Street Railway Journal

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THE SYSTEM OF THE NEW ORLEANS & CARROLTON RAILROAD COMPANY

The New Orleans & Carrollton Railroad Company undoubtedly has one of the finest equipped and operated street railway properties in the United States. The system, as now operated, is the result of a consolidation in 1899 of the Canal & Claibourne Railroad and the New Orleans & Carrollton Railroad. At the time of the consolidation the track and rolling stock was overhauled and renewed to such an extent that the system stands to-day as practically a newly equipped road. A map of the system is shown herewith, Fig. 2. It will be seen that it constitutes a belt line around the city, with four branches, and a terminus at the levee at the foot of Canal Street, where nearly all the street railway routes of the city terminate.

The greater part of the mileage is through a well populated part of the city. Of the belt line the part on St. Charles Avenue, Tulane Avenue and Carrollton Avenue is on what is known in New Orleans as "neutral ground," as seen in Fig. 3; that is a strip of ground maintained as a park in the middle of the street, and covered with grass and trees. Many streets in New Orleans have this neutral ground, and it is one of the distinguishing characteristics of the city. The neutral ground makes an ideal place to operate a street railway. There is no annoyance from team traffic, and the sod on the roadbed does away with the greater part of the noise and dirt that usually accompanies street railway operation. The New Orleans & Carrollton Railroad is fortunate in having so much of its track on neutral ground, and it has improved its traffic drawing opportunities in this respect by putting on fine rolling stock, well suited to the conditions, laying heavy rails to give smooth riding, and treating the public courteously through its employees. Some idea of the property can be had from the financial statement for 1900, which is as follows. It will be noticed that both receipts and expenses are low, as compared to Northern roads, although receipts per mile of track are correspondingly high:

Gross earnings from operation	$701,058.75
Operating expenses	362,592.28
Net earnings from operation	$338,466.47
Income from other sources	7,516.17
Gross income	$345,982.64
Deductions from income	202,599.82
Net income	$143,382.82
Car miles run	4,442,910
Earnings per car mile	$0.1585
Expenses per car mile	0.0808
Receipts per mile of track	21,664.65
Dividend on stock paid for 1900	8%

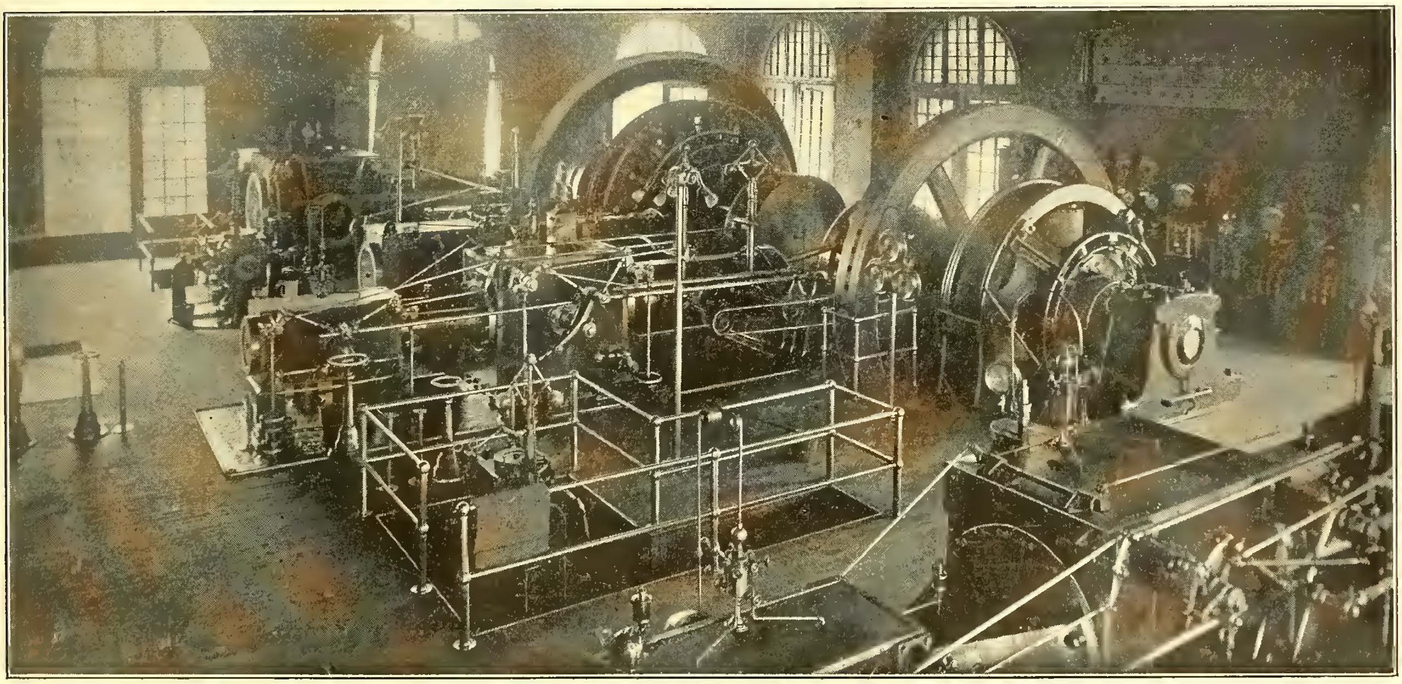

FIG. 1.—INTERIOR OF POWER STATION, NEW ORLEANS & CARROLTON RAILWAY

The company has 32.69 miles of track, and now owns 153 cars. About 100 cars were ordinarily operated in 1900, the period covered by the report. Bonds and stock are outstanding as follows:

Capital stock	$1,400,000
Bonds	535,000—6%
"	1,465,000—5%
"	749,000—6%
Total liability	$3,949,000
Liability per mile of track	$121,135

The belt line on St. Charles Avenue, Carrollton Avenue and Tulane Avenue is laid with 100-lb. A. S. C. E. road section T-rail. This is all on neutral ground. Part of this roadbed is open, as on a steam road, but the greater part of the neutral ground roadbed has sod up nearly to the tops of the rails. It is safe to say that this is the most agreeable riding roadbed to be found in the United States. The stiff rail gives smoothness, and the sod deadens the sound, and prevents dirt being carried on to the track. Of this 100-lb. T-rail there is 14 miles, and there is a mileage of 18.69 in 60-lb., 75-lb. and 93-lb. girder. The 93-lb. girder is the standard for paved streets. The belt line is 11½ miles around, and the running time, including a five-minute lay-over, is one hour. Cars are operated in both directions around the belt, and a service is also superimposed on this on St. Charles Avenue.

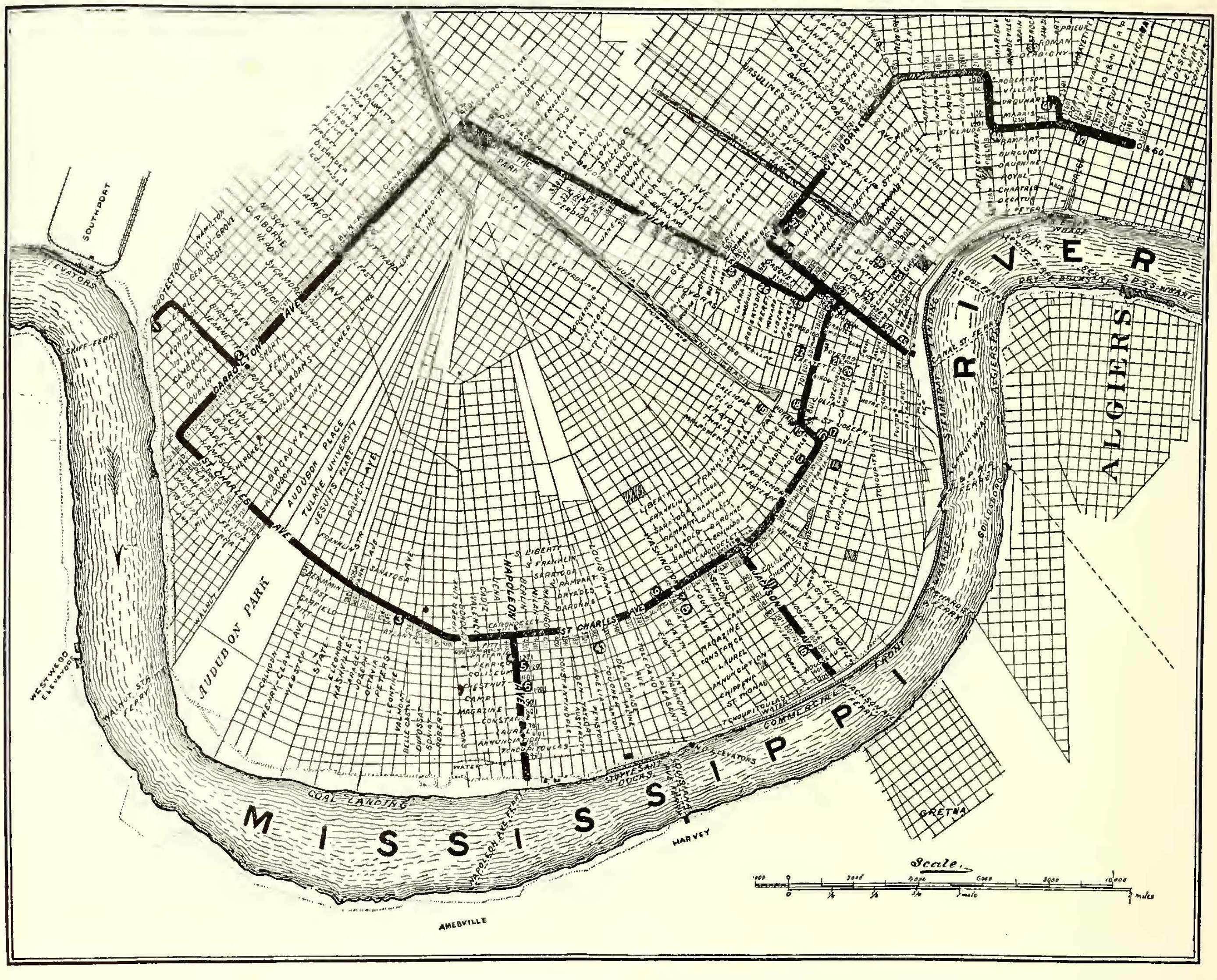

FIG. 2.—MAP SHOWING SYSTEM OF THE NEW ORLEANS & CARROLTON RAILWAY

SELECTION OF ROLLING STOCK

Excellent judgment was displayed in the selection of new rolling stock at the time the road was re-equipped. Strange as it may seem, open cars are very little used in New Orleans, because of the frequent and sudden drenching rains which come during the warm season. The water shedding qualities of a closed car seem desirable, and yet there is no city where the freedom and air afforded by an open car is more needed in hot weather. The car selected to meet these conditions is a 20-ft. body closed car, with cane cross seats and a center aisle. In pleasant weather the windows are lowered, and the passengers have practically the advantages of an open car, while the windows can be raised to afford complete protection from rain at a few seconds' notice. To be sure the question of a convertible car, suited to both summer and winter use, has been solved by adopting a similar car in many other cities with satisfaction to the public and a saving in investment for the company, but the conditions in New Orleans are even more suitable to this kind of car than in other cities. In the matter of car length also a good selection was made for the local conditions. In view of the competition of parallel lines, and the importance of making a fast schedule, with but short stops to let off passengers, the length of the standard car was limited to 20 ft., 8 ins.; that being the greatest length that good mechanical judgment dictated should be put on a single truck on a smooth track. The dimensions of these cars, which were built by the American Car Company, of St. Louis, are as follows: Body length, 20 ft., 8 ins.; platform length, 4 ft.; step width, 3 ft.; car over all, 30 ft., 8 ins.; over fenders, 31 ft., 8 ins.; height of body, 9 ft.; width over sills, 7 ft., 7½ ins.; width over all, 8 ft., 2 ins.; inside width, 7 ft., 3½ ins.; height window sill from floor, 28 ins.; height of dash, 36 ins.; width of aisle, 20 ins.; width of seat, 33½ ins. There are seven Hale & Kilburn seats on each side. The corner posts and bottom frame are of white oak, which is said to be the only thing that will last long as a corner post in New Orleans climate. The doors are double, and of mahogany. The ceilings are maple. The window sash are set in Para rubber. Headlights are set in the dash. The cars are very brilliantly lighted, having twenty 16-cp lamps per car. The canopy in front carries a lettered sign, which the lights inside the car illuminate. A push button for signaling the conductor is put between each window. The uniform color adopted is olive green and white.

These cars are mounted on Lord Baltimore trucks, which show themselves to be very easy riding, and easy to repair, as well as low in cost of maintenance.

THE MERIT SYSTEM OF PROMOTION

One of the principal features of interest to the visiting superintendent is the credit system by which promotions are made in the ranks of motormen and conductors, as there are few such systems in use among street railways. In the STREET RAILWAY JOURNAL for June 1, 1901, the credit system used by the Los Angeles Railway was described. The New Orleans & Carrollton credit system goes a step further than that in Los Angeles, in that the system of credits and demerits at Los Angeles only takes the place of suspensions, and does not govern promotions (being used only for moral effect), while the New Orleans system of marking not only takes the place of suspensions and other punishments, but also determines the promotions. When a man enters the New Orleans & Carrollton service as conductor or motorman he is given a credit of from 50 to 100 at the start, according to his previous record. For any creditable acts reported after that by the inspectors he is given a number of credits or merits. For infringement of the rules reported by the inspectors his account is charged with a number of debits or demerits. Each man's account of merits and demerits is balanced at the end of every month, and promotions to better runs are made from the men having the best records. There are 302 motormen and conductors on the road, and five inspectors. Merits and demerits are put on the records from information given in the inspectors' reports, or other reliable information obtained by officers of the company. One instructor is also employed on the road. His duties differ from the inspectors', in that he only instructs, never corrects. The records are kept in a book, one page of which is reproduced here (Fig. 4). It contains blank space for several names (to prevent wasting a page should a man leave the employ soon after being entered), and a space for merit or demerit marks for every day of the year, with facilities for balancing accounts at the end of each month. On an opposite page is space for entering more in detail remarks as to each merit or demerit. Whenever a merit or demerit is given a man a memorandum of the fact is sent him on the form shown in Fig. 5. The amount of demerit given is not stated in the notification.

The men are welcome at any time to call on the manager and look at the merit and demerit account book, and such calls are encouraged, because they give the men a chance to talk over their work with the manager. The system appears to be satisfactory to all concerned. The service given the public is surpassed nowhere, which fact speaks more for the plan than any amount of argument on the theoretical pros and cons.

The inspectors (who are called despatchers on this road) are furnished with blanks upon which they report each day:

1. The actual running time of all cars passing the despatcher's station, as compared with schedule. This is reported on a regular blank prepared for the purpose. A leeway of one and one-half minutes from schedule is allowed without report or reprimand.

2. Register readings of cars in passing despatcher's station. These are reported under the heading, "Special Things Done."

3. The particular things for the best interests of the company or against the best interests of the company which have been done by motormen or conductors. This is also reported under head of "Special Things Done."

4. The general quality of work of motormen and conductors. This is reported under the heading "General Service."

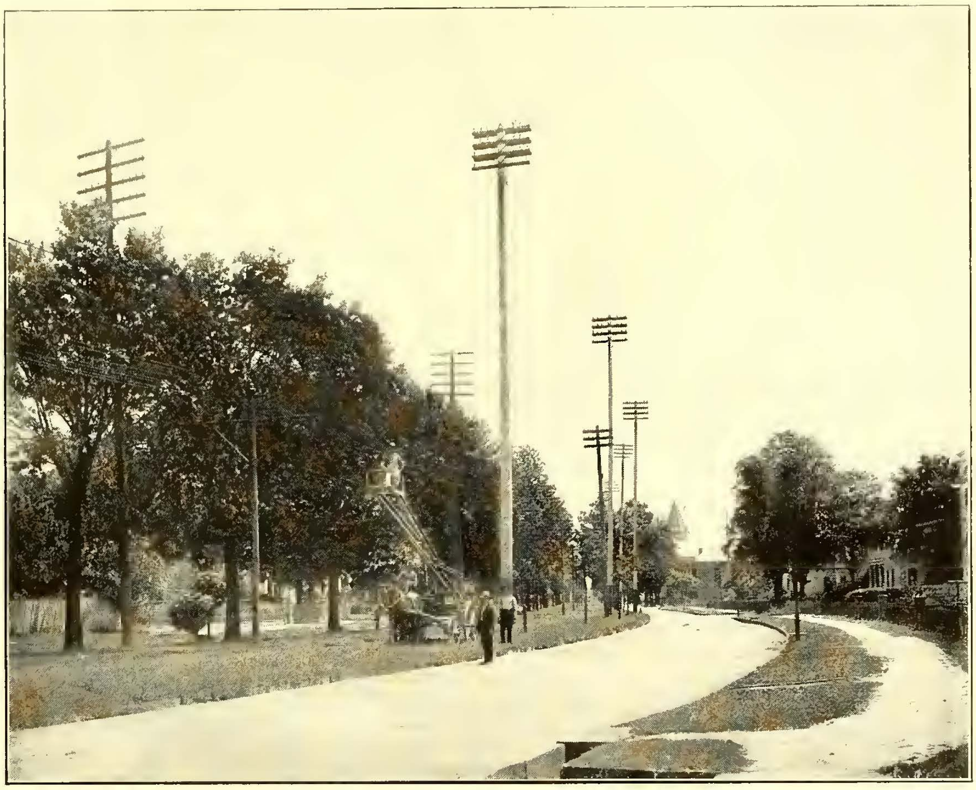

FIG. 3.—TRACK CONSTRUCTION ON NEUTRAL GROUND

5. Personal appearance of motormen and conductors. This is reported under heading "Condition of Uniform."

6. Other points of operation not classified.

The men are given to understand that what the company is anxious for is merits and not demerits, that it gives demerits only as a matter of necessity, and is only too glad to get men to whose record merits can constantly be added.

PUBLICATIONS

Competition in New Orleans has led to efforts on the part of both the principal companies to impress their individuality on the public as much as possible and call attention to the advantages of their lines. The New Orleans & Carrollton has two publications devoted to this end. One is a map, with time-tables, points of interest mentioned, etc., the other is the *New Orleans and Carrollton Weekly*, which is a diminutive but spicy journal, found on all the cars for free distribution. It has four pages about 2 ins. x 5 ins. in size. It is aimed to amuse and instruct the general public, and usually has an editorial on the first page on something of interest to all, and usually pertaining to the street railway service. On the following pages are witty paragraphs interspersed with announcements of attractions

Name .... *Address* .... *List* ....
Married or Single .... *Age* .... *Previous Experience* ....

Name .... *Address* .... *List* ....
Married or Single .... *Age* .... *Previous Experience* ....

Name .... *Address* .... *List* ....
Married or Single .... *Age* .... *Previous Experience* ....

Name .... *Address* .... *List* ....
Married or Single .... *Age* .... *Previous Experience* ....

Date	Jan.		Feb.		March		April		May		June		July		Aug		Sept.		Oct.		Nov.		Dec.	
	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D
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FIG. 4.—PAGE FROM BOOK USED WITH CREDIT SYSTEM OF PROMOTION

along the lines, or suggestions to passengers on points that if observed will make street railway travel more agreeable and safe. The little paper undoubtedly does much to cement cordial relations between the company and public.

New Orleans & Carrollton R. R. Co.

New Orleans, ... 190..

Mr. ....

....

Dear Sir:

The Company would call your attention to the following report in regard to your work. Any explanations that you desire to make may be written on the opposite side of this blank and same returned to the Manager.

Date .... Time .... M

Car No. .... Line ....

Place ....

Remarks ....

....

....

....

....

....

Very truly yours,

NEW ORLEANS & CARROLLTON R. R. CO.

MANAGER.

FIG. 5 —FORM USED FOR NOTIFICATION OF MERITS OR DEMERITS

WAGES AND EXTRA TIME

Previous to July 1, 1901, the wages of conductors and motormen on all the New Orleans roads were 13¾ cents an hour, 12 hours constituting a day's work, with 1 hour for lunch. In explanation of this it may be said that all wages and costs of living are low in New Orleans. On July 1, 1901, in response to a request from the men, the company raised wages to 18 cents an hour, 10 hours to constitute a day's work. It was felt that the request for higher wages was no more than just. The company always deals very liberally with its men, and on some of the hardest and poorest-paying runs paid men for more time than they actually put in. After the carnival last winter, when the men all worked under unusual strain and the earnings were unusually large, one day's extra pay was given each man who worked two days of the carnival. At Christmas $5 was given to each man of one year of service, and a proportionate amount for shorter service.

MILEAGE RECORDS OF PARTS

Mileage records are kept at the car shop office of all the principal wearing parts. The renewal of armature bearings is governed entirely by the mileage the bearings have made. When a car equipped with G. E. 1000 motors has run 20,000 miles, or a G. E. 800 has run 15,000 miles, with a set of armature bearings it is run in to have the bearings renewed, or at least to have them looked at and given a further allowance if such is permissible. It is found that the mileage records can be depended upon to tell when a set of armature bearings should be renewed, and full reliance is placed upon them. Genuine babbitt metal is used in these bearings. The babbitt from the armature bearings is remelted twice and used again in the armature bearings. It is then used on motor axle bearings. In remelting tin is added as seems necessary. Care are run in for overhauling entirely according to the mileage the armature bearings have made, and for nothing else, except for breakdowns or apparent troubles.

The system of keeping the mileage record is very simple. In the storekeeper's office is a book with one page for the mileage record of the different parts of each car. Each car mileage begins on Jan. 1 at 0. Every day the daily mileage is added, so that a glance at the book always shows the mileage of the car from Jan. 1 to the present time. When armature bearings, motor axle bearings, trolley wheels, pinions, gears or car-wheels are renewed, the fact is marked opposite the date on which it was done, and the date of removal is also noted. The difference between the total car mileage at time of putting on and taking off is the mileage of wear of the part. To facilitate matters in regard to the armature bearing mileage, the total car mileage at the time a bearing is to be taken off (when the car is run in for overhauling) is put down where it can be easily seen at the time the daily mileage is posted, and the total mileage of a car is compared with this figure fre-

LOT NO. .... ARTICLE ....

NEW ORLEANS & CARROLLTON RAILROAD CO. MINIMUM STOCK ....

