding month of last year, or an increase of 8328, equal to 15.8 per cent. The record is the smallest this year up to the present time, as July is a poor month for elevated road travel. The record so far this year, with a comparison with 1899, follows:

	1899	1900
January	58,762	69,504
February	60,292	70,050
March	63,909	72,264
April	63,878	71,665
May	50,588	68,296
June	56,117	67,892
July	52,644	60,972

ANDERSON, IND.—The perversity of a citizen of Summitville resulted in a funny legal complication a few days ago. The citizen in question having received a permit to move a house, proceeded with the work in the day. In its course the house was to cross the tracks of the Union Traction Company, and as soon as the officials of the company were advised of the movement they obtained a restraining order. The order was served just as the house was crossing the tracks, and the men when served with the notice immediately quit work, and left the structure on the tracks. The company then brought mandamus proceedings, and the court ordered the building taken away, but the men refused because lawyers advised them that the restraining order had not been dissolved. The company went with a force of men to remove it, but were stopped by the citizens. Passengers were transferred around the house, from one car to another, until the legal difficulties were overcome.

INDIANAPOLIS, IND.—The interurban electric railways entering this city still protest against the provisions of the franchises offered them by the city. The objections are against the clauses which require universal trans-