RECORD OF MATERIAL ISSUED

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
January																															
February																															
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July																															
August																															
September																															
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November																															
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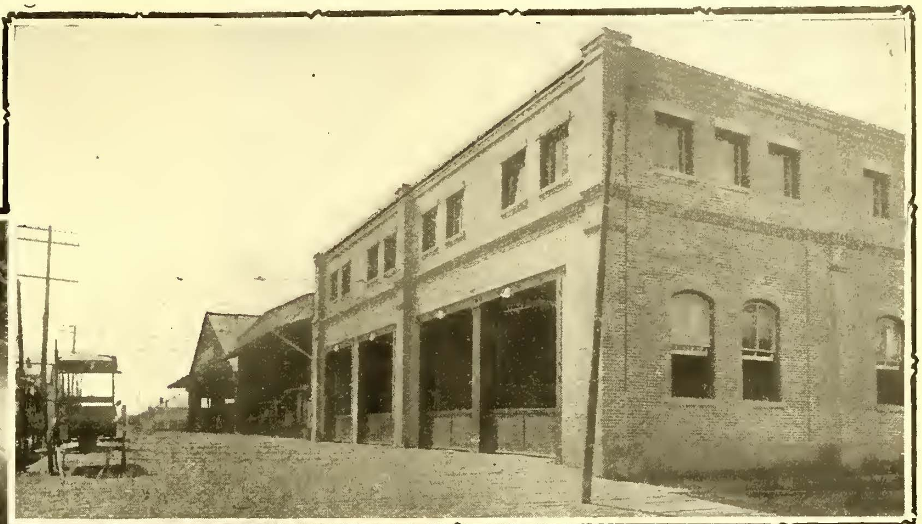
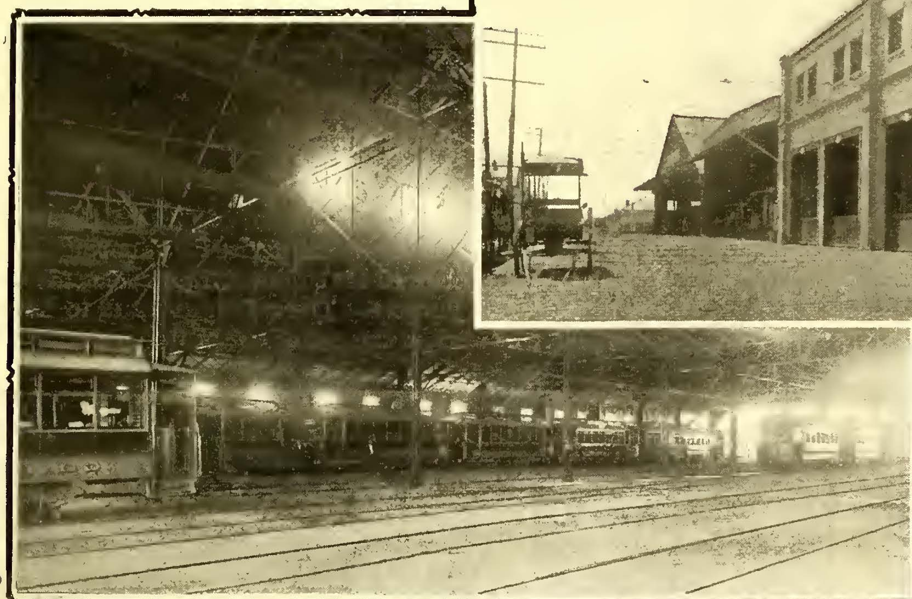
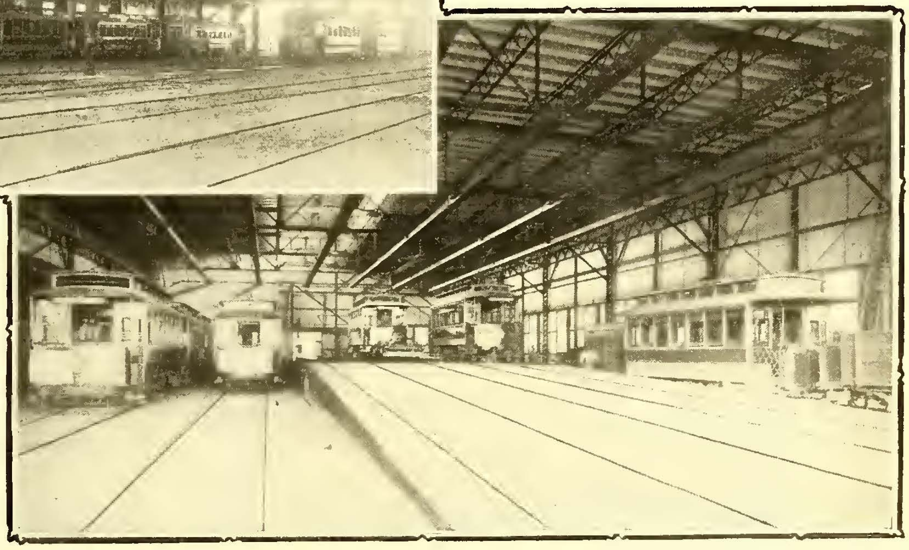
FIG. 6.—STOREROOM RECORD CARD

quently enough to prevent running over the mileage limit for a bearing. For example, if the mileage of a car should be 1620 miles Jan. 15, and the armature bearings were new on that date, 1620 miles plus 20,000 miles would give 21,-620 miles as the mileage on the day it should come in. When the mileage of that car approaches the 21,620 mark the clerk begins to watch it, and notifies the foreman of the time it should be run in. Kalamazoo trolley wheels are found to last 13,000 miles; Griffin car-wheels, 50,000 miles; steel pinions, 150,000 miles; gears, 250,000 miles; motor axle bearings, 20,000 miles (same as armature bearings); cast-iron brake-shoes, 15,000 miles.







FIGS. 8, 9 AND 10.—MAIN CAR HOUSE ON POPLAR STREET

STOREROOM RECORDS

A card index is kept of all stock in the storeroom. One card is used for each variety of article in stock, and the number of such article can be always seen on the face of the card without going out in the storeroom. The cards are kept posted from the requisitions. One of the cards is reproduced herewith (Figs. 6 and 7). Both sides of the card are utilized. The storeroom is a one-story brick structure, 21 ft. 6 ins. x 77 ft. 4 ins. This building contains both the office and storeroom; running around the inside of the storeroom is a gallery 6 ft. wide, giving access to the upper shelves. All the shelves are formed into lines by facial boards so arranged as to form a continuous ladder, making every bin accessible. In the center of the room is a cabinet containing 378 drawers, ranging in size from 3 ins. x 6 ins. x 12 ins. to 10 ins. x 60 ins. x 24 ins. There is also a rack for storing pipe, bar iron, etc. A small vestibule is partitioned off in the side, where the workmen draw their supplies, no one being permitted to enter the storeroom except the storekeeper. Each and every article has a lot number, which is stamped on the bin and on the corresponding card kept by the storekeeper. This card is posted daily, and shows the daily, monthly or yearly consumption. A system of Lot A and Lot B is kept, and no part of Lot B is used until Lot A has been entirely consumed, thereby giving a constant check between the stock and the cards.

FORM 305. 15c—12-00.

LOT NO.________ ARTICLE________

NEW ORLEANS & CARROLLTON RAILROAD CO. MINIMUM STOCK________

	On hand last day of previous month	Due on Requisition	Received by Requisition	Received by Transfer	TOTAL	Amount Issued	Remaining on hand	PRICE	AMOUNT	REMARKS
January										
February										
March										
April										
May										
June										
July										
August										
September										
October										
November										
December										

FIG. 7.—OPPOSITE SIDE OF STOREROOM RECORD CARD

About sixty men are employed on the repair, maintenance and cleaning of the one hundred cars operated.

CAR HOUSE AND SHOPS

The main car house and repair shops are at Poplar Street, on the belt line, an exterior view of which is shown in

Fig. 8. The main storage shed is a steel and galvanized iron structure, the interior and roof construction of which is shown in Fig. 9. It is 265 ft. x 127 ft., and has a monitor roof covered with slate. It contains ten tracks, each

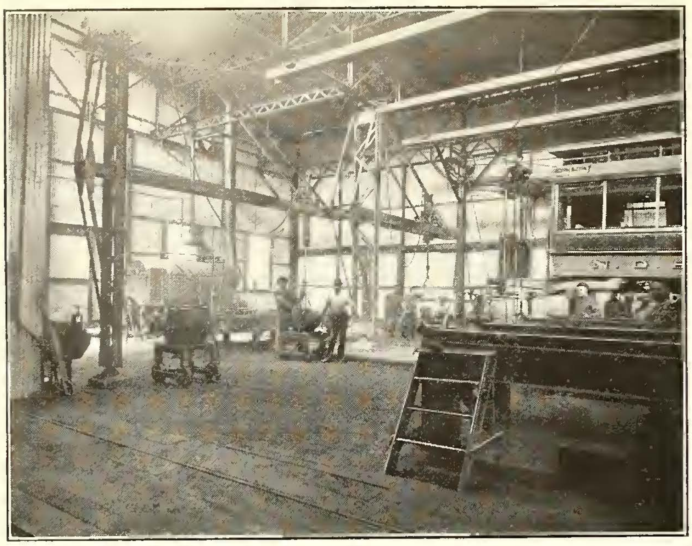


FIG. 11.—CARS FOR REMOVAL OF MOTORS AND AIR HOIST CRANES IN REPAIR SHOP

individual track running through from the street at one end to the street at the other end. The capacity of this shed is eighty of the company's standard cars. The "pit shop," as it is called, adjoining, is a galvanized iron building, 82 ft. x 212 ft. It contains seven tracks for the storage of extra cars, and three of these are elevated for a distance of 80 ft. Fig. 10 shows the interior arrangement. The elevation of two of the tracks is 3 ft. 9 ins. from the floor to the top of the rail. These elevated tracks are used in place of pits for repair work. The ground is so wet in New Orleans, much of the city being below the high-water level of the Mississippi River, which is confined by levees, that great difficulty has been experienced by

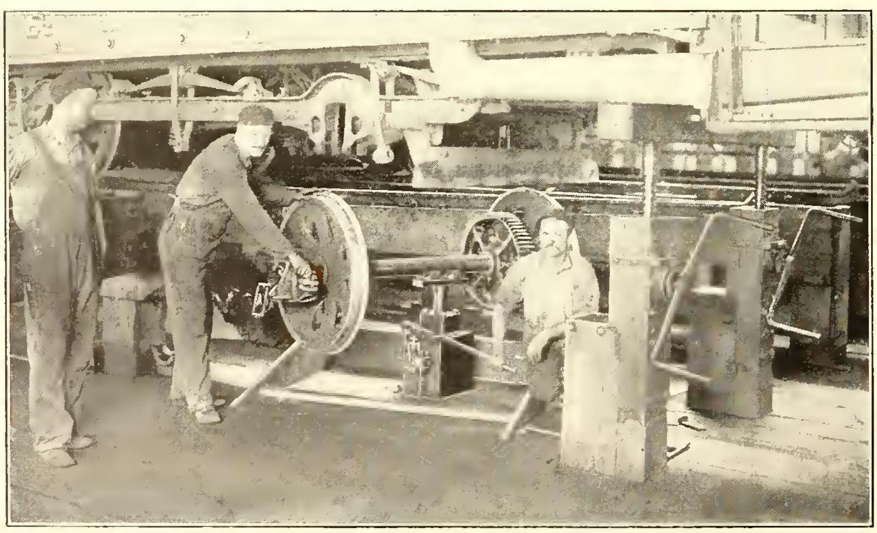


FIG. 12.—REMOVING WHEELS

the street railways there in keeping pits free from water. In the center of each of these elevated tracks, 10 ft. from the end, there is placed in the ground, set in concrete, a 5-in. pipe, 4 ft. long, capped at the bottom, with a special square flange. This pipe forms a receptacle in which is placed a Watson-Stillman hydraulic jack, 4 ft. lift. A narrow-gage track runs form this jack out to the end of the elevated tracks to the steel air-hoist cranes. The method of operation is as follows: The small car seen in Fig. 11, having an axle on only one end, is pushed along the track until the wheels strike a stop, when the small car is in position over the hydraulic jack; the jack is then raised, carrying the board which forms the top of the truck on top of the jack head, up under the motor shell to be removed. The bolts are then slacked off on the motor and the jack lowered until the motor is loaded on to the truck, the jack dropping low enough to clear the truck. The truck, with motor, is then pushed out beneath the cranes, where the motors are disassembled, cleaned, repaired, assembled and tested. The motor is then replaced beneath the car by the reverse operation. There is a third elevated track, 3 ft. 6 ins. from floor to top of rail, used for brake and truck work.

INGENIOUS WHEEL RENEWAL SCHEME

The use of elevated tracks instead of pits led the master mechanic to adopt an ingenious device for removing wheels which takes the place of the sectional track commonly used in pits for this purpose. The arrangement is to have a short piece of track at the end of one of the elevated repair

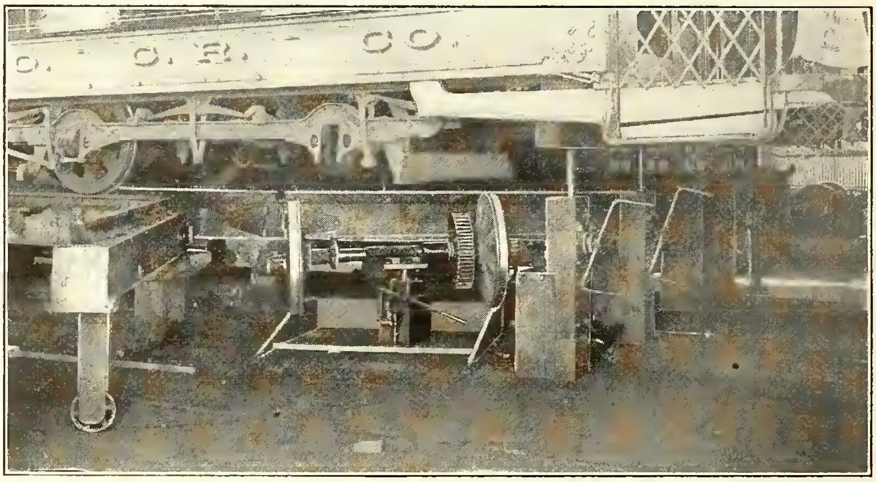


FIG. 13.—REMOVING WHEELS

tracks so fixed that it can be swung outwardly on hinges. Figs. 12 and 13 show this arrangement and the method of operating it. The two stringers of this track are cut at the second post and fitted with two large steel hinges each. The inside hinge, having a removable pin, acts as a fish-plate when closed; there is also a latch on the end posts to hold track in gage. The ends of these stringers are supported by a leg with a wheel, which slightly raises the stringer and supports the end of it when open; when closed the weight is entirely off this wheel, the stringer resting hard down on the end post. Banded to the end posts are two cotton screw jacks, which remove the weight of the car from the hinged stringers. The stringers are then swung out, the car remaining supported rigidly on the cotton jacks, as shown in the cut. The wheels are then lowered on a hydraulic jack set in a pipe casing, the same as used in the other elevated tracks. The incline shown on the floor loads the wheels on the jack head, in exactly the right place, so that they fit accurately when raised into position.

The wheels are replaced beneath the car by the reverse operation.

In this building there is located a 40-hp Economic boiler for steam heating the entire shop. There are a wheel press, emery wheels and drill press, operated by independent motors. The blacksmith shop is also located in this building; it is 30 ft. x 50 ft., and contains two soft-coal forges with telescoping hoods, one small Bradley coke forge for babbitting, and one Bradley coke forge 41 ins. long for long heats.

COMPRESSED AIR PLANT

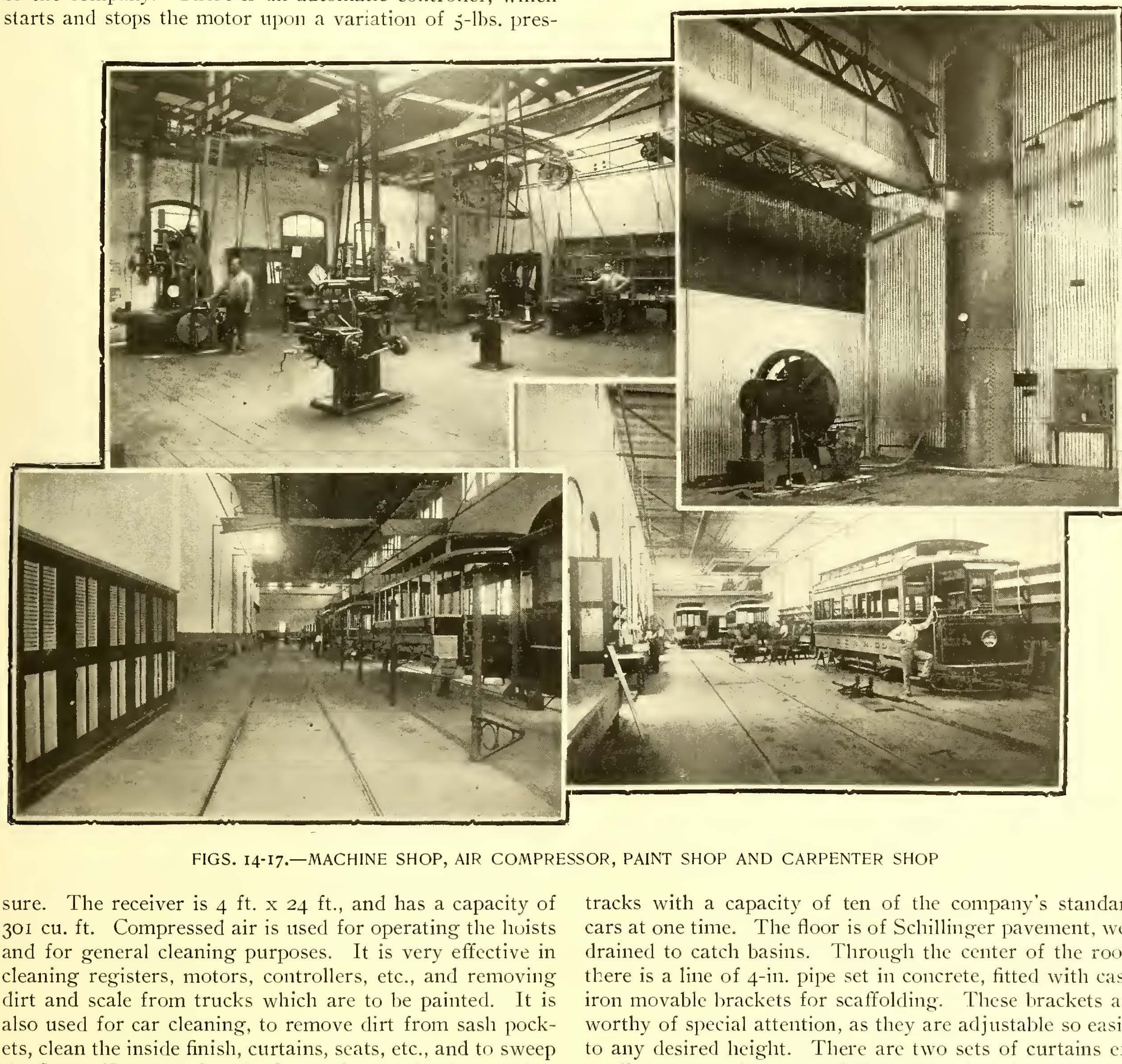
The shops are fitted throughout with compressed air. There is a Pedrick & Ayer compound compressor of 120 cu. ft. free air per minute capacity (see Fig. 15), driven by a G. E. 800 motor which was shunt wound in the shops of the company. There is an automatic controller, which starts and stops the motor upon a variation of 5-lbs. pressure. The receiver is 4 ft. x 24 ft., and has a capacity of 301 cu. ft. Compressed air is used for operating the hoists and for general cleaning purposes. It is very effective in cleaning registers, motors, controllers, etc., and removing dirt and scale from trucks which are to be painted. It is also used for car cleaning, to remove dirt from sash pockets, clean the inside finish, curtains, seats, etc., and to sweep the floor. For sweeping the floor a flat nozzle about 1½ ins. wide is used; it will sweep a car in a few minutes, removing the dirt from the corners and from around the cross-seat legs much better than is possible with brush and broom.

CARPENTER SHOP

The carpenter shop is a brick structure with steel roof framing and composition roof; the room is 36 ft. x 202 ft. x 21 ft. from track to under side of roof truss cord. It contains two tracks, as shown in Fig. 17, with a transfer table at the further end, leading to the paint shop, which is situated in the other half of this building. No. 1 track is used for repairs. When the car is repaired it lands at a transfer table and is transferred to the paint shop. Having been painted, it is returned by the transfer table to track 2 and trimmed out on this track, thereby avoiding excessive switching. In the further end of the building there is a gallery 25 ft. x 25 ft., where gluing, cabinet work, etc., is done. Further up, near the roof, there is a rack for storing panel stock, molding, etc. The capacity in this shop is ten of the company's standard cars.

PAINT SHOP

This shop (Fig. 16) is 36 ft. x 202 ft., and contains two tracks with a capacity of ten of the company's standard cars at one time. The floor is of Schillinger pavement, well drained to catch basins. Through the center of the room there is a line of 4-in. pipe set in concrete, fitted with cast-iron movable brackets for scaffolding. These brackets are worthy of special attention, as they are adjustable so easily to any desired height. There are two sets of curtains extending across the room. When a car is being varnished or ammonia used, these curtains are dropped to the floor, preventing the circulation of air, flying of dust, etc. One of the particular features of this room is the amount of high light, making it possible to ornament or varnish a car on the darkest day. These high windows entirely do away with shadows, a feature much appreciated by pencilmen and varnishers.



FIGS. 14-17.—MACHINE SHOP, AIR COMPRESSOR, PAINT SHOP AND CARPENTER SHOP

The walls of this and other rooms of the shops are covered with white water paint, which greatly improves the light and general appearance.

MACHINE SHOP

This shop is 40 ft. x 48 ft.; it is equipped with two lathes, a planer, bolt cutter, universal grinder, wet emery tool grinder, milling machine, radial drill, sensitive drill, and a 5-in. Niles double-headed boring mill, fitted with a special table, self-centering cam, car-wheel chuck, extra "T" slots with face-plate jaws, the right-hand head being fitted with regulation car-wheel boring bar. All wheels are bored to one of three standard sizes. All wheel seats on axles are accurately turned to one of the standards with snap gage, a square-nosed tool and finishing cut. Special home-made self-centering chucks are used for handling bearings, the one used for boring motor-axle bearings having a capacity of 100 in ten hours. A general view of the machine shop is given in Fig. 14.

THE MILL ROOM

is 38 ft. x 60 ft. The floor is raised 4 ft. above the ground, with the shafting and bolts below the floor. This gives a perfectly clear space (see Fig. 20) for the handling of long timbers. This room is equipped with a surfacer, a mortising and boring machine, a bandsaw, a combined universal woodworker and 4-in. x 10-in. four-sided molder, a variety saw, a reversible single-spindle shaper, an automatic railway cut-off saw and a wood lathe. This department is electrically driven independent of the remainder of the shop, but in case of accident could be driven from the main shop line shaft.

THE VARNISH ROOM

To this room, which is 30 ft. x 60 ft., all the furniture, inside linings, etc., are taken to be varnished. In the background of the picture is an adjustable rack, into which the sash, doors, etc., are slipped, perfectly level, until dry. Back of this rack is a color room, in which all paints are mixed and all brushes, tools, etc., kept.

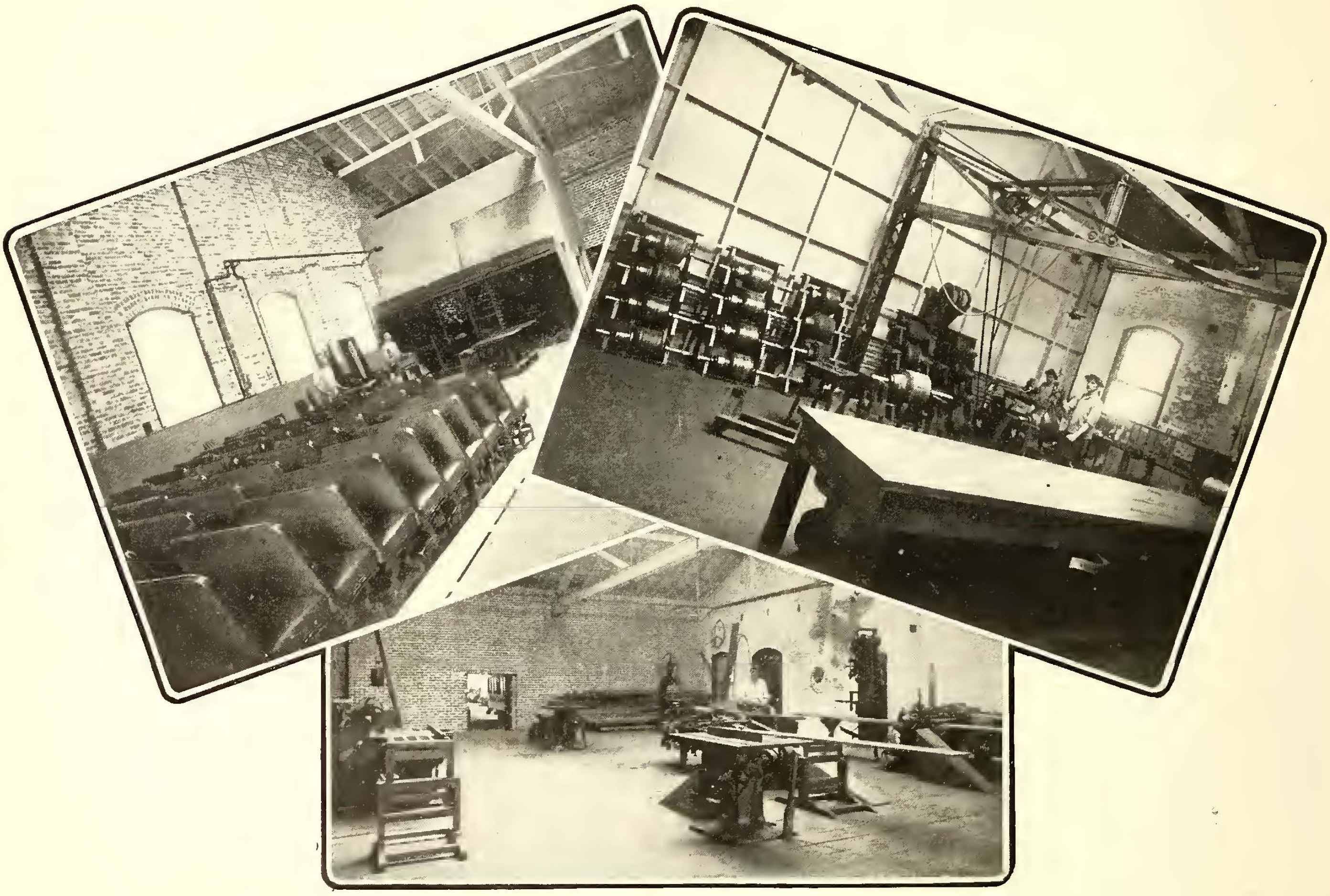
THE ARMATURE ROOM

is 40 ft. x 40 ft., fitted with racks for storing armatures, a steel jib crane with an air hoist for handling armatures (Fig. 19) to any part of the room, a field winding machine, a taping machine, coil formers and a Herrick testing set.

POWER HOUSE PERFORMANCE

The performance of power house No. 2 of this company stands among the best in the United States, the price of coal being considered. Indeed it is a question whether any other street railway power house is doing as well as this under similar conditions. The average cost per kilowatt-hour for the year 1900 was $.0084, not including interest or taxes. The average monthly output for that period was 291,723 kw-hours. The cost of coal was $2.85 per 2000-lb. ton from Jan. 1 to Aug. 31, and $3.20 from Sept. 1 to Dec. 31, 1900. The cost per kilowatt-hour by months was as follows:

January	$.0082
February	.0091
March	.0092
April	.0081
May	.0079
June	.0081
July	.0079
August	.0077
September	.0089
October	.0088
November	.0092
December	.0088



FIGS. 18-20.—VARNISH ROOM, ARMATURE ROOM AND MILL ROOM

For January, which was a fairly representative month, the costs were as follows:

Labor, engine attendance	$330.00
Labor, boiler attendance	140.00
Labor, ash and coal handling	55.00
Coal	1,346.45
Engine oil	18.63
Cylinder oil	29.40
Waste	8.13
Packing	12.50
Compound	.50
General supplies	31.90
	$1,972.51
Engine repairs, labor	$1.00
Boiler repairs, labor	8.95
Supplies for boiler repairs	6.00
Electrical repairs, labor	.60
Electrical repairs, supplies	3.48
Repairs, coal and ash apparatus	2.00
	$22.03
Coal used	944,900 lbs.
Output	248,760,300 watt-hours
Watt-hours per pound of coal	260
Pounds of coal per kw-hour	3.8

The power house force consists of three oilers, working eight hours each (one of whom has charge of the plant during the owl load); three firemen, working eight hours each; two helpers in the engine room, working ten hours each; two coal passers, working ten hours each; one boy cleaning and polishing; two engineers, working nine hours each. The power house, shown in Figs. 20 and 21, is equipped with one 850-kw G. E. generator, with cross-compound condensing Reynolds Corliss engine; two 300-kw G. E. generators, with tandem-compound condensing Reynolds Corliss engines; two 350-hp and two 250-hp Edgewater water-tube boilers, with Hawley down-draft furnaces. The firing and coal handling are by hand. The piping from boilers to engines is very short and direct.

The president of the company is J. K. Newman, and the vice-president, J. H. De Grange, both of whom are very active in the financial and general management of the company's affairs. The entire work of construction of the property as at present was done under the supervision of Ford, Bacon & Davis, consulting engineers of New York and New Orleans. A. H. Ford is manager in charge of the operating department, H. A. Davis is superintendent of equipment, and, as his title indicates, has charge of rolling stock, shops, power houses, tracks and overhead lines. E. W. Hiller is master mechanic, W. B. Brockway is auditor, and W. V. Crouch, secretary.

FIGS. 21 AND 22.– BOILER ROOM AND EXTERIOR OF STATION

The Boston & Worcester Street Railway Company, of Worcester, Mass, has begun work west of South Farmington for its proposed road to connect Boston and Worcester, Mass. The company is said to have successfully completed arrangements for entering Boston, and for passage through the Newtons. One of the most interesting points about the new road is that it will at once enter in direct competition with the Boston & Albany Railroad, a powerful steam road. The distance between Worcester and Boston, by the Boston & Worcester, will be 38 miles, while by the Boston & Albany the distance is 44 miles. The present fare charged between the two cities by the Boston & Albany Railroad Company is $1. The Boston & Worcester Street Railway Company, it is said, contemplates charging less than half this fare. While the speed on the electric road will undoubtely be less than on the steam road, the lower fare will probably attract considerable traffic.

Storage Batteries and 60-Cycle Railway Rotaries

BY EDWARD L. REYNOLDS

The use of storage batteries upon electric railways and lighting stations has within the last few years reached great prominence, and it has become an accepted fact with most engineers that batteries should necessarily form part of modern designs for power systems of this character.

The most customary applications of batteries to electric railway systems in the past have been in the stations where direct current is generated, and at points far out upon the lines, say from 5 to 10 miles from the power house. In both cases the batteries have in general been installed to regulate the excessive fluctuations in load peculiar to railway work. By thus relieving the machinery and copper of these rapid changes in load, and obtaining a constant load factor approximately 100 per per cent, the cost of operation, the maintenance of machinery and the first cost of machinery and copper have been in a great many cases reduced to an astonishing degree. Batteries have also been used very extensively in connection with roads operating from high-tension alternating-current transmission with rotary conversion to 500 volts direct current, the batteries in such a case being installed both in the power house and in the rotary sub-stations.

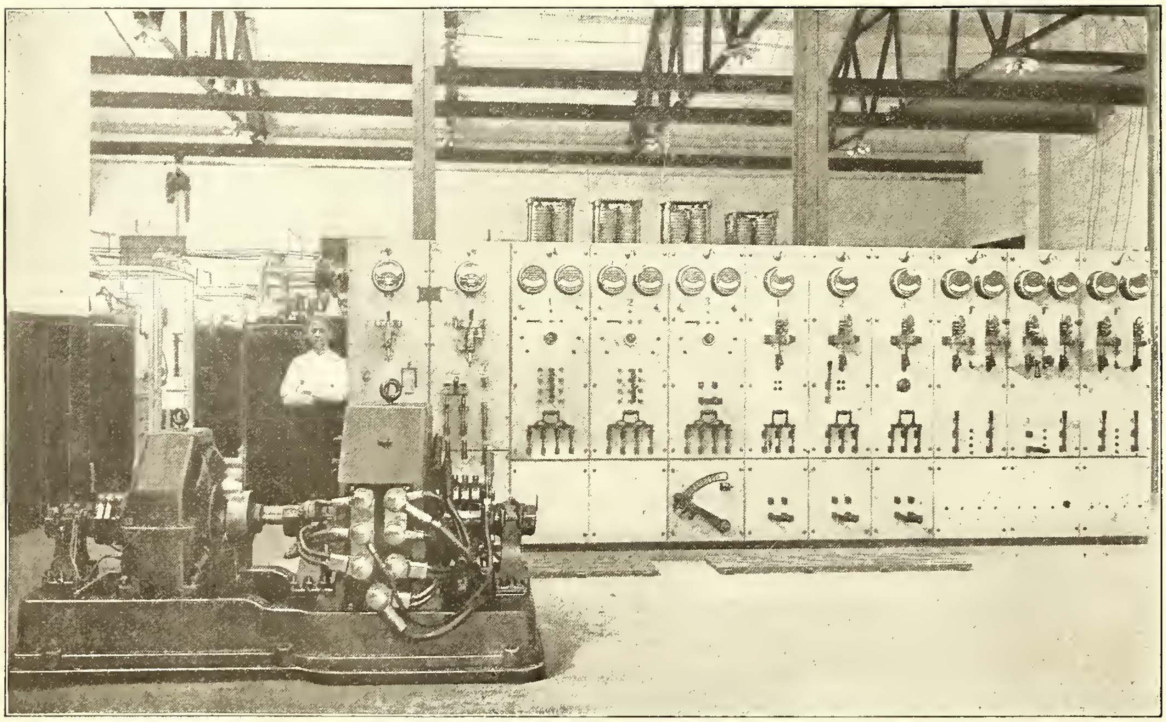


FIG. 1.—SWITCHBOARD AND BATTERY BOOSTER

The advantage of installations of the above general character are too well known for additional comment here, but it is the desire to call attention to one particular use of batteries in conjunction with 60-cycle rotary converters that prompts the following brief description of the Hamilton Electric Light & Cataract Power Company, of Hamilton, Ont. This application of the battery idea is of quite recent origin, and deserves most earnest consideration.

This company generates from water power. The water is taken from Lake Erie near the last lock of the Welland Canal, and led about 12 miles to the edge of the mountain. Here it has a head of 275 ft., and falls to the wheels through an iron flume of 8 ft. diameter at the top and 6 ft. at the bottom. Electric

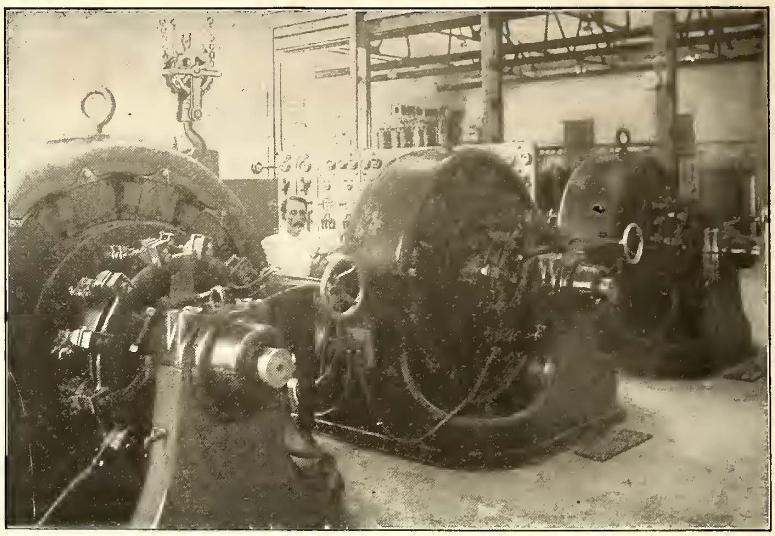


FIG. 2.—THE THREE 300 KW ROTARIES

power is generated at 2400 volts, two phase, and stepped up to 22,000 volts, three phase, and thus delivered 34 miles to Hamilton.

The sub-station at Victoria Avenue, Hamilton, contains all the machinery required to transform and distribute the current for the various uses required. Thus power is distributed to the Hamilton Street Railway Company, the Hamilton & Dundas Railway and the Hamilton Radial Railway, and is also used for

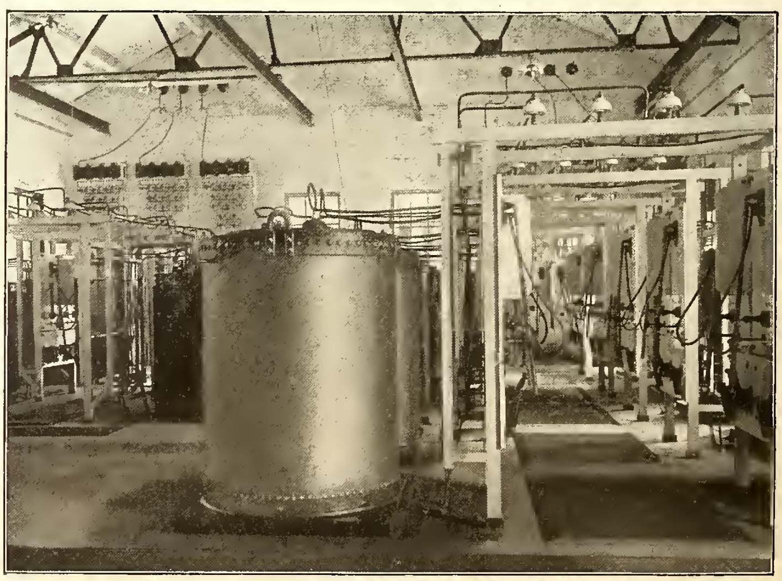
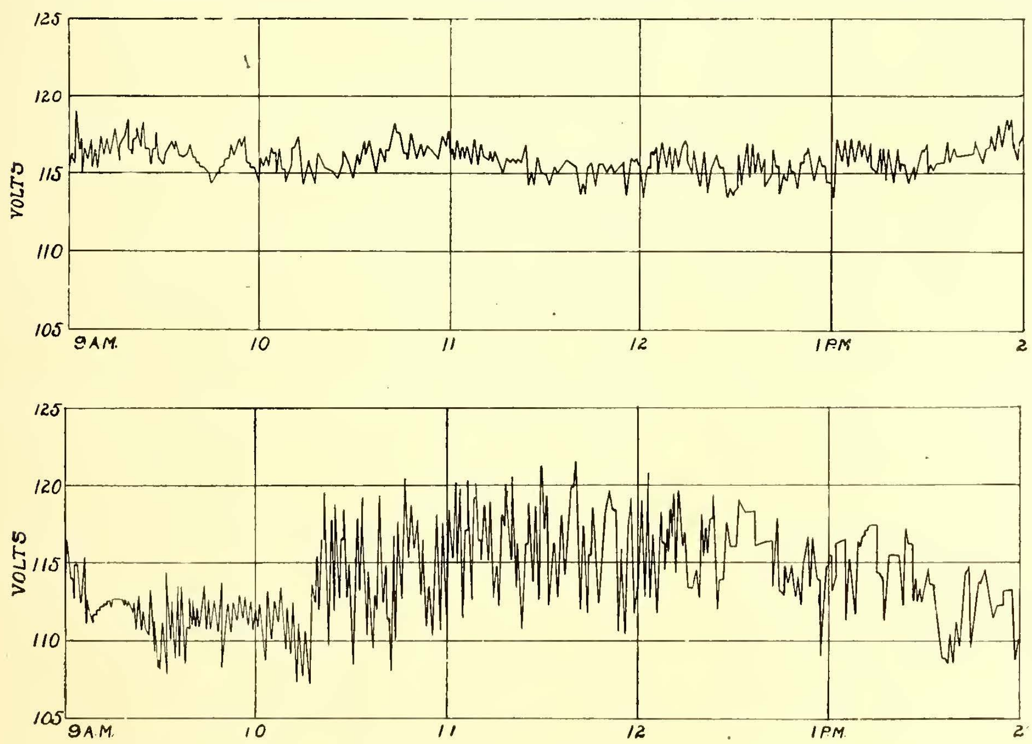


FIG. 3.—THE TRANSFORMERS

light and power in the town. This light and power consists of 110-volt incandescents and arcs and alternating-current motors. The apparatus in the sub-station consists of three 300-kw, 66-cycle rotary converters, with 550-volt secondaries, ten 175-kw static transformers, 22,000-volt three-phase to 24,000-volt two-phase, six 150-kw static transformers, 22,000-volt three-phase to 350-volt two-phase, and a storage battery of chloride accumulators of capacity equal to 400 amps at 550 volts.

The switchboard and battery booster are shown in Fig. 1, the rotaries in Fig. 2. The transformers are shown in Fig. 3. These machines supply current to the railways, and are operated in parallel with the storage battery. The latter absorbs the fluctuations of the current and enables the rotaries to run steadily with a fixed, constant load, which represents the average demand of the railway circuit. It is this fact that renders it possible to operate incandescents and arcs, electric street cars and synchronous motors from the same busses fed from current over the same high-tension transmission line.

FIG. 6.—VIEW IN BATTERY ROOM



FIGS. 4 AND 5.—VOLTAGE CURVES, WITH AND WITHOUT BATTERY IN CIRCUIT

The regulating effect of this battery is shown by the two cuts, Figs. 4 and 5. Fig. 4 is a reproduction of a voltage curve taken from a recording voltmeter, while the battery was in service. This voltage is taken upon the 110-volt lighting circuit, and shows a variation of such small magnitude that it is not detected from observation of the lights. Fig. 5 is a reproduction of a similar curve during a corresponding period of another day when the battery was off this circuit. Here, under the same local conditions, a fluctuation in voltage of large magnitude is seen, rendering operation impracticable.

This battery has uses other than the regulation of fluctuations. Frequently upon a system of this character some trivial accident to line or machinery will cause temporary shutdowns. In the plant under consideration such accidents have occurred several times, but the roads have never been closed down, since the battery has discharged upon such occasions to tide over the troubles. The Hamilton Company has found that one of the strongest points with regard to the operation of this battery lies in the fact that it would hardly be possible to operate the rotaries without the battery, on account of hunting. An additional advantage of this battery is that of supplying current to the roads during the early morning hours, when the load is light, thus giving an all-night service without the necessity of operating the rotaries continuously.

The flexibility of this system is marked, and the advantage of operating lights, synchronous motors and direct-current motors from the same transmission line is of manifest importance. It is sufficient to say that the storage battery has thus opened a field in which lighting and railway interests become one, and it is safe to predict that all high-tension transmission lines designed to supply direct current through rotaries for railways will be laid out upon the above general plan, and light furnished from the same lines wherever it is applied.

The Service Capacity of Railway Motors

BY N. W. STORER

From the manner in which A. H. Armstrong, in his article on the service capacities of railway motors, published in the April number of the Street Railway Journal, has misinterpreted the writer's article on a similar subject in the January number, it seems necessary that some further explanations may be given which will serve to enlighten any who may have been similarly misled. In the writer's article a new method for defining the capacity of railway motors was proposed. The method showed how to analyze and determine the value of the average losses sustained by a motor in any given service, and how these losses could be reproduced in their proper distribution in a continuous shop test. This test was proposed as a means of deciding whether this motor would have the requisite capacity for the given service.

To illustrate the method by an example, the acceleration and power curves for a given set of conditions were plotted, and from them the average losses were calculated. The class of service assumed was one with four stops per mile, a service approximating city and suburban. It was clearly shown that the average losses could be reproduced in a shop test by running the motor continuously at a current of 33 amps., that being the square root of mean square current in the motor during the total time, including stops, and at 300 volts, this being the voltage which with a current of 33 amps. would produce the average iron loss. Following this example, it was stated: "The foregoing analysis may seem to indicate that a large amount of calculation is necessary in order to select a motor for properly meeting given conditions, but this is not the case. The various cycles of work the motor has to do should by all means be laid out, and the equivalent heating current and the average voltage on the motor determined, but it is unnecessary to go into the refinements of iron loss to the extent that is done in this analysis. *The average voltage on the motor is usually below 250 volts, and for all such work an equivalent voltage of 300 may be taken for the continuous testing.* For interurban service, where a high average voltage on the motor is maintained by reason of the small number of stops, an equivalent voltage of 400 will suffice. Therefore, if the continuous capacity of railway motors is stated in terms of current at both 300 and 400 volts, this information will cover all classes of service with necessary precision. From the fact that the allowable heating current of the motor in the foregoing example is 35 amps. at 300 volts, and 33 amps. at 400 volts, it will be seen that the exact equivalent voltage is not necessary for the test. The temperature of the armature does not rise in proportion to the total loss in it, as the higher voltage gives higher speed and consequently better ventilation."

Mr. Armstrong takes exception to these statements, and thinks that the method gives "incomplete and, in many cases, misleading results." His objections may be summed up as follows: He states,

(1) That "it ignores the interchange of armature and field heat."

(2) That "it assumes the same conditions of ventilation on the testing stand as exist in operation."

(3) That "the voltages which were selected for the standard shop test are improperly chosen."

In answer to the first objection it need only be said that a test in which the motor is run with the average losses properly distributed between the copper and iron cannot "ignore the interchange of field and armature heat." The conditions of internal ventilation are practically the same, whether the motor is on the testing stand or in service, and the interchange of heat will therefore be the same.

The second objection, that the method assumes the same conditions of ventilation in a shop test as exist in service, is without foundation. Owing to the length of the writer's article, the question of temperature was not taken up, and this, perhaps, may have been the cause of the misunderstanding that Mr. Armstrong has shown. It is possible that one might interpret the article in this way, but no such statement was made, and such an inference was certainly not intended. It is well understood that the conditions of external ventilation which exist under a moving car will give a very much less temperature rise than the same losses in the motor will produce in a shop test.

The circulars issued by the Westinghouse Electric & Manufacturing Company, which were referred to in the writer's article, contain this statement: "Owing to the improved ventilation which is secured when the motors are under a moving car, the actual rise of temperature in service with this current would probably not exceed 55 degs. C. by the thermometer," instead of 75 degs. C., as obtained in a shop.

It will be seen by this that the method does not assume the same conditions of ventilation in shop test as in service. It does assume, however, that the entire motor will run cooler in operation than in a corresponding shop test, and this assumption is supported by reliable tests. It is evident that with an enclosed motor the total heat must be dissipated through the outside shell, and it follows at once that as long as the amount and distribution of the losses are the same in each case the relation between the armature and field temperatures will remain practically the same, whether the motor be run in shop or in service.

Tests made under the supervision of the writer have repeatedly shown that this is the case, whether the temperatures are measured by thermometer or by resistance methods. As would naturally be expected, however, the results obtained by the latter method are much more consistent and reliable. It is possible that Mr. Armstrong was misled by inaccurate thermometer readings in the tests which he described. In the light of all reason the statement that "the field constant," or, in other words, the rise of temperature in the field coils, during a shop test is practically the same as in service, while that in the armature may be as much as 41 per cent higher, is decidedly erroneous. There is no excuse or reason whatever for such a condition of affairs, and if Mr. Armstrong will make further and more careful tests, measuring temperatures by resistance method, there is no doubt that he will be convinced of the truth of the above statements. Service tests made under conditions approximating those in the writer's example gave a temperature rise between 25 and 30 per cent below that produced by the same average losses in shop test. This ratio, however, will not be the same for all classes of service. Its value depends on a number of conditions, such as the schedule speed, which determines the average velocity of the air about the motors; the length of stops, during which the heat will be dissipated at practically no greater rate than in a shop test; the state of the weather, including the temperature, velocity of the wind, etc., and, to some extent, the gear ratios used. Further data are needed to cover all classes of service, but it is safe to assume that the temperature rise in all motors in ordinary street railway service will be 25 per cent less than in a shop test giving the same average losses properly distributed. For suburban work a reduction of 30 per cent may be counted on, while for high-speed interurban service a value for this constant of 35 or even 40 per cent is not improbable.

The third objection, in regard to the voltages selected for the standard shop tests, is also untenable. In the light of facts, it is difficult to see any basis for this objection. The voltage of 300 was selected for the standard shop test because that voltage, with the continuous equivalent of the service currents, will give an iron loss equal to or somewhat greater than the average iron loss in the ordinary city work. As stated in the quotation above, the average voltage on the motor is usually below 250 volts. This, *of course*, means the average over the entire time the motor is in operation, including coasting and stops. In the example cited, which approximates city and suburban service, it was clearly shown that the average iron loss would be reproduced by running the motor in the shop test at 300 volts, or about one-third higher than the average voltage. The iron loss in a railway motor is a very complex function of current and voltage, increasing with both; but tests and calculations both show that the voltage of 300 for the continuous shop test will fully cover the average conditions. It is not claimed that this will give the exact average iron loss in every class of city service, but the results will be close, and it will be found that where the service iron losses average less than that given by 300 volts the schedule speed is also low, so that the ventilation is not as good as in the average case, and the temperatures of the motor in service and shop test will therefore still bear the same relation. Thus, although the voltages of 300 and 400 may have been chosen arbitrarily, there were good reasons for the choice.

The idea in proposing such tests is to secure a standard test for railway motors that will not only serve as a basis for comparison between different motors, but will also be a measure of their capacity for service conditions. For comparing motors of different construction a standard test is absolutely necessary, and it can be made only in the shop, where all conditions are entirely under the control of the engineer. A test which consists merely in keeping a constant load on a motor running in a place where it is protected from drafts is certainly capable of much greater accuracy than any attempt to make in service an all-day test under uniform conditions. It is true that in order to get the full advantage of the results of the shop test it is necessary to apply a constant which is determined by service test. But these service tests need not be made with each and every motor under all the different conditions. The constants should be practically independent of the motor, ane once obtained on one motor should be approximately correct for all.

The curves which Mr. Armstrong gives, showing the schedule speed at which a certain motor will pull certain loads, making different number of stops, are very useful. A large number of similar curves may be made up, and the method pursued in laying them out is immaterial, so long as the results obtained are reliable. But these curves do not obviate the necessity for a standard by which street railway motors may be compared. In fact, there is nothing in Mr. Armstrong's article which even suggests such a standard. The curves showing the temperature constants for different ratios of field and armature losses are interesting, but impracticable for the ordinary engineer to work with, and are of no more use to him than a chemical analysis of the steel castings of the motor would be.

Even the acceleration and power curves from which were deduced the curves and separate losses and the ratio of armature to field losses indicate the inefficiency of such a method. The results given therein—which are strictly correct only under identical conditions of service—when analyzed are as follows:

Distance between stops	1,000 ft.	4,000 ft.
Average voltage on motor	143 volts	344 volts
Equivalent voltage for shop test, approximate	200 volts	450 volts
Square root of mean square current	36 amps.	31 amps.
Ratio of armature loss to field loss	1.25	2.5
Schedule speed	12.6 M. P. H.	19.8 M. P. H.
Maximum rise in temperature	66 deg. C.	62 deg. C.

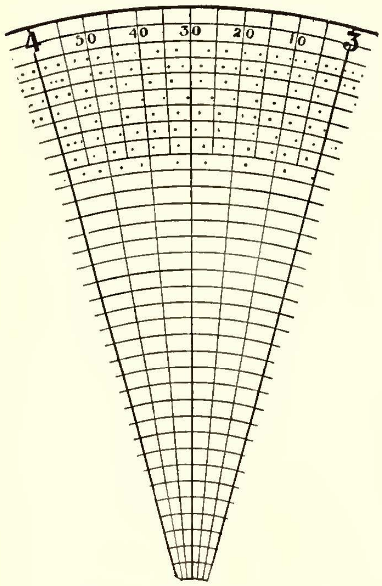
These are extreme conditions to be met by a motor using the same gear ratio for all conditions. If the service consisted of a series of runs of 1000 ft. each, a gear ratio giving a greater reduction in speed should be used. If the service consisted of a series or runs of 4000 ft. each, the gear reduction would preferably be less. With the proper gear ratio, the square root of mean square current for the shorter run would be lower, and the equivalent voltage higher. For the longer run the current would be higher, and the voltage lower than in the tests given. Both of these changes would work the motor at nearer the equivalent voltages of 300 and 400, which were selected by the writer as representing average service conditions. If the service consisted both of short and long runs, the gear ratio used in the tests would probably be satisfactory, and the all-day results in current, voltage and temperature would be between the extremes shown.

But, in spite of the extreme conditions obtaining in these tests, which, with the gears used, corresponds to service quite outside of the average, and in spite of the consequent wide variation in the ratio between the armature and field losses, the maximum temperature rise in the motor varied only from 66 degs. C. in the one case to 62 degs. C. in the other. Since the rise of 66 degs. C. resulted from a service equivalent to a test of 36 amps. at 200 volts, while the rise of 62 degs C. resulted from a service corresponding to a load of 31 amps. at 450 volts, it is evident that the heating effect of the iron losses is of comparatively slight importance, and that the labor of calculating ratios between the losses in armature and field is unnecessary. Thus, Mr. Armstrong's own tests, if properly interpreted, furnish excellent evidence in support of the writer's method of considering the square root of mean square current as the controlling factor in the determination of the service capacity of railway motors.

The Toledo & Monroe Railway, which will be part of the line from Toledo to Detroit, is proving one of the best paying interurban properties in the country. It has been in operation only about three months and only three cars are operated, yet each car earns in the neighborhood of $80 per day. The run of 22 miles from Toledo to Monroe is made in fifty minutes, and the fare is only 25 cents, considerably less than half the figure charged by the competing steam road. It is said that the steam road has lost 90 per cent of its local business in consequence of this competition.

The Automatic Train Recorder of the Brooklyn Rapid Transit Company

There is located in the office of the general manager of the Brooklyn Rapid Transit Company an automatic train-movement recorder, which produces a permanent record of the train service on the elevated lines. A circular record sheet ruled in concentric circles, which are divided by radial lines into twelve hourly spaces, and subdivided into five-minute spaces, is mounted on a clock movement and revolved in front of a row of needles, which punch out the record of train movements. The paper is so mounted with respect to the row of recording needles that the space between any two of the circular rulings runs continually before a needle actuated by trains on one individual line ot the elevated system, so that the record punched out by any needle in the twelve hours required for one revolution of the sheet will accurately represent the number and spacing of trains passing a given point on the line in question during a period of twelve hours. It will be seen that a circular record sheet is peculiarly adapted to this purpose, as the outermost circles of the sheet on which the scale of minutes is comparatively large may be used for record of service on busy lines having short intervals between trains, while the circles nearer the center of each record sheet may be used for less busy lines, on which the intervals between trains are comparatively long.



A PORTION OF THE RECORD

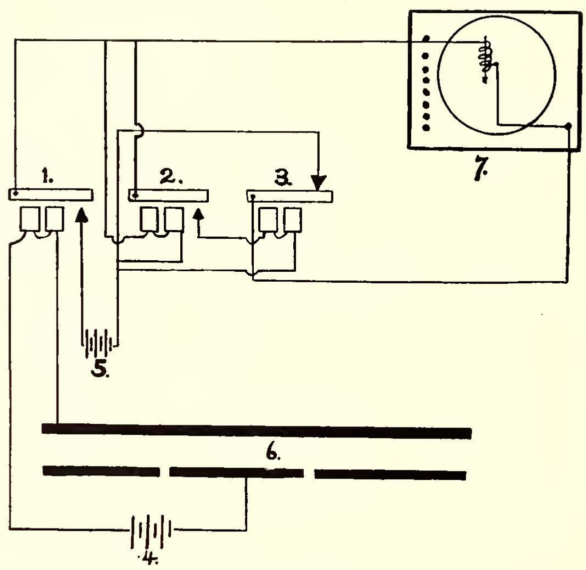


DIAGRAM OF CIRCUITS

The apparatus in question produces a record of the trains passing a given point; to accomplish this result an insulated section of rail 30 ft. in length is installed on each line at the point at which it is desired to record the movement of trains. Referring to the accompanying diagram, a circuit containing a relay (1) and battery (4) is closed by the first pair of wheels of a train entering the insulated section (6), and remains closed until the last pair of wheels leaves the section. The operation of relay (1) closes the circuit operating the recorder needle (7), and the circuit operating relay (2) in multiple with it. The operation of relay (2) closes the circuit energizing relay (3), which open-circuits the recorder needle (7) and holds it open until the main-line relay (1) is opened by the passing of train from the insulated section. This series of movements, insuring the immediate release of the recorder needle after it has punched its record, is, of course, to prevent the retarding of the record sheet, which would happen if the needle were allowed to stay down and hold it during the time required by a train in passing the insulated section. When a train has left the section the various relays drop back to their original positions, as shown by the diagram, and are ready to receive, transmit and record the next succeeding train report. Should a train for any reason have to stand on the insulated section no derangement of the recording devices can occur. Independent batteries are now used, but as soon as the required relay magnet coils are wound the apparatus will be operated by current taken from the third rail, at 500 volts.

The advantages of having such a record are manifold. The general manager has before him a record of train operation of unquestionable accuracy, which shows him the interval maintained on all lines at all hours of the day and night; he has instantaneous notice of the character of service at any time he cares to inspect the sheet, and if for any reason he suspects that an adequate service is not being given he has a ready means at hand of reliably informing himself on the point. By an examination of the records any irregularity of the service on the line or division, or if trains are not regularly spaced, is apparent from the irregular spacing of the dots on the record sheet, and so plainly indicated that no study nor consideration is needed to develop the fact. The ease with which the character of service maintained on any line may be instantly judged is in strong contrast to the trouble required to get the same information from train sheets, and, when obtained from train sheets, the information is usually many hours old, and the several items not necessarily accurate.

In case of complaints two or three days old from patrons of the road concerning long intervals between trains, the record sheet for the day and hour in question may be consulted and immediate information be obtained as to the train movements at that time. Many other ways of utilizing this kind of record will suggest themselves to the railroad man, and possibly different uses made of it than those enumerated, under different local conditions. This method of automatically recording train movements on different lines by means of an insulated rail section, and the other apparatus described, is due to General Manager Brackenridge, and the system has been in satisfactory service for the past five months.

A national convention for the discussion of commercial reciprocity will be held in Washington, D. C., beginning Tuesday, Nov. 19, and continuing for three days. This convention will be composed exclusively of manufacturers properly accredited as delegates by trade and commercial organizations, and its deliberations will be confined to commercial reciprocity in its bearing upon the industries of this country and its influence upon our export trade. The object of this convention is to ascertain accurately the views of representative manufacturers on this subject, and to formulate, if possible, some practical suggestion for such legislation or diplomatic negotiation as may be necessary to establish more intimate commercial relations between the United States and other nations. The co-operation of all organizations that embrace manufacturers within their membership is earnestly solicited in order to insure the complete success of this effort to give definite form and expression to the views of the manufacturers of the United States on the subject of commercial reciprocity.

Modern Electric Railway Switchboard Practice

BY G. U. G. HOLMAN

To present readily the more recent practice in switchboards for electric railway installations, the subject has been divided into two divisions. One is the control of direct currents from the generator; the other, the control of alternating currents from the generator, following, as we will, this control through the conversion of the alternating current to direct current for use on railway lines.

The direct current class of switchboard is dependent in its style upon the capacity it is designed to handle, this capacity varying from that required for a few cars to that necessary to operate a system of many cars. The alternating-current class for obvious reasons has more often been applied to the larger systems, inasmuch as greater capital has hitherto been represented in the station equipment, than a small railway could possibly afford. The smaller direct-current railway plant is more numerous, although the aggregate kilowatt capacity of such railway power stations in the United States does not equal that of the larger plants.

Attention to-day is drawn to the alternating-current high-tension system, as a method of lifting a combination of small street railways in proximity to each other from poor-paying to good-paying properties. This is particularly noticeable where water power is available within an economical distance for such transmission, whereas, with the direct generation of 500 volts or 600 volts, the copper cost of transmission the same distance would make the proposition untenable. The supply even of one small railway, with power from a distant alternating-current source, primarily installed for other power purposes, has made it possible for the road to be a paying proposition from the cheapness of its power. Where power from the old plants cost from 1½ cents to 2½ cents per kilowatt-hour, the cost with polyphase equipment is brought to ¾-cent and even ½-cent per kilowatt-hour.

Before going into the detail of the methods of controlling the generator output to the line, it will be well to take up some of the questions familiar to the manufacturers' engineers, but, perhaps not so well known to station men, such as relate to the kinds and properties of the material used for switchboard panels, the allowable capacities of different forms of current carrying metal connections, and the practical clearance experience dictates should exist between certain potentials.

Slate and marble have superseded the skeleton formed wooden switchboard of the earlier days, for the mounting of switches and instruments, although it may come about in the future that the skeleton type will again be used for supporting hand operating mechanism, but built of steel, owing to the increased practice of isolating the greater current and potential devices inside of fireproof compartments placed some distance away from the instrument and operating panels.

Slate or marble for switchboard purposes must necessarily be free from metallic striae. Each substance is selected, first, for its insulating qualities, and second for its capability of finish and its mechanical strength. Electrical tests are made on the rough slab before drilling and polishing, and after the mounting of instruments and mechanism, since the drilling of the holes may develop a conducting strata, or one of poor insulation. For railway 600-volt direct-current work, tests are made at 3000 volts alternating. Railway development now being aided by long distance transmission of high-potential polyphase currents, we are compelled to consider working voltages *above* 600 volts, so that in the use of electrical transmission for railway work, double the working voltage is used for the tests. Slate should not be used for a working voltage of over 1000 volts. Tests are made from stud to stud, and from studs to ground, or the iron frame of the panels.

Suitable slate is rarely found in iron-producing localities, since slate from such sections is likely to have iron present. Plain slate finish is objectionable, owing to the green and yellow spots and blemishes brought out by the polish. It is consequently generally black enameled, first being thoroughly baked to dry out any moisture present. In this way the enameling process improves the insulation qualities of the slate. It is to be more highly recommended than marble for railway switchboards, from its more favorable action under arcing and under accidental contact with oil.

Marble for tensions of over 3000 volts should be polished on both sides. When used with oil switches mounted on the back, a coat of suitable varnish should be given the back surace of the marble in order to prevent it from absorbing the oil. Marble and molded insulation projection 1 in. from the panel surface about a live conductor permits the safe use of 5000 volts. Adding 1½ ins. more to the height of the molded material permits the use of 10,000 volts. Making the total height of the insulator 3½ ins. permits the use of 15,000 volts with safety.

In railway switchboard work, copper is almost wholly used for the current-carrying conductors. It is not advisable to use bars of over ¼ in. in thickness, where the heating is to be kept below 20 degs. C. rise above the temperature of the surrounding air. About 1000 amps. is the current per square inch practice indicates for such bars. Copper will give a temperature rise of, say, 15 degs. C. at 1000 amps. per square inch of cross section. With aluminum, we can use 600 amps.; cast copper, 500 amps.; composition metal, 100 amps. to 300 amps., and with iron, 150 amps. per square inch. Of both bars and circular studs the smaller sizes allow greater amperage per square inch, owing to the increasing ratio of surface to area the smaller the external dimension. For a 20 degs. C. rise in circular studs of the following diameters is given the approximate number of amperes per square inch allowed in practice:

½-in.	stud,	1,200 amps.
¾ "	"	1,200 "
1 "	"	1,100 "
1¼ "	"	1,000 "
1½ "	"	950 "
1¾ "	"	850 "
2 "	"	800 "
2½ "	"	700 "
3 "	"	650 "

The temperature rise at the point of contact of surface upon surface varies, of course, with the applied pressure, and with the area of actual contact; or, expressing it in another way, the allowable amperes per square inch of apparent contact varies with the perfection of contact. Thus the allowable amperes per square inch for contact clips, such, for example, as are on a knife-blade switch, varies from 50 amps. to 100 amps. Bolted clips allow from 100 amps. to 200 amps. per square inch; and laminated brush contact, from 300 amps. to 500 amps. per square inch. The smaller the superficial area of contact, the greater is the allowable amperes for the same temperature rise. Thus a contact clip of one-half square inch area will allow a much greater density of current per square inch, than a clip of 1 sq. in. area. In this respect the underwriter's requirements of 50 amps. per square inch of superficial area of contact fails, for it is obviously unfair to the producers of small switches which can easily be built of 75 amps. and even 100 amps. per square inch, with a very low temperature rise. But in very large switches, even 50 amps. per square inch is too large a figure. Temperature rise, or a sliding scale of amperes per square inch of contact, would be more fair.

The size and number of the main and equalizer cables for each generator, as dictated by experience, is an important detail, and is given in the table below:

Generator kw volts = 575	Amps.	Main circ. mil	Equalizer circ. mil
100	174	1—300,000	1—300,000
200	261	1—400,000	1—400,000
300	522	1—750,000	1—750,000
500	870	1—1,500,000	1—1,500,000
800	1,392	2—1,500,000	2—1,500,000
1,000	1,740	3—1,000,000	3—1,000,000
2,000	3,480	4—1,500,000	3—1,500,000
3,200	5,570	6—2,000,000	4—2,000,000

Cast copper has a conductivity from 30 per cent to 60 per cent of that of rolled or drawn copper, although there are

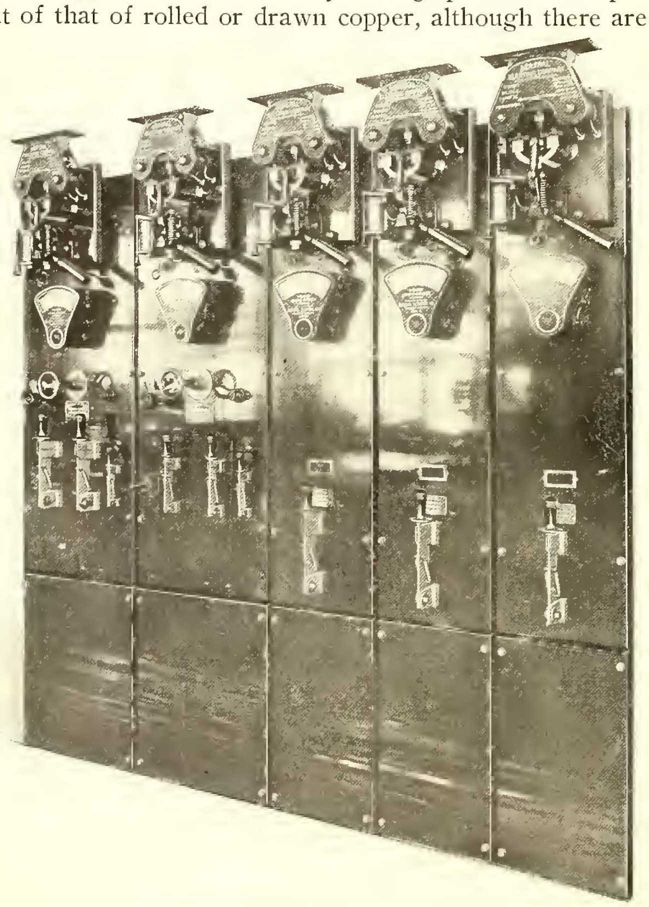


FIG. 1.—STANDARD G. E. RAILWAY BOARD

mixtures, very high in copper, which can readily be cast, possessing a conductivity of 80 per cent of drawn copper and presenting a good appearance. Ordinary cast copper is apt to be spongy and have blow holes. Round shapes of copper can be readily drawn or rolled, but thin flat bars are not easily drawn to gage, coming out of the die with surface blemishes, and untrue to gage. Experience dictates that perfect copper bars may only be obtained by rolling, but the drawn stock can be obtained slightly cheaper in price.

Striking distances of 500-volt current-carrying metals vary with the current strength. By striking distance is meant the distance between metals maintaining a difference of potential at which an arc might form. Tests have shown that with 25 amps. at 625 volts, the safe striking distance is $2\frac{1}{8}$ ins.

with	50 amps.,		$3\frac{1}{4}$	ins.
"	100	"	$4\frac{5}{8}$	"
"	200	"	$5\frac{1}{4}$	"
"	300	"	$5\frac{1}{2}$	"
"	400	"	$5\frac{5}{8}$	"
"	500	"	5 11-16	"
"	700	"	$5\frac{3}{4}$	"
"	1,000	"	$5\frac{3}{4}$	"

It will be noticed that the necessary distance increases rapidly with the smaller currents, but develops a less ratio of increase with the higher currents. A curve plotted would approach the form of an iron magnetic saturation characteristic and is useful in the designing of current-controlling apparatus. Of course, the rating of current-carrying parts of a switchboard has come to mean the rating able to stand a continuous 25 per cent overload, and a temporary overload of 50 per cent. Sometimes a 100 per cent overload is specified, which is duly considered in the design of the apparatus. A good margin is provided for safe striking distances, or spaces.

We now take up the railway-generating station of, say, two or more direct-current generators of 400 kw, or less, each. As many generator panels are required as there are generators, and as many feeder panels as there are total feeder lines, divided by the number of feeder circuits per panel. Such is one of the simpler forms of a railway switchboard and is shown in Fig. 1.

In Fig. 1 is a switchboard composed of two generator and three feeder panels built by the General Electric Company. Fig. 2 pictures another switchboard of about the same capacity as Fig. 1, made by the Westinghouse Electric & Manufacturing Company.

Fig. 2 presents a diagrammatic view of a railway switchboard with the same number of generator and feeder panels as shown in Fig. 1, with the addition of a central Load Panel. This panel has an ammeter of sufficient capacity for the total output, and a voltmeter mounted on a swinging pedestal bracket. On this same panel is mounted a Total Output Recording Wattmeter, making the Load Panel complete. By comparing these two switchboards it will be noticed that the circuit breakers at the tops of the panels of each are of a radically different type on each board, about which more may be written later.

This same style of construction for a small generating station is retained in that of larger direct-current stations, each generator panel being built, of course, to carry the greater current, but 5000 amps. seems to be a safe limit. The feeder panels are generally built with each feeder-circuit switch of from 300 amps. to 2500 amps. capacity, which capacities are carried out in one, two and four-circuit panels. In the four-circuit panel it is not desirable to have more than 500 amps. for each switch, nor more than 1500 amps. per switch in the two-circuit panels, the 2500-amp. switch being mounted on a single panel. In smaller capacities, fuses instead of automatic circuit breakers have been used, but this is not good practice. Automatic circuit breakers are the only protective device to be recommended.

A Booster panel has upon it the necessary switches for controlling the Booster output, very much like an ordinary generator panel.

The Battery panel may consist of merely one panel with the different switches for controlling the battery charge and discharge, and for controlling the combinations of cells required, together with the voltmeter, ammeter and protective devices, or there may be also an additional panel devoted solely to a sliding switch for readily cutting in and out the end cells.

It will be unnecessary to detail the panel construction now so universally adopted, or to point out that one manufacturing company uses an angle iron, and another one a channel iron, for the frame supports of the slate or marble slabs; that all build each panel of two or more separate slabs, butt jointing them to form panels, and butt jointing the panels to form switchboards. The material used, however, varies from slate to several varieties of marble, such as blue, white, pink, etc., and is from $1\frac{1}{2}$ ins. to $2\frac{1}{2}$ ins. in thickness. Two inches thick is very suitable. The edges are generally beveled ⅜ in. to ½ in., in order to minimize the possibility of being chipped.

The reader is familiar with the general layout of the generator and feeder panel of the capacity above referred to, so that this will not be elaborately described, more than to again refer to Figs. 1 and 2, and enumerate the devices.

Each picture shows the construction followed by two leading manufacturers, the wiring diagrams being identical. Each generator panel has mounted upon it

1 Circuit Breaker.
1 Ammeter,
1 Field Rheostat,
2 Single-Pole Main Switches,
1 Lightning Arrester—(in back),
1 Potential Receptacle.

bracket. The bracket mounted permits the attendant to swing the face of the instruments at right angles to the switchboard so that they may be readily read. The ammeter of the load panel, indicating the sum of but two generator ammeters, is not essential for a simple station, but the recording wattmeter is essential.

Each generator-panel potential plug receptacle is connected in multiple with one voltmeter, the other being permanently connected to the bus-bars. Thus the potential of the generator ready to be thrown in parallel with the other may be known. One voltmeter alone may be used if wound differentially, one coil being permanently connected to the bus-bars. When a generator is to be connected in multiple with the busses, a plug is inserted in the generator-panel receptacle, the potential of the generator being thus opposed in the voltmeter to that of the bus-bars. The

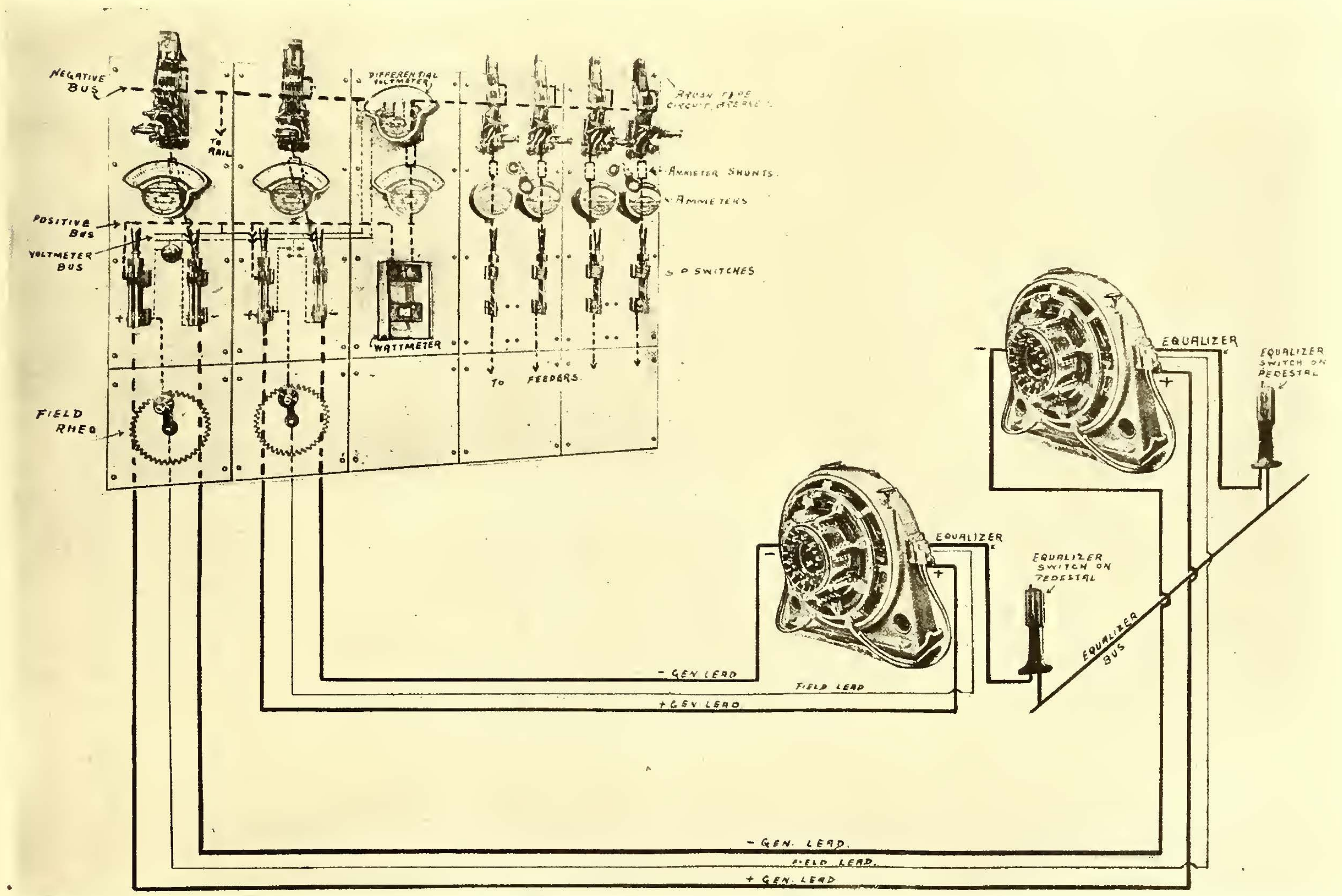


FIG. 2.—STANDARD WESTINGHOUSE RAILWAY BOARD

In Fig. 1, there is in addition to this list, on the generator panel,

1 Field Switch,
1 Lighting Switch,
1 Pilot Lamp.

Each feeder panel, shown at the right of each picture, has

1 Automatic Circuit Breaker,
1 Ammeter,
1 Pilot Lamp,
1, or more, Quick-Break Knife Switches.

The switches are of the same type as those on the generator panel. On the back of each feeder panel, a kicking coil and lightning arrester should be provided for each feeder circuit.

The central panel, or Load Panel, of Fig. 2, might, in a small plant, be dispensed with, since two voltmeters could be mounted at the end of the switchboard on a swinging

generator potential is adjusted until the difference is zero. The generator is then connected to the bus-bars, the plug withdrawn, and the voltmeter indicates the bus-bar potential.

As to whether the instruments shall be of the horizontal, or vertical edgewise type, round pattern, illuminated dial, or any other design, is a matter of fitness and taste. The illuminated dial type is, however, of practical convenience, well warranting the additional expense.

Everything mounted on the panels of the switchboard of our sample type is back connected, the rheostats and discharge resistance as well. It might be pointed out that it is good practice to connect lightning arresters on all direct-current feeder panels, and to put kicking coils in all direct-current feeders. But such coils are not necessary in the generator leads. It is better to have the generator ammeter excited from the machine circuit and not from the bus-bars. But feeder ammeters should be excited from the bus-bars with bus fuses in the exciting circuits of all feeder ammeters. Voltmeters of the permanent magnet type are strongly recommended.

For a greater number of generator and feeder units, the principles hold good as those described for the simple switchboards of Figs. 1 and 2. It then becomes a mere matter of adding more units, and also of great advantage to add the useful load panel and a station panel. If boosters and storage batteries are in use at the station, panels for their control become necessary.

For larger railway station switchboards, single polarity panels are to be recommended, since in the larger generator units, the generator panels become crowded at the back of the double-pole panels, with the consequent risk of short circuit when working at the board. This risk is obviously lessened by adopting the one polarity.

To accomplish this desirable object and to equalize on the positive side of the generators, the positive main switch is located beside the equalizer switch on the equalizer pedestal near the generator. The positive and equalizer switch being very nearly of the same potential, there is no danger in their proximity. The positive bus-bar is located under the station floor and is extended to the feeder bus on the station panel of the switchboard, as indicated in the accompanying diagram of Fig. 3. The series fields are closely paralleled in this way, both ends of each series winding being tied by short runs to bus-bars close to the generators. The positive bus-bar is made short, and all positive generator leads to this bus are made the same length in order to insure close equalization. Only one main lead, the negative, runs from each generator to the switchboard, the positive current of all generators being carried to the feeder section of the switchboard through a single bus connection.

Fig. 4 shows the connection of a single polarity generator panel, made by a prominent manufacturer. It will be noticed that all switches, instruments, and heavy uninsulated parts are of one polarity; that is, negative, or ground polarity. This panel, in large capacities, is made up with a new type of brush switch, easily hand operated by virtue of a toggle joint. The field rheostat and contact switch are removed from immediately back of this panel to a position above or below the floor, the rheostat being then actuated by means of a sprocket chain, or by gearing.

The removal of the positive main switch to the pedestal alters somewhat the customary sequence of operations in starting a generator, the procedure for which becomes as follows: All switches on the panel being opened, first close the equalizer switch on the pedestal, which is, with the new arrangement, the left-hand switch, as viewed from the front; next, close the positive main switch, which is the right-hand switch on the pedestal; then close the field switch on the panel, insert the potential plug, adjust the potential by the field rheostat; close the circuit breaker; and, finally, close the negative main switch. When shutting down the generator, reduce the load by moving the field rheostat, thus lowering the potential; the circuit breaker should then be opened; next open the negative main switch on the panel; and, finally, open the positive and equalizer switches on the pedestal near the generator. The field switch need not be opened until the generator has stopped revolving, or may be left in the closed position at all times, except when it is desirable to work on the generator while its armature is in motion, being left open at such a time in order to prevent the machine from building up its own voltage.

Generators connected in this new way may be run in parallel with previously installed generators working on the other method of connection without any change of the latter.

It is good practice to connect a lightning arrester to each tap from the positive main bus under the floor to the positive main switch on the pedestal of the generators.

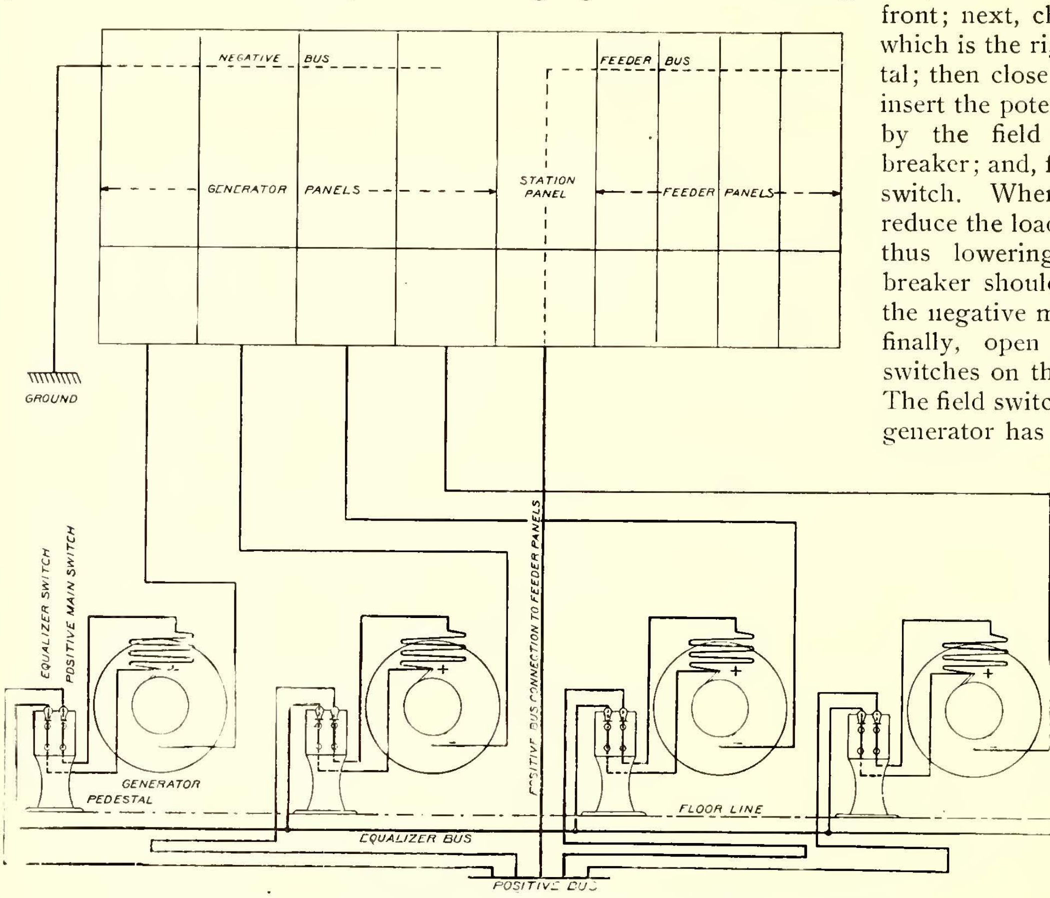


FIG. 3.—DIAGRAM OF POSITIVE, NEGATIVE AND EQUALIZER CONNECTIONS

Of recent years the question of equalizing on the negative as against the custom of equalizing on the positive side, has been carefully considered, and reasons for the adoption of one or the other method are here presented, the balance of the argument favoring equalizing on the positive side.

Referring to Fig. 5, the upper diagram presents the connections of three generators in parallel, equalizing on the negative. The lower diagram shows three generators equalizing on the positive side. The important point in a selection of either system is the possibility of an internal ground, within the generator windings, or from the brush holders of the generators to the frame. A ground, when the generator is equalizing on the negative, as shown in the upper sketch of Fig. 5, at a point on the positive brush connection of generator No. 1, thereby causes this generator to become a short-circuited series machine. If running alone, the short-circuit current flows through its own series field, excitation being kept up, and the generator kept alive, without hindrance from any operation at the switchboard by the attendant, such as opening the field discharge switch, or opening the circuit breaker.

If this generator is operating in parallel with others, the current divides between the series field of all machines, but still it may itself have sufficient field to retain its excitation. Provision has not been made for a circuit breaker in the path of this machine short-circuit. Generators Nos. 2 and 3 will tend to send current through the positive bus and the circuit breaker of No. 1 to the accidental ground. The circuit breaker of No. 1 generator will trip, thus cutting off generators Nos. 2 and 3, but still allowing No. 1 to continue the short-circuited current into the accidental ground with resulting damage, unless the equalizer and negative main switches of this machine be opened on the pedestal, or the engine be shut down. Considerable damage may be done before either of these two possible remedies may be applied, since the quickest method, that of pulling the pedestal switches near the generator, is more than likely to be delayed owing to the switches being surrounded by smoke and fire.

If the ground be internal in the armature winding it sets up a pulsating short-circuit, with the voltage varying from zero to the maximum armature voltage, which might, or might not, be sufficient to keep up the excitation by means of the series field, according to circumstances. Obviously the breaking of the shunt field at the field-discharge switch will not stop the trouble, the generators acting as series generators regardless of their shunt fields.

The only means of protecting against this danger when equalizing on the negative is the connection of the circuit breaker between the negative brushes and the series field. In order to save cable and losses, this circuit breaker would, in most cases, be located on a pedestal either near the generator, or on the machine frame itself. In order to avoid this circuit breaker tripping on a mere overload, another circuit breaker, set for a lower current, would be necessary on the switchboard, and connected to the positive lead, thus compelling the use of two circuit breakers for each generator.

In either case of equalizing, whether on the positive or on the negative side, it would be best with large generators to carry the leads of but one polarity, from the machine to the panel at the switchboard. In order to directly connect the armature to the series field, and to put the circuit breaker in series with the armature, this polarity must be opposite to that carrying the series field. Thus, when equalizing on the negative, the circuit breaker would be placed in the positive lead, as shown in the upper diagram of Fig. 5, and when equalizing on the positive, the circuit breaker would be placed in the negative lead, as shown in the lower diagram of Fig. 5.

The action resulting from a ground on generators equalizing on the positive side may be traced in this same sketch. Should a ground occur on the brush holder ring of No. 1 generator, current would be supplied from two sources, one from its own armature, and another from the armatures of the generators in parallel with it. The current from the armature of the generator itself would trip the circuit breaker of machine No. 1, and cut off the supply from this source. The current from the other generators would be abnormal and broken, in consequence, by the circuit breakers. The whole station output would be cut off, but the burn-out would be prevented from spreading, which would be the least of the two evils. Practically current thus generated would not go through the series fields, the armature reaction of the different generators would lower their voltage, and the violence of the momentary burn-out would thereby be diminished. Moreover, the amount of current actually received on generator No. 1, due to its burn-out, from generators Nos. 2 and 3—assuming the station to be of three generators of equal size and the station load, equal at least, to the rated capacity of two of the generators—before tripping the circuit breakers on Nos. 2 and 3, would be the total capacity of these two circuit breakers minus the station load at the time. This would not be a very large amount.

Consequently one circuit breaker gives ample protection

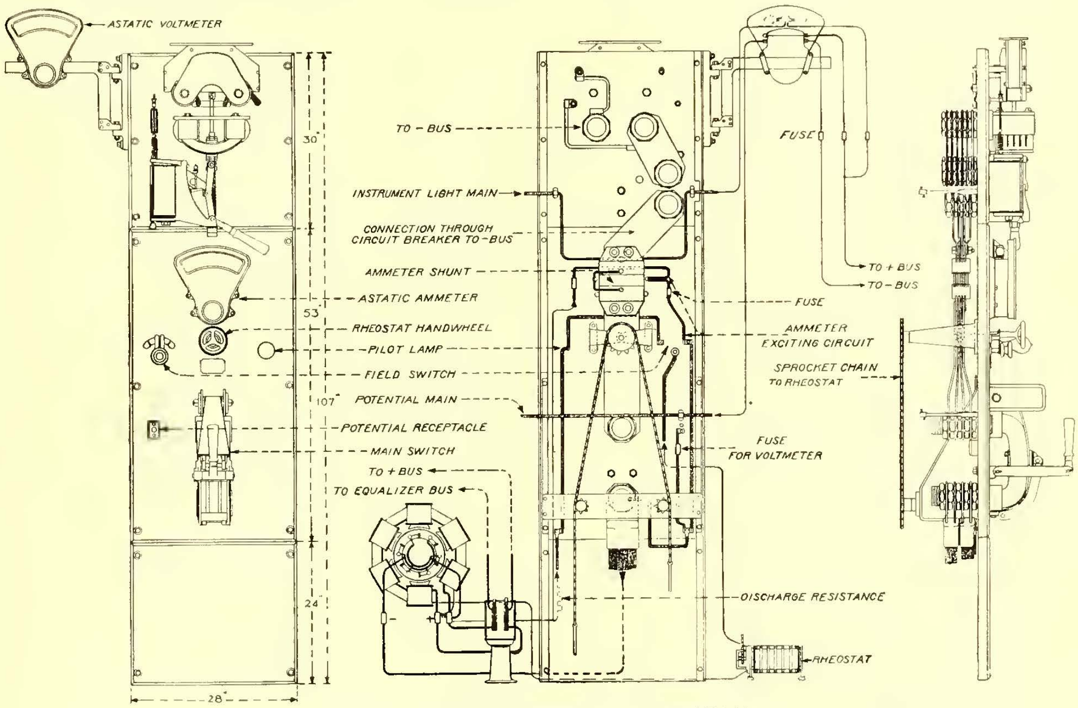


FIG. 4.—SWITCHBOARD PANEL DIAGRAM

in case of any ground, when equalizing on the positive, whereas equalizing on the negative necessitates two circuit breakers per generator. This fact, and that it is almost universal practice to equalize on the positive side, is one of great weight in determining the advisability of equalizing of generators on the positive side.

Rotary converters, to be referred to later as a part of an alternating-current transmission system, may be equalized on the negative side, as, in case of a ground, they are protected by the alternating-current cut-outs, the armature not being driven from an outside source. Equalizing on the negative side of converters, simplifies somewhat the switchboard wiring. It is, therefore, good practice to equalize compound converters on the negative, except where called upon to work in parallel with direct-current generators in the same sub-station.

As to good practice with large direct-current generators, with regard to the use of lightning arresters and kicking coils, the arresters should always be in the generator mains between the generator and the switchboard, at any convenient place, and should always be on all direct-current feeder panels to give protection against discharges from outside lines. Kicking coils should be omitted between the generators and bus-bars, but they should always be placed in each feeder circuit on the feeder panel.

Generators being usually built to stand an overload from the rated capacity, of 25 per cent for a period of two hours, and a momentary excess of load of 50 per cent, and even of 100 per cent, the switches and instruments should likewise be able to stand the excess current. Furthermore, although a 100 per cent overload specification is unusual, yet, in railway work, it is a service to which the apparatus is likely to be subjected, and provision in the ammeter scale should be made, so that such an overload may be noted.

Besides the methods of rheostat operation previously described, in the large capacity generators, the rheostat is operated by a hand wheel, mounted on a pedestal placed on the floor in front of the switchboard.

Switchboard illumination, particularly of the instruments

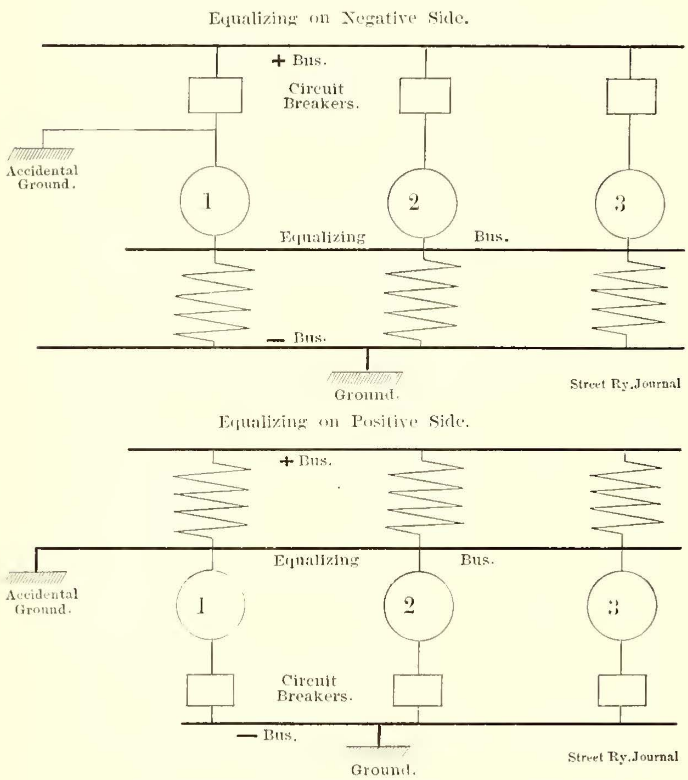


FIG. 5 —ALTERNATIVE CONNECTIONS FOR EQUALIZING RAILWAY GENERATORS

mounted thereon, is of practical importance. Some have advocated that it be done by the general station illumination and that the instrument dials are better lighted in that way. But the protecting glass in front of the dial reflects light, so that the attendant is compelled to seek certain positions to read the instruments. Hence, this reflection appears to bother less when the instrument is illuminated by its own switchboard lamp. Of course the instrument dial, lighted up by the lamp behind it, is undoubtedly most easily read and the "Illuminated Dial" is deservedly popular.

The generation of alternating currents is of increasing interest to electric railway men for the reasons indicated earlier in this article. Consequently, it is important to discuss the subject of the control of such currents in connection with their service in railway work.

The three-phase system is to be recommended because of its greater simplicity and economy. As in each wire of the three-phase system, two alternating currents differing in phase are combined, the loss is less than when the same power is transmitted by single or two-phase currents. Also a three-phase circuit needs but three wires, while a two-phase circuit needs four wires. The wires being the same size in both systems, the two-phase system requires, then, 33 per cent more copper, and the complications introduced by the fourth wire of the two-phase system.

With three-phase currents at 6600 volts, power can be transmitted with less than 1 per cent of the copper which would be required for the same power over the same distance with the same loss, by means of direct currents at 550 volts. Stating this fact in terms of the size of wire, a No. 6 wire will take the place of a 1,000,000 circ. mil cable.

We have to deal with two broad classes, one, the direct generation of high voltage of, say, over 5000 volts, alternating current, which is directly connected to the transmission lines; and the other, generating alternating current at a comparatively low potential of, say, 2000 volts, thence conveyed to step-up transformers, the high-tension side of which is connected to line. The occasional practice on the Continent of conveying the low tension to a motor-generator rather than to a transformer is not so efficient. Of course, the generation of the high-tension line voltage direct is a saving of the energy of transformation and of copper, and as regards the station control of the electrical energy, it is more simple. The attendant in working about the switches and apparatus must from necessity be more careful than when working about apparatus of 2000 volts, but the controlling panels are, of course, perfectly safe, since the high tension is not on the panels.

Descriptions of stations of great capacity and of refinement in instrument details have recently been presented to the readers of the STREET RAILWAY JOURNAL in such completeness that it will be only necessary to give here a diagram of the wiring connections for a moderate-sized station.

The diagram, Fig. 6, follows the various transformations of a high-tension system from the alternating-current high-tension generator and its exciter terminals to the 600-volt direct-current railway feeders.

This diagram does not show the exciter connections on account of the assumption that the readers of the STREET RAILWAY JOURNAL are familiar with low-tension switching and panel-switchboard connections. But, on the generator-panel section of the diagram, Fig. 6, may be observed the tap from the exciter feeder panel for one generator panel. The generator rheostat is in series as usual with the generator field, and from this generator proceeds the three high-tension wires represented at the extreme right of the diagram. The high-tension circuit-breaking switch, shown in this part of the figure, controls the output of this generator, the switch being actually located at a distance from the panel, but controlled by electric or pneumatic means from a controlling switch. This is preferably located on a controlling or benchboard, generally in front of the instrument panels. The function of the generator panel is relegated, therefore, merely to interpreting the amount and action of the generator current. Even the rheostat control may not be affected by a handle upon the generator panel, as it may be controlled by a handle upon a benchboard, or by means of an electric motor which is in turn governed by a controller, the handle of which is on the benchboard.

Taps from the generator leads are taken to potential transformers, from the low-tension side of which current is led off for different uses, as for synchronizing lamps, the wattmeter and the voltmeter. The control of this use in the two last is vested in a four-plug receptacle, shown in the diagram, the connections of the four-point plugs and the position of these plugs for their various uses being represented at the lower right-hand portion of the diagram. The power-factor meter is continuously in circuit like the ammeter and the voltmeter. Its function is to indicate to the switchboard attendant at all times the power factor of the current from the generator, since in two generators working in synchronism, the power factor of each must be alike for an equal division of the load. Two dissimilar indicated power factors tell which machine to speed up. The current transformer shown in circuit with the middle leg of the generator leads gives the current supply for the ammeter, wattmeter and power-factor meter, and at a safe working voltage. Of course, this current is in a constant ratio to the main current, the instruments being calibrated in that ratio.

The generator main switch controls the output of that generator to the busses, from which taps are taken to a similar switch, as represented in the diagram, controlling sub-station, where the process of transforming the energy to 500 volts or 600 volts direct current is undertaken in the same manner as is often done in the generating station itself. Such a sub-station at the generating station is shown in the diagram, Fig. 6.

Taps from the generator busses proceed to sets of static transformers. A circuit-breaking switch is in this circuit, the switch being controlled in the same manner as the circuit-breaking switches before described. Overload relays, the ammeters and the power-factor indicator, are fed by the current transformers in the two legs, as shown in the diagram. The synchronizing lamps, voltmeter and the potential coil of the power-factor meter are each supplied by the potential transformer, which is energized by a circuit from the low-tension side of the main transformers.

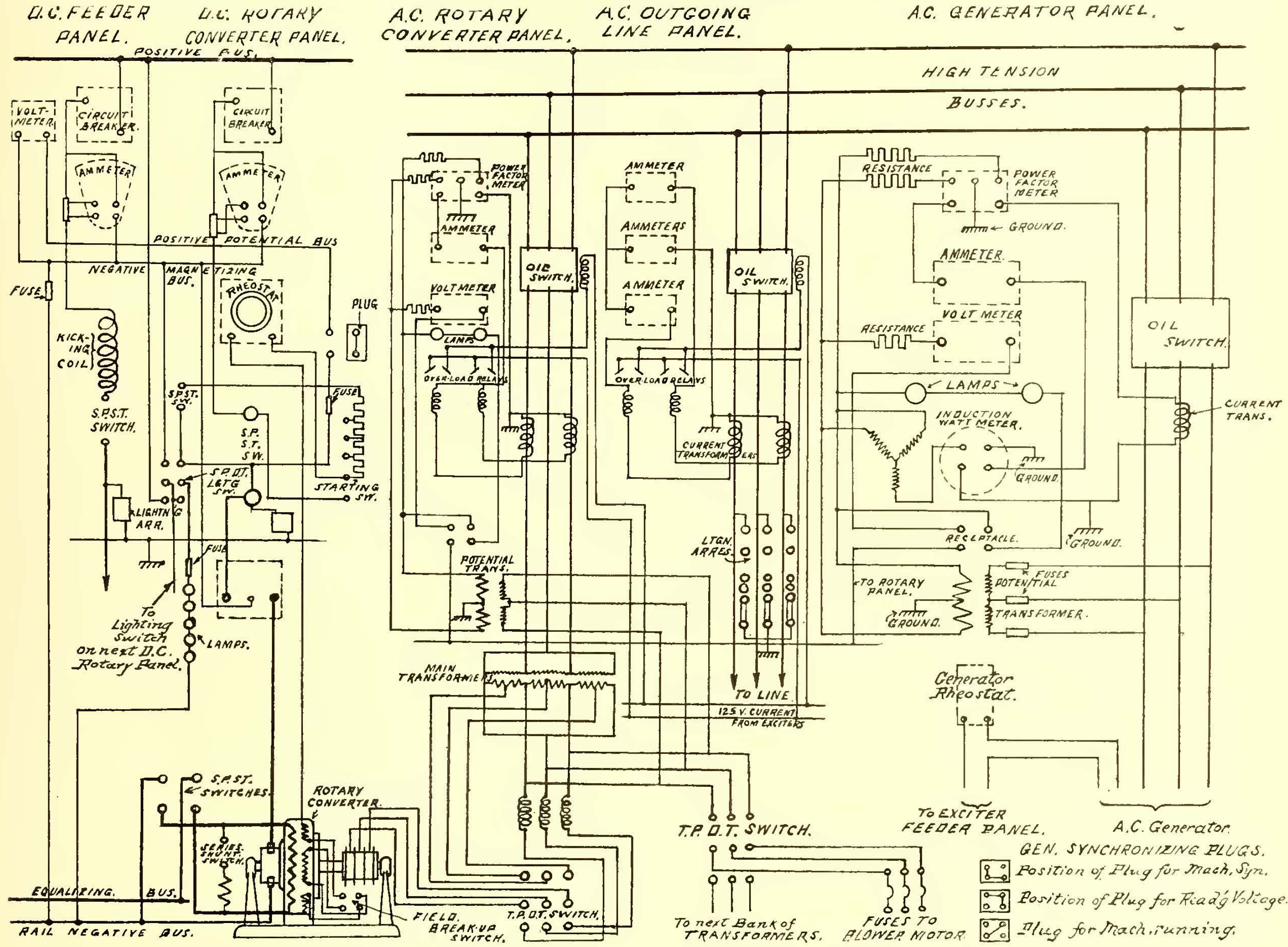


FIG. 6.—TYPICAL DIAGRAM OF CONNECTIONS FOR ALTERNATING CURRENT BOARD

the output to line. But, as more than one generator may be supplying energy to the busses, the outgoing line panel has mounted upon it three ammeters for measuring the current in each leg. The two transformers shown provide current to them and the overload relays, and note that but two, and not three, transformers are in circuit. It has been found that only two transformers are necessary if the connections shown are adopted, the middle-leg transformer not being needed. The relays operate by virtue of an abnormal current strength in the solenoid, causing a movable core to close a circuit tapped from the exciter busses. This closed circuit trips the mechanism controlling the main switch. The switch in the outgoing-line circuit, being liable on short circuits to be called upon to open the circuit of several times the normal capacity of the station, should be preferably of an oil type, opened or closed by pneumatic or electric means, which movement is in turn controlled by a tripping mechanism.

It is to be noted that lightning arresters are placed in the outgoing-line circuit, which line continues to the distant

The blower-motor circuit, when blowers are installed for transformers cooled by air blast, is arranged to be switched on either of two banks of transformers, as shown in the diagram.

The function of the alternating-current rotary panel is then to control the input to the static transformers, of which the low-tension side feed the alternating-current side of the rotary converters. The rotary converters can not be connected direct to the high-tension line, instead of first reducing to a lower pressure, on account of the fact of the difficulties common to converter design, making it prohibitive.

We will not take up in this article the relative advantages and disadvantages of using two, three, or six-phase rotary converter work for lack of space. Compound rotary converters are connected and paralleled on the direct-current side in precisely the same way as similar direct-current generators, equalizing switches and bus-bars being used. So likewise the same precautions have to be used when working with storage batteries in parallel with their low-pressure feeders. Rotary converters have always been arranged to start from the direct-current side, either from the direct-current busses, or from the direct-current side of a special motor-generator set. The next best method is that of an induction motor directly connected to shaft of the rotary converter. But the simplest method is to switch the alternating-current side of the transformer secondaries directly on to the alternating-current side of the converter. For this purpose taps are made on the secondaries of the transformer in order to get a reduced starting voltage, say one-half, and by means of the D. P. D. T. switch shown in the diagram this half voltage can be thrown on the converter without a compensator, and after sufficient speed has been attained by the converter, the full alternating-current voltage can be thrown upon it. The direct-current main and field switches are kept open, the voltmeter being left across the direct-current side, and full alternating-current voltage is gradually cut in. The direct-current side indicates nothing at the moment of starting, except slight oscillations of the voltmeter, on account of its energizing current being alternating. As the rotary increases speed, the voltmeter needle moves backward and forward, corresponding to the diminishing frequency of the pressure at the direct-current terminals. When synchronizing speed has been reached, the needle will again be steady, for the current in the voltmeter is direct current, the exact time for cutting in the rotary field being just before synchronism is attained, and is indicated by the voltmeter needle beating slowest. It is important, however, to always close the field circuit when the voltmeter needle is on a certain side of the mean position, for one side is right and the other wrong, depending upon the individual case. If the field is cut in circuit when the needle is on the wrong side of the scale, the polarity of the direct-current side of the converter is reversed, and in most rotaries this means that it must be cut out and again synchronized in order to get the synchronism at the right pole. A polarity indicator on each direct-current rotary panel would prevent the operator from making a mistake, since its use would allow synchronism always at the right pole, for after excitation has been put on, the polarity of the direct-current side can be checked before the rotary is connected to the direct-current busses.

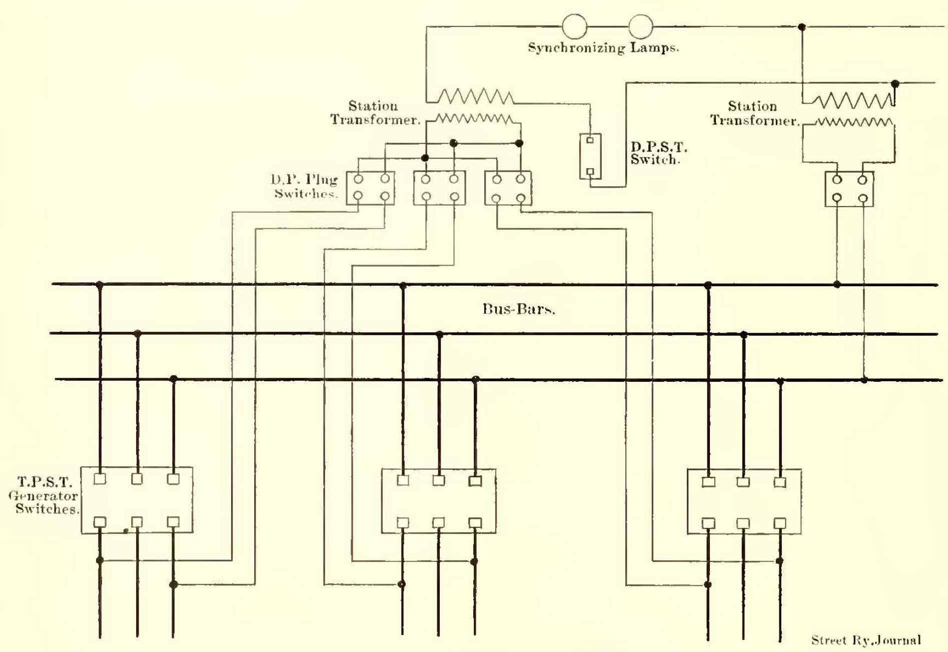


FIG. 7.—SYNCHRONIZING CONNECTIONS

Lamps can be substituted for the voltmeter mentioned above, across the direct-current terminals, as shown in the diagram. They would be bright at the first moment of starting, and also when synchronism is reached, while between these limits, the light will pulsate, and the excitation should be put on when the light is beating slowest. The lamps will be either bright or dark, according to circumstances.

The alternating-current input of the converters is prevented from being excessive by the use of the overload relays, represented in the diagram, controlling the circuit-breaking switch. The direct-current output of the rotary is guarded from overload by the automatic circuit breaker, shown in the diagram, as on the positive leg of the circuit. This leg is placed, and controlled, on the direct-current rotary panel, similar to the ordinary direct-current railway panel, the style of ammeter used being one operated by a shunt.

The diagram shows a starting switch for aid in starting the rotary, each clip of the switch being attached to a graduated resistance. Thus the starting voltage may be controlled by steps. The direct-current rotary panel supplies current to the positive bus, from which the feeder frame receives and controls the current output to the railway feeders. A kicking coil is shown in the feeder circuit. The lighting circuit and the lightning arrester connections are clearly shown by the diagram, as well as are the connections to the negative, or rail, bus, and to the equalizer bus.

The mechanical methods used for the control and the breaking of high-tension currents of great amounts of energy will not be described in this paper. In general, it may be stated that potentials of 2000 volts in such amounts of energy as is required even in small railways cannot be safely handled with switches of the open-brake type of such dimensions suitable for easy hand operation and for small space. The switch contacts are invariably broken in confined space, so that the action of the expending air and gas by virtue of its explosive effect blows out the arc, or the contact is broken in oil, the arc being dissipated without damage to the apparatus. Of these various forms of circuit-rupturing devices more may be presented at another time.

The details of small capacity, current and potential transformers used in connection with the instruments and relays of high-tension alternating-current systems will not be given here. Their functions have been presented in the description of the station wiring diagram of Fig. 6, but it is advisable to ground the frames and the secondaries of potential transformers, and the secondaries of current transformers. The switchboard frames also ground in order to prevent the attendant from receiving a possible shock. In grounding the secondaries of potential transformers it is impossible to synchronize bright between machines. They can be synchronized bright with the bus-bars, or can be synchronized dark with each other, but can not be synchronized bright with each other unless the grounds are removed from their synchronizing transformers. But with the use of the midscale voltmeter for synchronizing, the grounding of the secondaries works all right, the ground connection even serving as one synchronizing bus-bar. The circuit breakers are isolated and away from the instrument and operating panels, being operated by hand mechanism at the panels, or their electrical or pneumatic operation controlled from the panels. When hand operated, the position of the handle indicates to the attendant if the breaker be in the closed or the open position, but the handle position does not indicate whether the breaker was opened by intention, or automatically by the overload tripping device. So that with hand-operated automatic circuit breakers, some visible or audible signal system is imperative in order to indicate if the tripping was automatic. An incandescent-lamp signal is recommended, the lamp to burn when the breaker has tripped on overload, the color preferably being red. Thus the red signal will indicate to the attendant the necessity of resetting the breaker.

Where the circuit breaker is isolated at a distance from, and merely controlled at, the switchboard, a double-signal system is imperative. This consists preferably of a green or white incandescent lamp to indicate by burning that the circuit is closed, and also of an additional red lamp which by burning indicates that the circuit breaker has opened. The operation of the controlling device indicates by its position whether the circuit is open by intention.

In installations as these the switchboard proper becomes merely panels upon which are instruments and operating handles, the difficult and skilful portion of the current-controlling apparatus existing away from sight, below, back, above, or all three. In some cases it is advisable to have the operating panels arranged as an inclined table or bench, the vertical panels being solely used for the mounting of instruments and relays.

For the proper opening of the circuit breakers in connection with the switchboard under discussion, it is highly important that there should be some means of operating the breakers on an overload. An Automatic Relay is recommended for all high-tension service of 5000 volts, or over. It is readily adjustable to either hand, air, or electrically-operated circuit breakers, so that the breakers will respond automatically to those conditions under which they should be opened. The relays have a marked advantage over fusible cut-outs in the way that they can be readily built to operate under other conditions than plain overload, such as overload with time limit and reversed current.

A description of the method of operation of these three types of relays may follow at another time, but their use has been found to greatly improve the operation of systems where continuity of service is imperative. In some cases it is desirable to combine a time-limit relay set for overloads, and an instantaneous relay set for short-circuits on the same circuit-breaking switch, the time relay being adjustable so as to act at the expiration of from one to ten seconds.

While on the subject of high-tension circuit breakers (circuit-breaking switches), it will be well to point out that the capacity of the switch at a certain voltage depends, in alternating-current work, on whether the load is or is not an inductive one. The kilowatt capacity behind the automatic circuit breaker in the event of a dead short-circuit is of vastly more importance in determining the use of certain circuit breakers than the fact that they will permit a certain current with minimum heating, and safely stand on open circuit a certain voltage. For possibly at the instant of the interruption of the circuit by the switch, an energy of five times the normal capacity of 5000 kw in generators may be exerted with a possible failure of the circuit-breaking switch. Hence the station kilowatt capacity is important information when advice is requested as to the suitability of a circuit breaker at the given station voltage and the specified normal current.

In transmission systems where the line runs to one sub-station and from there branches to a second sub-station, it is good practice to take the line going to the more distant sub-station from the line side of the near sub-station switch instead of from the sub-station side. The more distant station can then be run when the bus-bars of the near sub-station are cut off. In case of duplicate incoming lines and duplicate lines to the more distant sub-station, the same arrangement should be followed of tapping the outgoing lines from sub-station No. 1 to sub-station No. 2, from the incoming lines back of the sub-station switches of No. 1, instead of from the No. 1 sub-station bus-bars. In case cross-connecting switches be used so that one-half of line No. 2 can be run on the half of line No. 1, air-break switches may be used.

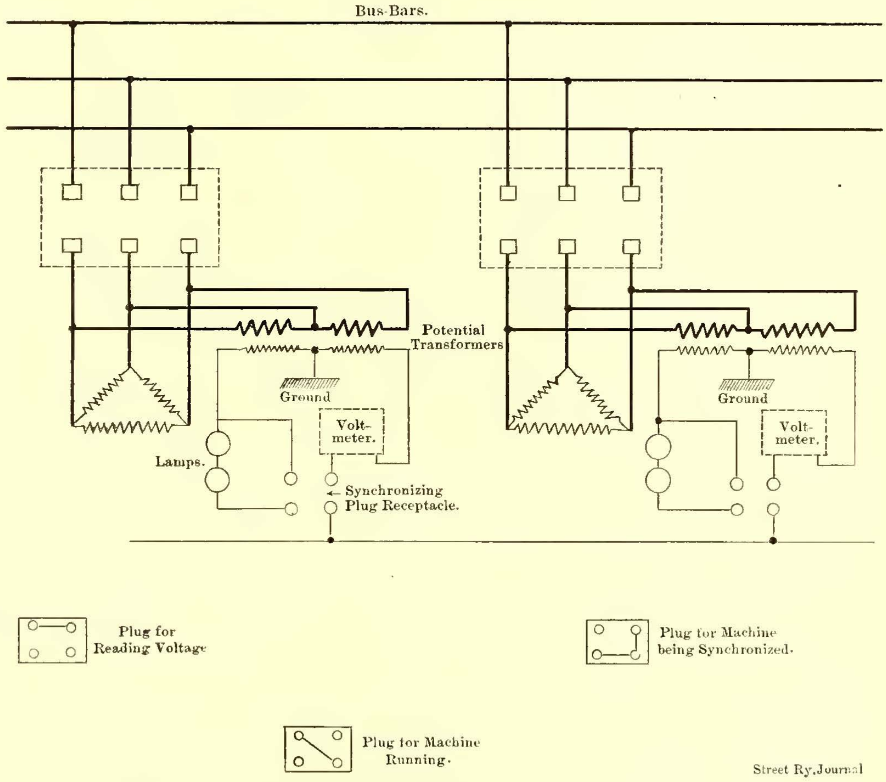


FIG 8.—HIGH POTENTIAL MACHINES SYNCHRONIZING WITH EACH OTHER USING MACHINE VOLTMETERS

The usual method of synchronizing alternators is to connect a lamp or lamps in the circuit of two potential transformers, the secondaries of which are connected in series, and the primaries are connected to the different circuits to be synchronized. As long as the frequencies of the two circuits are unequal, the lamps will be alternately light and dark. When the fluctuations of the lamps become very slow the machines are nearly in synchronism. With the connections as shown in the diagram of Fig. 7, the machines will be in phase when the lamps are bright, and in opposition when they are dark. The switch should be closed when the pulsations are very slow (about one in two or three seconds) and while the lamps are at maximum brilliancy.

The synchronizing on one side of, say, a three-phase circuit does not prove that the other phases are ready for parallel operation, unless it is known that the connections correspond all through in both generators. When machines are first thrown in parallel, two sets of phase lamps will prove whether the connections are right, since they will give simultaneous indication that both phases are in step. The middle wire takes no part in the synchronizing connections.

When two separate transformers are used for synchronizing, as shown in Fig. 7, note whether their connections are the same, otherwise their indications may be misunderstood. For this reason it is better practice to use regular synchronizing transformers properly arranged and mounted together. The connections of a pair of transformers can be proved by testing with primaries and secondaries in series.

Another and preferable way to synchronize is, instead of using lamps, to use voltmeters with such connections that the point of synchronism is reached when the voltmeters are beating together and at midway on the scale. The great advantage of this method, which is to be credited to Mr. J. E. Woodbridge, of the General Electric Company, is that the exact instant is indicated at which the generator switch is to be thrown in, whereas, with the use of voltmeters connected in as lamps, the indicated time to throw in is at the ends of the scale. Since the beating needle hesitates at each end of its throw, the exact instant to throw in can not be as accurately indicated as when the needle is traveling at its maximum speed.

In Fig. 8 is given a diagram of connection of two high-potential machines synchronizing with each other, using the machine voltmeters. By using the proper one of the three varieties of plugs, connected as shown in Fig. 8, the voltage of either machine may be read or the machines may be made ready to show synchronism. If the potentials of the generators were low enough, the potential transformers could be omitted, and the two outer connections to the plug receptacles marked *A* and *B* directly attached to the respective machine leads and the middle lead discarded.

Variations in the methods of leads and plug connections would permit synchronizing of the generators with each other, using a special voltmeter; of machine synchronizing with bus-bars, using special voltmeter or machine synchronizing with bus-bars, using machine voltmeter; or synchronizing with each other, using three voltmeters each.

It is true of railway switchboards as in other switchboards first, last, and all the time, that *ample* provision should be made for space in the station to properly locate and place the current-carrying conductors and the current-controlling devices. Enough space to make a thorough workmanlike job is nearly always denied, this part of the station design not always receiving sufficient attention. In the beginning of a layout, it is too often the thought of the designer that *any* place will do for the switchboard, under which term is, in reality, concealed a mass of intricate connections and mechanical devices which is by far the most difficult problem of the station design.

The writer wishes to acknowledge the courtesy of, and to express his thanks to, the General Electric Company and the Westinghouse Electric & Manufacturing Company for the supply of some of the cuts used.

A new tramway concession, covering a distance of 23 km, has been secured in Vigo, Spain, by "El Banco de Vigo." No company had been established up to the date of the report (Oct. 14), but plans have been announced for the building of the line at a cost of 2,700,000 pesetas ($405,000), to be operated by electricity.

CORRESPONDENCE

Operation in Parallel of Alternators Run by Tandem-Compound Engines

COMPAGNIE D'ELECTRICITE THOMSON-HOUSTON DE LA MEDITERRANEE, PARIS, Oct. 9, 1901.

EDITORS STREET RAILWAY JOURNAL:

The excellent description of the high-speed electric traction between Milan and the Italian lakes in your August issue contains the following observations under the heading of "Steam-Generating Plant":

> The running of alternators in parallel when direct coupled to tandem, instead of cross-compound engines, will probably give some trouble to the engineers, and the operation of the plant will therefore be watched with considerable interest.

There has not been the slightest difficulty experienced in the running in multiple or coupling of these generator groups at zero load, or when supplying current to the rotary-converter sub-stations in regular service, these sub-stations being also operated in multiple on both the alternating-current and direct-current sides. The cross currents between generators, when running in multiple, and with cranks coupled at haphazard, are practically negligible, and a very small percentage of the full-load output of the 750-kw dynamos. The total weight of the fly-wheel is 36 tons, of which 25 tons is in the rim. The revolving parts of the dynamo weigh 17 tons.

I am informed by G. Boner, manager of the Franco Tosi Works at Legnano, Italy, builders of the engines at the Tornavento power station, that the same type of tandem-compound engine, direct coupled to alternators, has already been supplied by his firm to the Trieste and Bologna lighting stations, and that the parallel operation has been perfectly satisfactory. It is a fact that certain European engine builders succeed remarkably well in the design and construction of tandem-compound engines, giving a very uniform turning moment and a low-steam consumption. Their success in this direction may be attributed to their thorough appreciation of all conditions of the problem and to the care exercised in the design. The balancing of parts; the governor, and the steam-distribution mechanism in particular are the objects of careful study, with the view of obtaining a uniform turning moment without recourse to the heavy fly-wheels usually employed by American builders.

It may be of interest to point out that balanced poppet valves are employed throughout, and that this type of valve has also been found to be very well suited for use with superheated steam.

A. S. GARFIELD, Consulting Engineer.

Storage Battery Boosters

BOSTON, Mass., Oct. 2, 1901.

EDITORS STREET RAILWAY JOURNAL:

I was much interested by the very clear and concise exposition of the use of the series booster in railway work in the paper read by W. J. Davis before the New York State Street Railway Association. There is a development of this idea in connection with storage battery work which has seen a number of applications, and which may be of interest to your readers.

Many roads now operating have lines reaching out 7 miles to 12 miles from the power station, that is on the limit of what is practicable for a direct-current transmission, with reasonably heavy loads. A storage battery near the end of such lines is often used to hold up the line voltage; it charges at moments of light load, and discharges at moments of heavy load, thus, as it were, working the copper, when it would otherwise be idle, and increasing its transmission value very greatly. In this way the voltage at the end of the line is held up sufficiently to secure good results on ordinary days. Roads of this type, however, have days during the year, Sundays and holidays in summer, for instance, when the load doubles. Under these conditions it becomes impossible to keep the battery up to its work as a regulator without cutting out a number of cells, and the booster finds a place at once; but owing to the presence of the battery at the end of the line, the problem is materially altered. The battery maintains a practically steady voltage at the point where the boosted feeder taps into the trolley, and the booster need no longer have a straight line characteristic. In fact, it is much better for it to have a falling characteristic, as any tendency to increase or decrease the load on the booster and its feeder is thus automatically counteracted, permitting the booster and feeder to run steadily loaded at the average load, and throw the fluctuations on the battery.

The result is to eliminate entirely from the station load the disastrously heavy fluctuations which a series booster would introduce, unless its capacity is quite small, compared with that of the station. It also brings down the size of the machine required for the work, and reduces the energy wasted. That this is the case is readily seen from the following hypothetical considerations. Suppose a current of 100 amps., transmitted continuously throughout the day, would supply the needs, the boost being 100 volts—then a 10-kw machine will do the work, and the lost energy is 10 kw, divided by the efficiency of the booster set, which may be 65 per cent, thus making the loss, say, 15 kw, multiplied by the hours of operation.

On the other hand, with a series-wound booster and no battery, the load must be cared for as it occurs. It would be nothing unusual to find the booster doing from 10 amps. up to 300 amps., at voltages varying from 10 to 300; that is, supplying from 1-10 kw up to 90 kw, requiring certainly not less than 40-kw or 50-kw booster outfit, and at times wasting as high as 90-65 = 138 kw. Supposing these heavy pulls to occur one-quarter of the time—then the loss would be $138 \div 4 = 34$ kw $\times$ the hours of operation + the loss that is going on the other three-quarters of the time. Added to this is the disadvantage of putting on the station a load varying from 1-10 kw up to 138 kw, when you might have a steady load of 15 kw.

On the other hand, of course, there is the loss in the battery, which may be 20 per cent of the work done by it, which is not by any means 20 per cent of the load that is boosted, a large proportion of which goes to the battery. With 100 amps. steady output by the booster, and a demand which, as assumed above, varies from 10 amps. to 300 amps., the battery will go from 90 amps. charge to 200 amps. discharge, doing, say, 200 amps. discharge one-quarter of the time, and 66 amps. charge three-quarters of the time, or, say, averaging a passage through it of 100 amps. at an average voltage change of not over 25 volts. This would be a loss of 2½ kw, and against this we may offset that portion of the loss by the series booster left uncomputed above.

In the way of flexibility, there is still another advantage offered. There is no objection to using as a booster a small, spare unit of the regular equipment, if the station has one, as is not infrequently the case, thus increasing the value of this machine to the station by simply arranging a few double-throw switches, so that the machine may be readily thrown into service in either capacity. In this case it may be advisable to arrange a switch to cut out the series field, and also to excite the shunt field from the station bus-bars when the machine is used as a booster. Again, we are freed from all possibility of partial failure, due to sluggish magnetic circuit. It sometimes happens that a series-wound booster, under rapidly fluctuating work, has a somewhat sluggish magnetic circuit, and is unable to build up its voltage in time to meet the demand, so that it never reaches the full voltage that should accompany the maximum load. PHILIP W. DAVIS.

Street Railway Train Units

CHICAGO, Ill., Oct. 15, 1901.

EDITORS STREET RAILWAY JOURNAL:

For a number of years past, as you probably know, it has been the custom in Chicago to operate cable cars in trains of from two to four cars, and during the rush hours four-car trains are very common. Last spring there was some well-meant but misdirected agitation here, however, in favor of a reduction of the length of these cable trains. It was argued that because single cars are operated upon Broadway, New York, that this was necessarily an improvement over the Chicago cable line practice for Chicago conditions. As I find even among street railway men, who are supposed to understand traffic matters some misapprehension as to this matter, I will trespass on your space to mention some of the benefits derived from the Chicago plan.

The advantage of operating cars in trains of three or four as against single cars where the headway is very frequent, is manifestly that there is a chance to operate more cars on a given length of track without having them interfere with each other. For example: If a four-car train were cut up into four individual units, and those four units were obliged to travel within the one-minute headway, which frequently prevails between the four-car trains, it would mean that the individual cars must be operated on a fifteen-second headway. While this is possible, as demonstrated on Broadway, New York, it materially reduces the schedule speed that can be maintained. There is, under Chicago conditions, much less interference of one car with another and less interference with other traffic on the street with trains than there would be with single car units. A train of four cars, of course, occupies a considerable length in the street, but when once it is passed the street is free of car traffic until the next train comes along, which, with the wide streets of Chicago, means that there is less congestion than there would be with four individual cars.

It is sometimes argued by street railway managers that trains of such length do not load and unload as quickly as shorter ones, but practice does not seem to bear this out entirely, although there is undoubtedly a little difference.

This discussion is, perhaps, without interest to a large number of street railway men in this country, because the cable road is now almost extinct, and there are not many cities where it is desirable to operate more than single cars, even if it were possible with the present electrical equipment. There is a suggestion, however, in the train idea which may be of some value in street railway practice of the future in large cities; that is, it is possible that, under certain conditions, it will be found advantageous to couple together a number of electric motor cars to form a short multiple-unit train to help relieve the congestion on crowded city terminal streets. The addition of trailers to the present motor-car equipments is not to be considered because of the slower rate of acceleration.

JAMES R. CALDWELL.

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NOTICE.

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Special effort will be made to answer promptly, and without charge, any reasonable request for information which may be received from our readers and advertisers, answers being given through the columns of the Journal *when of general interest, otherwise by letter.*

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All matters intended for publication in the current issues must be received at our office not later than Wednesday of each week.

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A Western contemporary in the electrical field asks. "What is the matter with the steel used in the track and contact rails on the elevated road of Boston?" Some months ago we took occasion to comment on the peculiar conditions that have arisen since the starting of the elevated lines in Boston. That there is an immense amount of iron and steel dust in the vicinity of the elevated tracks is a matter of common knowledge. This might lead anyone who reads the reports at a distance to inquire as to the composition of the steel in the track, and to pronounce it faulty, as our Western contemporary has done. Unfortunately for our contemporary's assumption, this is not borne out by the facts known to those on the ground. The unusual amount of noise caused by the trains on the Boston Elevated, as well as the unusual amount of iron dust, is a matter well known to the residents of that city. The cause for this noise is found to be the peculiar way in which the wheels wear. A train of cars, equipped with new wheels, is said to run as noiselessly as on any elevated road. After the cars have been in service for some time, however, a number of flat spots, about one-fourth the size of a man's hand, appear on the chilled tread of the wheel. It is to the presence of these flat spots that the great amount of noise is due. What causes these is a matter which is puzzling the elevated railway officials. It has been determined that the flats are not due to any sliding of the wheels, as men have been detailed to watch this carefully for weeks at a time. The equipment of the Boston Eievated, as to tracks and wheels, is the same as that of other elevated roads in this country, with the exception that the difference between the wheels and track gage is only $\frac{3}{8}$ of an inch, which is somewhat less than on other roads. It is possible that this causes a pinching on the curves (and the curves are very numerous on this road) which causes the peculiar wheel wear. The wear on the track would also seem to indicate this. There is one other respect in which the Boston equipment differs from any other, and that is in the use of right and left-hand motors, so as to bring the gears on a track on the same side, instead of on opposite sides, as is usual. One theory is that this arrangement slightly unbalances the truck, so as to cause the unusual wheel wear, but this has not been demonstrated as yet. Taken altogether, the situation is a peculiar one, but it is not one upon which it is safe to theorize at a distance.

At the last convention of the American Street Railway Association one of the topics discussed was the very small recompense paid by the government for the transportation of mails. The rate paid per car-mile for the transportation of the mails is not sufficient to pay expenses, and it is an encouraging fact that some of the street railway companies have decided that there is no advantage to them in carrying on the business at a loss, and consequently they have preferred to throw up their mail contracts rather than to continue doing what amounts practically to paying for the privilege. Street railway companies are overtaxed now, and it is unreasonable to ask them to further defray the expenses of the government by performing a service for which the authorities are unwilling to pay a fair price. While it is not our purpose to enter into the realm of politics, to compare different methods of government or to advocate State subsidies, it is interesting to note the assistance which is constantly extended to investigators of electric railway problems in countries outside our own. A notable instance of this is afforded at the present time in Germany, where the spectacle, remarkable in this country, is given of the leading electrical firms working hand in hand with the government in a technical investigation of the problem of high-speed electric railway service. The experiments now being carried on in this direction on the Berlin-Zossen line are familiar to our readers through various articles in this paper, but the fact may not be so well known that these experiments have been largely due to the initiative taken and assistance given by the German Emperor in the interests of high-speed service. The practice in this country of selecting our legislators and executive officers from the legal profession has become so settled by custom that it would be a very novel experience to see at the head of the State a leader in scientific research; yet it is hard to conceive of any branch of industrial activity in which there is a greater opportunity for securing results, which would be of value, not only to the American manufacturer, but also to the well-being of the general public, to whom rapid and cheap transportation is of incalculable benefit. A genius for solving the problems of State is not the exclusive property of members of the bar, and from the suggestion afforded in Germany a cue is given to Americans to elect, as magistrates, at least as an experiment, some of the engineers or others who have contributed in such great measure to the advance made in railway work. Certainly among those who have had charge of the upbuilding of some of our large manufacturing or street railway companies are many who are eminently fitted for occupying any office within the gift of the American people.

We have often felt that, in spite of the appreciation which the multiple-unit system has received, it still had operative advantages which have hardly yet come to be valued according to their merits. Up to date it has been employed mostly on elevated and interurban roads, and mainly by reason of its undeniable advantages in the matter of quick and smooth acceleration.

On broad general principles there would seem to be intrinsic disadvantages in employing a dozen motors to do the work of two or four. In the mere matter of running at full normal output the locomotive or single-motor car at the head of a train has undoubted merits, but when stops are frequent, not only does the use of the multiple-unit system result in easy acceleration, but in virtue of this very property, leads to highly efficient operation.

Its sphere of advantage doubtless has limitations, but these are of no consequence for our present purpose. Putting all matters of efficiency aside, the gain in the smoothness and quickness of acceleration is immensely important. As the speed of electric cars has steadily increased from year to year there has been a constant tendency to quicken the acceleration, and the ordinary motor equipment cannot, or at least does not, lend itself readily to this change. Too often the result has been a sharp, jerky start, hard on the equipment and very unpleasant for the passengers. But easy starting is emphatically the long suit of the multiple-unit control, and the result is that a modern elevated or interurban train can work at fully double the rate of acceleration which is disagreeable in a street car, without the slightest inconvenience to the live load. The Boston elevated road furnishes a conspicuously successful example of such smooth acceleration, the trains reaching their full speed before the passengers have fairly realized that the train is gaining headway. As a correspondent suggests elsewhere, it certainly seems that such an advantage could be extended from elevated and interurban service to urban traffic, at least under favorable conditions. There are many instances in which two-car or three-car trains could be worked on surface lines without material difficulty. At ordinary surface speeds such a unit is certainly under better control than a single long car, and its carrying capacity during the rush hours would be a very valuable addition to the ordinary facilities for rapid transit.

Moreover, from an operative standpoint such an arrangement has certain marked advantages. At present the extra rush of cars at particular times and to meet the requirements of particular occasions demands the services of a considerable number of "trippers," for whom there is no work during the major portion of each day. Their position is an unenviable one, and has led to much friction between employers and employees. They either have to be paid for work which they do not perform, which is manifestly unjust, or have to pick up scanty earnings at inconvenient hours, which is certainly a hardship.

With short multiple-unit trains, perhaps of only two cars, the carrying capacity of a line during the rush hours could be practically doubled without requiring the services of motorman trippers, thus cutting the present difficulty in half, if nothing more. It would really be the restoration of the useful and valuable features of the old trailer system without its inconveniences and dangers. Such a train occupies less space than a pair of long cars in close succession, has the same capacity, is under better control, requires less labor, and by and being under better control, could make considerably better time under similar conditions.

So far as public utility is concerned we think the train would have an advantage, in that the cars on a given line would be enabled to hold a more uniform schedule than when extras are run. If cars are run, for instance, on a ten-minute headway during particular hours, the public gets used to planning for that headway, and would catch the trains as easily, on the whole, as it now catches the regular cars, plus extras, and so far as comfort, always an important matter, is concerned, we think the trains would be preferable for the reasons already stated. Obviously such a service would not be effective or desirable on all lines, but there are many instances in which it could be most usefully employed, and we should like to see it given a trial in careful and conservative hands.

On interurban roads, with extensive terminal connections, the tendency toward preserving a uniform schedule would be valuable in promoting through traffic. The trolley lines around almost every large city have grown into a suburban network, with very wide ramifications. In summer particularly there is a great amount of rather long-distance traffic which could be greatly stimulated if quick and certain connections between road and road could be depended upon. With cars under ten or fifteen minutes' headway the preservation of an accurate schedule is of particular importance, and leads to considerably increased traffic.

More than this, a wider use of multiple-unit trains would lend itself readily to an extension of interurban service, which is, sooner or later, bound to come, that is, the introduction of through cars taking passengers over comparatively long distances without change—a step in the evolution toward regular railway practice. As things now are a through car running over a track where there is considerable local traffic is apt to be a disturbing factor in the local schedule. If, however, it could simply become part of the next local train to break loose again, and go on toward its proper terminus, the through car habit would soon become fixed, and with it would come an increased use of the electric road. A function of this sort is far from universal in its application, but every street railway man knows of cases where it would prove of some importance. A change of cars is always an inconvenience to be avoided, if possible, and the ease with which multiple-unit trains can be built up and decomposed furnishes a ready way out of the difficulty. Take, for example, the common problem of dealing with suburban cars converging toward the city. If the cars in the outlying region are fitted for multiple-unit work they can come in as single cars, and then be made up into trains for the run into the city, dropping their motormen to take charge of the next outgoing cars. Conversely outgoing trains would split up, and diverge instead of merely making connections. Even on surface lines the indications are that two-car or three-car trains, with the admirable control usual with the multiple-unit system, could handle more traffic per hour than the same cars operated as single units. When underground or elevated tracks are available multiple-unit trains form the ordinary equipment, and there are many cases in which such trains could advantageously be split up at the termini, allowing the separate cars to go to their destinations on their respective surface tracks, or over other underground or elevated lines.

Some of the early advocates of multiple-unit trains laid great stress on this feature of the system, even going so far as to show how time could be saved by dropping off cars to make flying switches on to their respective branches. We are hardly of the opinion that flying switches are to be recommended as a regular practice in passenger traffic, but certainly a multiple-unit car can be dropped off or taken on much more quickly than the passengers can change cars, to say nothing of the annoyance and discomfort of changing. If the separate cars are to operate on the surface only, uniting as trains for the suburban or elevated portion of the trackage, their speed would, of course, be subject to certain limitations, but save on very long runs under the latter conditions, the gain in avoiding changes would more than counterbalance the lowered speed. Most passengers would justly regard five or ten minutes in running time as dearly saved at the expense of a hurried rush to change cars midway in their journey.

Never was there a greater opportunity for the inauguration of real rapid transit on a magnificent scale. Surely there are no insuperable difficulties to be overcome on the engineering side of the question, and the matter of traffic arrangement is not more difficult of adjustment than it often is in ordinary railroad operations. We hope to see the day when every district of all large cities will be thoroughly welded together by a homogeneous system of electric traction under, on or above the surface. Nothing less will answer the physical requirements of the situation. No matter of how many corporate parts the whole great system is composed, now or at any other time, that system should be a unit, so far as traffic is concerned, and sufficiently homogeneous in its equipment to insure that unity. Unless this condition is fulfilled there will be work to be undone at no distant day.

One feature of the management of the Metropolitan Street Railway Company, of New York, which is characteristic of the way things are done in that company, as well as the personality of the president and general manager, is the noon luncheon to heads of departments at the offices of the company on the eighth floor of the Cable Building, 621 Broadway. Here every noon as many officers and heads of departments as are not required by urgent duties to be elsewhere meet and take lunch together. A regular caterer is employed, and lunch is served in the dining-room adjoining the president's office. In this way the officers and department heads are kept much more closely in touch with each other than would be possible in any other way without consuming an unnecessary amount of the time of each.

The Service Capacity of Railway Motors

The ordinary stationary, direct-current motor, as used in driving machinery, ordinarily has to carry a steady load or a fairly steady average load, at an approximately steady speed. Under such conditions, assuming that there is no undue sparking at the commutator within the range of current supplied to the machine, its output and rating are determined by its heating, and the maximum steady load that it will steadily maintain without rising more than 50 degs. C. in temperature, when the temperature of the air in the room is 25 degs. C. is defined to be the full-load rating of the motor. For all such motors this rating is satisfactory.

When, however, a motor drives a crane or operates a street car, both the speed of operation and the tractive effort are very variable. For such intermittent service the motor, if it runs sparklessly, can carry, for short intervals of time, much greater currents without final overheating than the steady loading would permit. A motor which at steady full-speed running would reach the limiting temperature elevation at, say, 30-kw intake and 30-hp delivery, might safely deliver, at intervals, 100 hp for a few seconds, and 70 hp for a few minutes. Under the intermittent conditions of service, it might do all the work that was required, up to, and including, 100 hp; so that it would only be necessary to employ a motor rated at 30 hp, according to the standard rating for steady service, in order to operate a 100-hp crane, an apparent inconsistency.

Moreover, it is evident, that unless the precise conditions of work and intermittent working are defined, it will be impossible to say beforehand whether the 100-hp crane, *i. e.*, a crane which will work occasionally up to a maximum rate of 100 hp, will need a motor of 20 hp, 30 hp or 40 hp, as defined by the steady full-load and speed condition. It will depend upon how often and for how long the 100-hp efforts will be needed, as well as how often and how long the intermediate powers will be required.

Consequently, no test taken under steady load and speed conditions can satisfactorily define the rating of a motor required for variable and intermittent working, when the exact conditions of irregular operation cannot be foreseen. A 30-hp street car motor, as rated from the temperature elevation at steady load and speed, may keep within the prescribed temperature limitations when working on one road, where its maximum output is 70 hp, while on another road the same motor, with the same maximum output, will get too hot, because in one case the maximum input will be maintained longer, or there may be more duty at, say, 50 hp, and less at 10 hp, than in the other. The American Institute of Electrical Engineers, in its standardizing rules, has pointed out that no precise running period under steady conditions can be accepted satisfactorily, selected for the rating of street car motors, and such motors are not usually rated by their manufacturers according to the rules for stationary motors.

Nevertheless, efforts have been made to arrive at a reasonable basis for rating railway motors in horse-power. John Lundie offered a suggestion in the *Electrical World*, of Oct. 21, 1899, and which was later republished in the Street Railway Journal. He gave a rule which virtually means that a railway motor should be rated by the steady current it will carry at full pressure for an indefinite period without exceeding the limiting temperature elevation. He virtually stated that the total quantity of electricity, as measured, say in amp.-hours, which the motor would be required to absorb in an hour, under actual service conditions, should be equal to, or not greater than, the quantity of electricity in amp.-hours which the motor would stand under test with the steady current producing the limiting temperature. He maintained that within the range of a motor's operation it did not matter how great or how small the working current was, so long as the total amp.-hours passing through the motor was the same. In other words, twice the normal current working for half the time would have the same effect upon the final temperature as the normal current working all the time.

Objections were offered to this suggestion on the score of inaccuracy. It was pointed out that while the rule might be approximately true, and might be a useful rule under certain practical conditions, it could not be depended upon for accurate comparisons of motors, because it assumes a constant electrical efficiency in the motors at all loads, a proposition which is only roughly true of street car motors as a class.

In our issue of January, Mr. Storer proposed a new and more nearly accurate standard of rating service capacity in street car motors. He pointed out that the only way to predetermine by calculation the size of motor required for a given electric road and schedule speed was to map out the speeds and currents throughout the route, to find the total quantity of energy lost in the copper and in the iron of the motor under those conditions, and then select a motor in which the same amount of copper loss and of iron loss liberated under shop test by a steady current at a steady speed caused the limiting temperature to be reached. He furnished the required copper loss by supplying the motor with a definite steady current, and he ingeniously furnished the additional required iron loss by supplying a definite, steady pressure at motor terminals. This rating is, therefore, based upon the effective current, or square root of mean square current, which shall liberate in the motor the same loss as gives the calculated total of variable running conditions, together with an approximate adjustment for iron losses. Mr. Storer advocates measuring not only the steady current which will ultimately raise the temperature of the motor in the shop by 75 degs. C. above the surrounding air at 300 volts, and at 400 volts, terminal pressure, in addition to the usual information concerning the time during which greater current strengths can be safely carried. He does not advocate rating the motor in kilowatts according to the effective current strength, which will ultimately bring the motor to the limiting temperature, because this current is so small that the motor would appear to be of unduly small power. A motor working occasionally up to 100 hp might only be a motor of 25-kw input, according to this rating. He intimates, however, that from this information of service capacity, a competent engineer can determine, by careful computation, whether the motor will meet the conditions of service expected.

As our readers will remember, A. H. Armstrong discussed this subject in our issue of April, of this year, and took issue with some of the points raised by Mr. Storer. Mr. Armstrong also indicated that a railway motor can only be scientifically chosen for its work by carefully computing, from the full particulars of expected service, the various losses in the motor, and the mean temperature elevation which those losses will produce. He took the position, however, that it is necessary to separate the armature loss from the field loss, and that the final temperature elevations depend upon their ratio, as well as upon their sum. He throws doubt upon the practical value of temperature elevations observed in shop tests. He finally advocated giving for each motor a curve sheet, showing the schedule speed which it is capable of maintaining for a given weight moved, and a given number of stops per mile. The results embody certain arbitrary, but average, accelerations and frictions. This curve sheet gives the information usually required by the purchasing engineer, in a very compact and convenient form, but Mr. Armstrong also appears to intimate that it is not possible to supply any electrical heating data of the motor, as furnished from shop tests by which the purchasing engineer can predetermine the capability of the motor for a given set of service conditions.

In this week's issue Mr. Storer replies to Mr. Armstrong, and defends his January article.

We think that the motor service capacity curves advocated by Mr. Armstrong connecting weight and schedule speed with the number of stops per mile are very convenient and useful, but we also consider that Mr. Storer's effective heat limiting-current strength at reduced voltage is also valuable to the purchasing engineer, since it enables the engineer when supplied with the remaining data connecting tractive effort, power and speed with current and temperature to predetermine the working temperature of the motor with a reasonable and satisfactory degree of accuracy. If the limiting temperature elevation of a shop test is 75 degs. C., the corresponding elevation under service conditions will probably be about 55 degs. C. Considering that street car motors are almost always run completely enclosed, all the heat liberated in their armatures must find egress through the steel shell. While it is no doubt true that the temperature elevation of the armature depends not only upon the loss in the armature, but also upon the loss simultaneously occurring in the field, yet the subject, in its refinement, is so complex, that for ordinary purposes it is sufficient to ignore this limitation, and to consider the motor, from the point of view of heating, as a resistance coil, plus a rotating iron core, the hysteretic loss in which depends mainly upon the terminal e. m. f.

Neither Mr. Storer nor Mr. Armstrong advocates placing motors on the market under a numerical horse-power rating determined from heat tests, for excellent reasons above referred to. Both agree upon the necessity of making thorough tests upon the motors in the shops, interpreting the results in the light of experience under service conditions. When complicated service conditions have to be faced intelligently, it is but reasonable to ask for correspondingly full information concerning the behavior under test of the motors required. Consequently, it would seem desirable that not only should Mr. Storer's ultimate effective heat-limiting current be given with all the other data for the motor, but we think that Mr. Armstrong's reduced results of speed and weight in terms of stops per mile should also be looked for at the hands of the manufacturer. The two sets of data are mutually co-operative, and afford a mutual check.

The Electric Tramway in Colombo, Ceylon

BY H. S. MORRISON

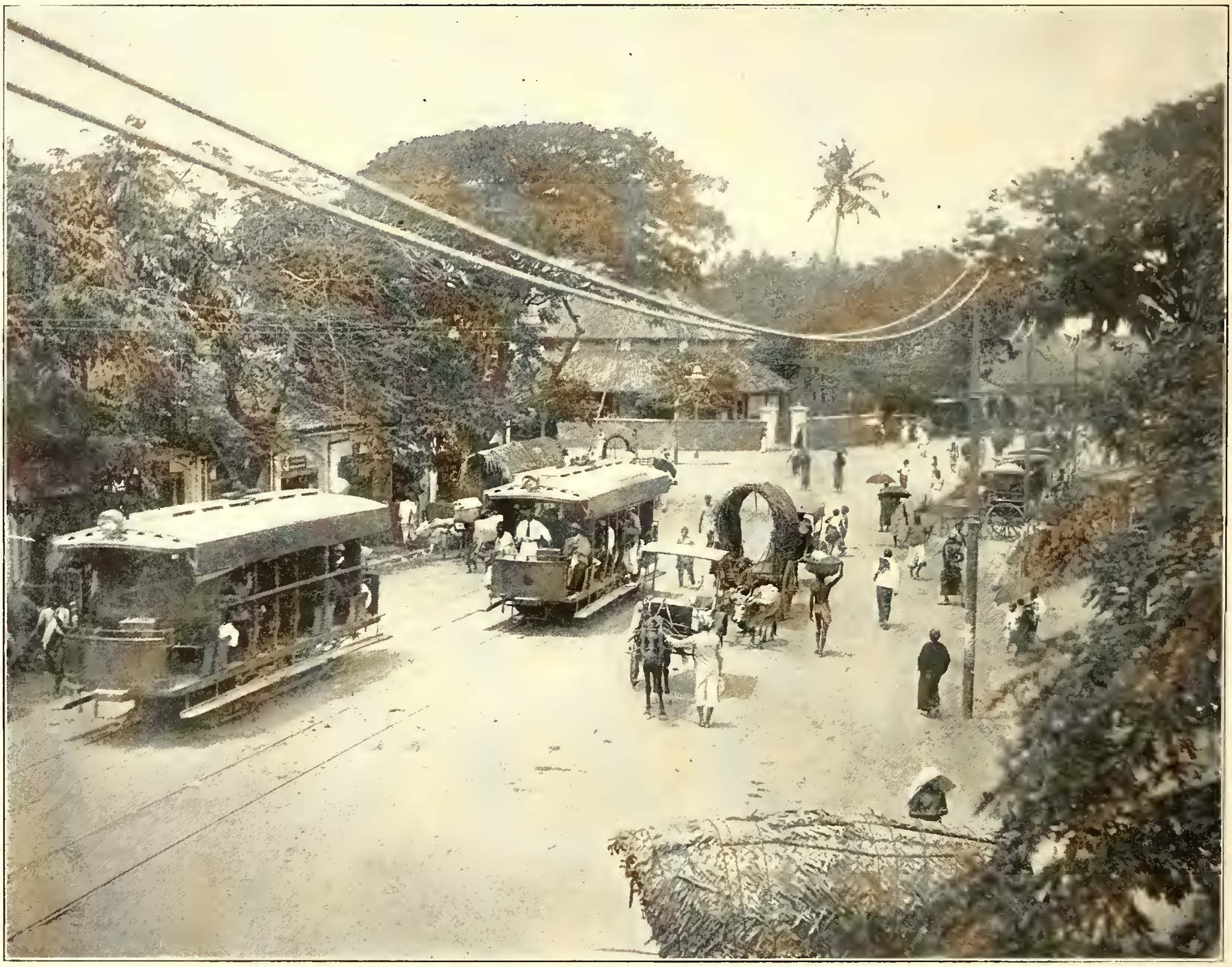
The Colombo Electric Tramway has been in running order but little more than three years, but in that time it has proved so satisfactory and has been so generously patronized by the native population, that several extensions of the line are planned, and will soon be constructed. The city of Colombo has a well-earned reputation for enterprise among the cities of the East, and the electric railway was an assured success almost from the very beginning. None could tell in advance how the native Singhalese would welcome the new departure, but they have proved appreciative patrons, and almost every car which the writer noticed on a recent visit was well filled with dark-skinned men and women. Like other people of the Far East, the natives of Ceylon vastly prefer riding to walking, and as the fares on the railway are very low, they are able to gratify their natural inclination.

The line at present in operation consists of two divisions, each $3\frac{1}{2}$ miles long, and extending through various streets of the business section, and out into the residence neighborhoods. As the streets are generally wide and well paved, the company had no difficulty in choosing thoroughfares through which the road could be constructed at a minimum of cost. "The Ceylon Planters' Company," as the corporation is styled, obtained a concession from the British Colonial office for twenty-six years, with the privilege of renewal under certain conditions. When the franchise was obtained the company engaged the well-known English firm of Kincaid, Waller & Manville to construct the line and plan the various buildings to be used as a plant, and no reasonable expense was spared to make the equipment all that could be desired for the maintenance of an efficient service.

One difficulty was encountered in the very beginning, and that was to find suitable ground for the erection of the power station and engine room. Some lots were finally purchased near the geographical center of the city limits, and several thousand 35-ft. piles were driven until the foundation was considered secure. An engine room 118 ft. x 44 ft. was erected, and adjoining it a boiler room of the same length and 39 ft. wide. Galvanized iron was used for both walls and roofing, and the ends of the boiler room were left open, as there is but little change of season in Colombo, and no danger of injury to the apparatus from rough weather. At one end of the boiler room, and several feet distant, was erected a stack 141 ft. high and 4 ft. 4 ins. in diameter. The engine room is large and roomy, and there is ample space for the installation of new machinery when extensions of the line are made.

At present five engines of the horizontal tandem type are in use, three of them McIntosh & Seymour and two Ball & Wood. The generators were purchased from the General Electric Company. There are three Blake-Knowles pumps. The switchboard and its appliances were supplied by the British Thomson-Houston Company, and is furnished with Kelvin voltmeters and ammeters.

The boiler room is supplied with four Babcock boilers.



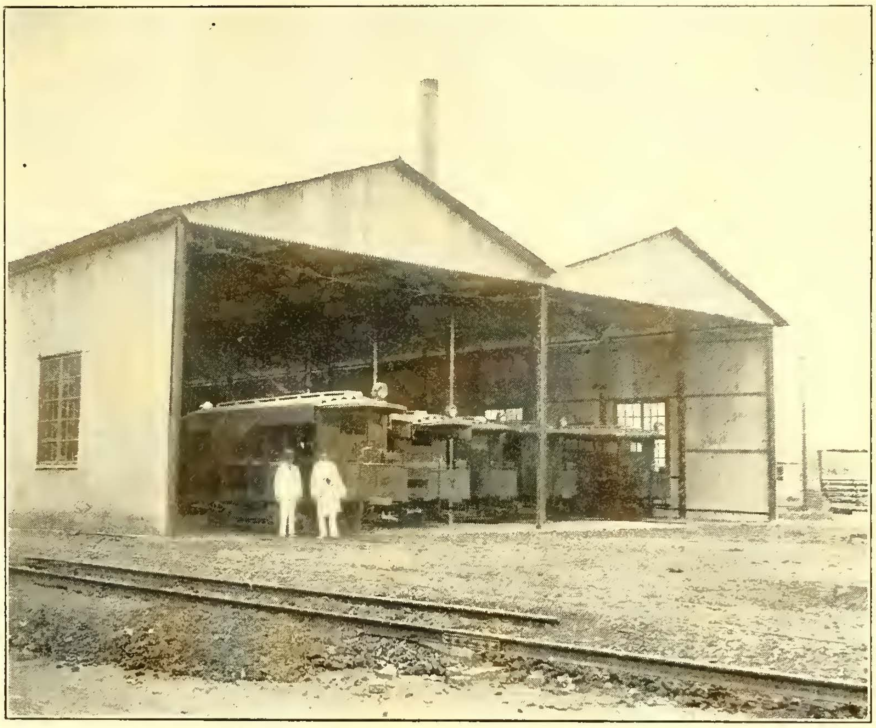
STREET SCENE IN COLOMBO, SHOWING TRAMWAY

Green economizers are used, and there is a separator for each battery of boilers. The piping is duplicated throughout. There is no coal handling machinery used, for coolie labor in Ceylon is too cheap to make it necessary. There are four firemen and seven coolies constantly at work, and the wages of the latter amount to scarcely what it would cost to hire one coal shoveler in America.

There are no times when the Colombo Tramway finds it necessary to add extra cars to its service, for the working hours in shops and factories vary greatly, and there is no morning and evening peak, as in American cities. There are ordinarily twenty-two cars in operation, and about 4300 kw-hours a day are used. About 16 tons of coal are burned each day. It comes from India, and the average price is $5 a ton, delivered. About 20,000 gallons of feed-water are used in a day. The average car-mileage is 2600, and the station expenses are about 3½ cents per mile.

The trolley wire is No. 00 S. W. G., with rail return installed under Board of Trade regulations. So far the company has had no trouble with electrolysis in Colombo, but the engineer said that he had not as yet found any type of overhead materials which give satisfactory insulating results in the Ceylon climate. In view of the fact that many electric railways are now being constructed in the tropics, he thought it would pay the supply companies to give this matter some attention.

Most of the streets through which the railway passes are wide, and there is a double track throughout its entire length. The maximum grade is 8.3 per cent, and 400 yards long, and the minimum curve radius is of 50 ft., so it will be seen that the route offered few obstacles to the constructing engineers. Both sections of the line terminate at the landing jetty in the business section, or "Fort," as it is called, and from there they extend through the native quarters and out into the shady roads, where the bungalow residences of Europeans are found. For 2 cents or 4 cents one can ride almost anywhere, and the vast majority are 2-cent fares. The rails weigh 90 lbs. per yard, and are laid upon iron ties. There are two Chicago copper bonds to each of the joints, which are laid opposite. The sub-construction consists of 6 ins. of concrete, and the company expects that it will last for a long time to come.



CAR HOUSE OF THE COLOMBO ELECTRIC TRAMWAY

INTERIOR OF POWER STATION AT COLOMBO

The car house is built within the same enclosure with the power station, and is also of galvanized iron. It is 162 ft. long by 70 ft. wide, and can shelter about thirty-eight cars. There is one motor transfer table. The motor cars are nearly all from the J. G. Brill Company, of Philadelphia. Their average length is 26 ft. 4 ins., and the wheel base is 6 ft. They have first-class and second-class seats, and weigh about 8 tons. The trucks were supplied partly by the Brill Company and partly by the Peckham Manufacturing Company, and the motors were furnished by the British Thomson-Houston Company. The average life of the pinions used is from twenty-five days to thirty days, that of the gears four months, that of the trolley wheels from three to five weeks.

The car wheels are 30 ins. in diameter, and weigh 350 lbs. They usually last from four to six months. Both hand and electric brakes are used. The cars are furnished with "Providence" fenders, which are very necessary in Colombo, as the natives swarm in certain streets, and refuse to heed the warning gong.

There are no registers, each collector being furnished with a punch, which he wears about his neck. The passengers are given receipts for fares paid, which are the same kind as used on many of the European railways, and are shown to the company's inspector upon demand. The speed of the cars is not regulated by law, but they ordinarily run slowly, and make frequent stops.

The repair shops are very completely fitted out with American and English lathes and other machinery necessary for keeping the cars in good condition. The company is entirely dependent upon its own resources for making repairs, as there is no shop in Colombo with facilities for doing the sort of work required.

The Colombo Tramway is exceedingly fortunate in the matter of cheap labor. The Singhalese partake to some extent of the prejudice of the Malays against doing ordinary manual labor, but they also share their delight in anything which has to do with the manipulation of machinery, and the company found it an easy matter to train the natives to become expert motormen and conductors. The wages paid vary from $3 to $14 a month, and as there are but 110 motormen and conductors altogether, the monthly wage list in this department is not very high. In the power station and repair shop the wages are also very low, and the Singhalese make no complaint about working twelve and fourteen hours a day. The company treats them with consideration, however, and they are said to be well contented with their positions.

Since the electric tramway has proved successful in the city of Colombo, it is expected that the system will be introduced into other cities of Ceylon and the neighboring region of Southern India. It is evident that there is a great opening for such roads in far Eastern cities, for it has been demonstrated that they are always well patronized by the natives, when the fares are reasonably cheap. It seems to me that one is very much needed in Singapore, and when I again make a circle of the globe I hope to be able to go about in all these interesting cities in a comfortable way, instead of being jolted and shaken up in a jinrikisha. The English and German electrical concerns are already awakening to their opportunities in this part of the world, and certainly the Americans should not be the last to realize that Oriental cities must soon be supplied with a service of electric street railways.

A New Electric Freight Road

A new electric freight and coal road, formed from the Day Electric Railway, operating between East St. Louis, Ill., and Belleville, and competing directly with the Southern Railroad and indirectly with the Illinois Central Railroad and the Louisville & Nashville Railroad, is now in regular operation. The road is 14 miles long, and is now known as the St. Louis & Illinois Suburban Railway. Over a year ago the idea of operating the road as a freight line was conceived, and the conversion was finally effected after overcoming the objection of the residents along the line, which objection was one of the principal obstacles faced by the owners. The gage of the road had to be made standard so as to permit the operation of the regular freight cars, and railroad yards have been built at Winstanley Park. The company plans to tap the mines between East St. Louis and Belleville, and there is every indication that a large amount of business can be secured in this territory. The electric locomotive used by the company is particularly powerful, and was built according to suggestions advanced by General Manager Bramlette, of the St. Louis & Belleville Traction Company. The locomotive has, in tests, pulled a train of twenty cars loaded with coal. The cars were of the regular 60,000-lb. capacity type.

Notes and Comments on the Street Railway Accountants' Convention

BY A. O. KITTREDGE, C. P. A.

An experienced railroad man, answering a question which had been addressed to him by one who had not looked in upon the sessions of the accountants' association, said: "The convention of the Street Railway Accountants' Association showed considerable enthusiasm in advocating frank and intelligible reports and expressing a disposition to standardize methods. When it came to discussion, however, it was manifest that there was a wide difference between abstract theory and practice. It was also evident that the practice recommended and approved by different men varied greatly." This statement is of interest in that it reflects what an outsider has to say concerning the accountants. Carefully considered, it is entirely complimentary. It also carries with it the suggestion of what may be done to round out the work of the organization and make it complete.

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From my own point of view, based upon not only what was done in the convention, but also upon the impression left in the minds of those who were present and took part in the proceedings, as has been revealed by conversation with them since the convention adjourned, I regard the recent gathering as having about it more of real usefulness and utility than any other meeting that has been held. It also served in a marked degree to show the real progress that has been made since the organization was formed. At the Niagara meeting, as many will recall, when the question of store accounts, or accounts with supplies, was brought up, it transpired that only one of the accountants present had anything at all in the way of such records. One or two with some emphasis declared they had enough to do in regular work without giving attention to refinements of such a character. Now the whole association gives careful attention to the report of a committee charged with recommendations in this line. Again, in one of the early conventions, when the question of reserves was brought up, it called forth vehement gestures of expostulation, if not positive statements, that the members would have none of the doctrine requiring such provisions and their attendant calculations. At the recent convention one of the speakers greatly interested his audience by explaining the practical working of reserve accounts in the company over whose records he presides. For a fact, progress is being made, and each annual convention is a milestone on the road toward highest efficiency.

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The paper presented by Col. T. S. Williams, of the Brooklyn Rapid Transit Company, entitled "Capital Accounts from the Viewpoint of the Investor and the Public," was aggressive and correspondingly interesting. The paper in full has been published, and therefore it need not be epitomized in this connection. The speaker's bold attack upon the methods of the Third Avenue Railroad Company, the Baltimore & Ohio Railroad Company and the Long Island Railroad would do credit to any one of the numerous reformers for which Brooklyn is especially noted. Colonel Williams was enthusiastically applauded, but only one member gave any particular information in regard to the methods of the company which he represented. This was H. C. McKay, controller of the Milwaukee Railway & Electric Light Company, who said that his road believed in maintaining proper reserves for depreciation. By that plan, he declared, provision was made for any matter that might come up in the future.

He explained that there was charged to operating expenses an amount which the management thought would be sufficient to cover all expenses of this character for the year, with the result that they always had a fund on hand. The same plan, he said, is applied to insurance. The company maintains an ample insurance reserve. It also maintains a reserve to cover depreciation of roadway and buildings. The provision for depreciation is a percentage of gross earnings. Having thus created the reserve, there is charged against it any unusual expenses as they arise which belong to it, for example, the renewal of a mile of track. The reserve account for maintenance of buildings is similarly debited for any necessary renewal of buildings. Again, a reserve is maintained for injuries and damages. To this is credited a certain percentage on gross earnings, the charge going into operating expenses. Whenever there is an amount for injuries or damages to be paid, the fund is on hand for the purpose, and the amount is paid therefrom without disarranging the accounts for the period in which the disbursement is made.

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These remarks of Mr. McKay were interesting in the extreme to those who have watched the course of the street railway accountants, expecting to see, sooner or later, a devotion to the principles of good accounting which, in some respects, was lacking at the time of the organization of the association. Reserve accounts have been discussed at different times during the history of the association, but have always been looked upon, apparently, at least, by the convention as something extreme in character, and a method or remedy for certain evils for which the association was not yet ready. That at least one of the best managed roads in the country has within its system a complete equipment of reserve accounts, and is willing to make known this fact to the public, is certainly encouraging. Not long since I had the opportunity of examining in considerable detail the accounting system maintained under Mr. McKay's management, and from personal inspection can bear testimony to the adequate provision that is being made all along the lines indicated. Another illustration which Mr. McKay did not mention, but which would have been quite apropos in this connection, is that of fire insurance. The company is reserving, as against the costs of fire insurance, somewhat more than is consumed in premiums. The reserve amount is gradually accumulating, and the result will be, sooner or later, in case insurance arrangements cannot be made satisfactory to the management, that the company will be in position to maintain its own insurance, having accumulated out of gross earnings quite enough to replace what would be the probable loss in case of a serious fire. The safe condition of the company that maintains reserve accounts is thus readily illustrated. No doubt Mr. McKay's remarks will afford food for reflection upon the part of many managers and accountants whose attention has been called to the same.

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I was talking a short time since with the president of an important street railway organization whose lines are within the State of New Jersey. The question of taxation came up. The kind of reports that should be made in justice to stockholders was being discussed. Said this gentleman to me:

"I am distressed in view of the treatment that we receive from the State of New Jersey. It is called the mother of corporations, and undoubtedly enjoys large revenues from corporations in general, including particularly those which find refuge under the laws of the State, even though their operations are conducted in other parts of the country. It seems to me," he continued, "that New Jersey does not, in this respect, take good care of her children who stay at home." Then he went on to tell about a book which he declared had been prepared and issued under State authority and distributed for the use of local assessors, tax boards, etc. This book, a copy of which I have not had the pleasure of examining, contains, according to this street railway president's description, estimates of cost, bills of equipment, statements of necessary expenditures to accomplish certain results, etc., covering the entire scope of street railway work. For example, there is presented the average cost of track, with different weights of rails and upon different plans of construction. The price of poles and the cost of trolley wire are given, and catalogues and price lists of equipment of power houses are likewise presented. The whole scheme, according to my informant's understanding of the case, is to put into the hands of local assessors such information as will enable them to carry the tax charged against the roads up to the highest possible limit.

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My informant may or may not have been right as to facts. However that may be, it seems to me, at this age of general information, with experts on hand at either side to make estimates, with facts being disclosed every day concerning the cost of roads—not only by reason of the public accounts of new investments, but also by facts disclosed through the record of receiverships and the like—it is scarcely necessary for any commonwealth to prepare a manual for the purpose credited to this book by the president of the street railway company whom I have quoted. All such matters are bound to adjust themselves in time. The street railway company has rights as against the public just as clearly defined as those of the public against the street railway company. The fair line weighing one against the other is, sooner or later, to be determined in every instance. Whenever the community, through its tax board, demands more from the railway than is right there will be a proper adjustment sooner or later. On the other hand, if the railway obtained advantages against the community, either by fraud, concealment, through political preference, or from any other cause whatsoever, the public in the course of time will require and obtain adjustment. There is nothing safe in such matters except absolute frankness and unswerving integrity. That which is concealed will be in time proclaimed from the house-tops, and that which is withheld will, in the course of time, be demanded with penalties attached.

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An example of what can be secured by intelligent cooperation with the community is strikingly illustrated by what was accomplished by a prominent Western street railway company a few years since. It secured a renewal of a very valuable franchise without a reduction in fares. The municipality in which this electric road was situated demanded a reduction in fares. It was popularly supposed that the company was making a very large profit, and that, therefore, it could very easily be made to drop to a 4-cent, or even a 3-cent, fare. The action of the management at this juncture was that of taking the community frankly into its confidence. Its affairs were shown up in detail, and experts were put upon the stand, who explained the accounts in a manner to convince all. In this way it was shown what the earnings of the road really amounted to; it was shown, also, what the expenses were, not in lump but in considerable detail, and finally there was shown what was left for dividends after the necessary fixed charges had been provided for. The result was a triumph for the road. The franchise was renewed at the 5-cent rate, and to-day the street railway referred to enjoys a singular popularity with the community in which it is operating. All this the management very justly attributes to the fact that it has been absolutely frank with the community. I am alluding to matters that have been fully exploited not only in this journal, but in others, and which, in more or less detail, are known to every street railway president and manager throughout the United States.

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The report of the committee on a standard accounting system for material and supplies, including the necessary blanks, was a model in method, arrangement and manner of presentation. It was brought to the attention of the association by F. E. Smith, chairman of the committee and auditor of the Chicago Union Traction Company. The report showed in every respect that a very large amount of work had been expended upon it. It was logical in arrangement and commanded careful attention. As it was printed in advance and has been included in accounts of the proceedings of the convention and published in this paper, it is before the reader for such particular attention as he may desire to give it. Suffice it to say in this place that the subject of lot numbers seemed to be the one point upon which discussion turned. In the handling of materials and supplies, there are several distinct steps to be considered. There is the purchase of the goods, the receipt of the goods, and the disbursement of the goods. Fnally, there is accounting. In the purchase there is the requisition coming from the division or department wherein the supplies are required; second, the order from the purchasing department on firms or individuals, and finally the record of bills approved by the purchasing department. In the case of stock on hand carried in store, there is auxiliary to, or parallel with, the order from the purchasing department on firms and individuals, the order from the purchasing department on the company's stores.

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The second step is the receipt of the goods and stores, and here came in the question of lot numbers. The report asserted that for the proper identification of all material and supplies put into stock a lot number should be assigned. It went on to say that, having assigned a lot number to some specific material, a notation should be made on the duplicate order for it to the effect that these goods have been assigned such a number. Then, as the goods are distributed according to the requisitions coming in, the lot number would identify the goods as they go out. The scheme of lot numbers, it was pointed out, avoids a ledger account or the maintenance on the double-entry plan of stock cards, and yet ledger accounts or cards were provided for those who desire to maintain them. The lot number not only identifies the goods, but also gives a key as to their purchase price or cost. It enables the accounting department to charge out the goods at the price at which they were taken in. After thus giving particulars of lot numbers, the report continued with respect to the handling of bills, the recording of goods, and concluded this division by reference to a stock ledger (which may or may not be kept as auxiliary to the lot-number scheme) and the method of handling second-hand material and scrap. In the debate all sorts of views were presented by the speakers, and the impression was created in the minds of those who heard the discussion that there is very little uniformity and method in the accounting for materials and stores among street railway companies, big and little, throughout the country at the present time.

In the course of the report an important quotation was presented from a paper entitled "Material Account," by A. D. Parker, general auditor of the Colorado & Southern Railway, read before the meeting of the Association of American Railway Accounting Officers, held in Denver in May last. Mr. Parker likens the employee, in charge of the materials and supplies belonging to a railway company, to a storekeeper who is alive to the interests and demands of his customers. He asserts that he is in touch with his material every day, and careful distribution of the articles themselves, either on the shelves or along the floor and platform, answers the question of requirements. Mr. Parker goes on to say that instead of making a diversified classification of material it may be divided into a number of practical headings which give the requirements necessary. The point that does not seem to be covered in this quotation, and which is yet, perhaps, essential to it, being suggested by the comparison of the keeper of railway supplies to a storekeeper, is that of the terms and conditions under which the supplies of stores are issued. The principle referred to is one that was not made entirely clear, neither in the report of the committee nor yet in the discussion, and that is, stated in the simplest form, that materials and supplies must be charged out at the same price at which they are taken in. If an article goes into store costing a dollar, when it goes out it must go out at a dollar. The quotation in the market may have changed materially. Its place, perhaps, could be supplied at 75 cents, still it must go out at a dollar. Or the reverse may be the case. The price may have gone up materially since the article was bought, and it can only be replaced to-day for $1.50. Still it must go out at the dollar. The comparison of the keeper of railway supplies to the storekeeper is in some respects unfortunate, for abuse of the merchandise account is the conventional way in which storekeeper's accounts are conducted. Sight is lost of the principle of equality in debiting and crediting. For example, a local merchant conducts a merchandise account which, on the debit side, is charged with the goods as they come in, taken at cost, while on the credit side it gets figures representing their sales value. In other words, there are two sets of values in the same account. Up-to-date bookkeeping changes all this and insists that the merchandise account shall in no respect be a sales account, but shall be what the street railway people require, namely, a store's account, and that it shall be conducted with one set of values only, namely, cost price. Goods are taken in at cost and go out at the same identical cost. The balance in the account, therefore, represents the cost of the goods or supplies on hand.

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The lot-number scheme, which is a variation on plans very commonly pursued by manufacturing companies, has about it many things to recommend it. As pointed out in the report, it may be used with or without ledger accounts or a card equipment. That is to say, that even though cards or ledger accounts are maintained, still every lot of goods should be identified by number. It is not this latter use of the lot-number scheme that appeals to me particularly, for some plan of identification of the goods is necessary to any ledger or card scheme. The identification of lots by numbers makes it possible to charge materials out at the same price they came in without maintaining a complete scheme of ledger accounts or card records. Therein is a great advantage of the lot-number scheme, as explained above.

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The subject of discount for sharp cash on purchases received considerable attention. The discussion showed that there was no uniformity of sentiment or practice with regard to the treatment of such items. Some delegates declared that it was their invariable practice to enter all discounted purchases at the net amount. In other words, the position was taken that materials or supplies or equipment, or whatever was purchased, should go at the net price paid for it, and that the discount was in no wise a special earning of capital. In support of this position one of the accountants pointed out that it was part of the function of a railway company, equipped as it should be with the necessary capital for conducting its business, to get all its supplies, whether rails or trolley wire or power house equipment, at the lowest possible prices, and then to make all possible money out of the use of the same. On the other hand, if the discount were considered a special earning of capital, the credit of "Discounts on Purchases," or whatever they were to name the revenue account, would sometimes amount to such a considerable amount as to disarrange the general showing. One gentleman went so far as to say that the profit shown by this plan might, perhaps, exceed that which would flow from the regular account. It is to be frankly conceded that this gentleman had the best of the argument. Nothing that is entitled to special consideration can be said in support of the proposition to credit discounts to a special account as opposed to taking in the goods at the net price paid for them. While this is true so far as street railway properties are concerned, yet there are other ideas worthy of consideration when it comes to other lines of business.

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In this connection it may be interesting to some to have their attention called to a rule which prevails in at least one important street railway company. There is considerable routine work to be done in the office from the time that the goods are received to the formal act of paying the bill. If, for example, the discount on a bill can only be obtained on payment in ten days from date, then there must be very prompt work done upon the part of the receiving clerk, invoice clerk, auditor, etc., in order to get the bill into the treasurer's hands in time to send a check against this specific date. In the office of the company referred to a rule prevails that if by any neglect or delay upon the part of any of the employees such a bill fails to get to the treasurer in time to secure the discount, then the person responsible for the delay must pay to the company, as a penalty for his neglect, the amount that the company has lost by way of discount. In other words, this company makes the same rule apply to its office force in the handling of invoices payable that it applies to its conductors in the matter of fares. If the conductor's register shows that he should have collected fifty fares and he only turns in forty-five, he is promptly required to make up the difference. There is an element of sentimental justice in this plan which will be recognized at once by the reader, but I doubt that all the companies throughout the country would be willing to follow the lead of the company referred to in this regard.

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The object for which the Street Railway Accountants' Association of America exists ever obtrudes itself. The question of "why" is one which perennially is discussed among the members, as well as by those who are considering the question whether or not it would be a good thing to join. I chanced to be a party to a conversation a few days after the recent convention adjourned, relating to this subject, that in some respects cleared the fog which perhaps has unduly obstructed my vision in the past. One of those who were debating the subject referred to the terms that are used in the name of the organization and in the description of its work. "Accounting," it will be noticed, is emphasized. It is an association of street railway "accountants." In the reports of committees that have been at work even since the inception of the movement, there has been a standard system of street railway "accounts" more or less discussed, if not actually exploited. The humblest member of the association is an "accountant," while most of the members hide their beaming faces behind the term "auditor." A few are "controllers." To interview any of these gentlemen at home one, as a rule, is obliged to ask for the auditor's office or the controller's office. From this environment of advanced terms and this backing in the way of exalted names and positions, the public has very commonly supposed that accounting in the broadest sense was the object of the association, and that sooner or later practical street railway accounting would be exploited. But the conversation referred to negatived all this.

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Without going through the details of the talk, for the conversation was a somewhat lengthy one, the result may be summed up by quoting the assertion of one of the persons as follows: "We have been discussing expense accounts and the classification of expenses. It is extremely desirable that all this routine should be made uniform. There is left yet to discuss various other divisions of accounts, for example, at the convention just closed we gave more or less attention to storeroom accounts." Right here said the other: "But why do you commence with mere bookkeeping details? Why did you not start at the other end?" When "the other end" was explained to mean the balance sheet and the profit-and-loss statement, he asserted: "Why, everybody understands how to do that." When this assumption was objected to upon the ground that there might be a specially desirable form for this that might be standardized, the reply was: "I, for one, would never give away to anybody my way of getting at the balance sheet or my way of making up the profit-and-loss statement, nor would I expect my associates among the accountants to give me their methods. All that we want to do in the association, and all that we propose to do, is to discuss details, leaving the main issue to the judgment of the individual." It is only fair to this gentleman to say in this connection that he declared that he spoke only as an individual, and not in a way to commit his fellow members to anything of the kind, much less to appear to be voicing the official sentiment of the association.

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The question has been asked me why I am so insistent upon a division between accounting and bookkeeping, and why I have felt free to criticise what the association has so far done as to bookkeeping details, and to seem to have insisted all along that the organization was neglecting its opportunities in that it did not bring accounting to the fore. Specific questions of this character have been addressed me very recently, and it gives me much pleasure to answer them so far as the opportunity will permit. To make my point clear it is necessary to refer somewhat to the ordinary conception of accounting features and in some measure to definitions which are in current use. Having thus established that which is usual, I can contrast therewith that which, to my mind, seems best for the purpose, even though it departs from the beaten track.

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If we look up the definition of a balance sheet—and, by the way, this feature of business statements is lacking in much of the literature that relates to accounting—we shall find that it is described as something derived from the books of account. It is something made up from the accounts as contained in a ledger. It is the thing that follows—the derivative, the boiled-down conclusions. Now this definition will no doubt be accepted without any objection by the majority of accountants, and yet it seems to me that the definition in itself is faulty, and that it indicates a state of affairs equivalent to placing the cart before the horse, at least so far as concerns what the managing man really wants to know.

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All this is easily made plain by reference to what we do in opening a set of books or in closing a set of books, and also by the statements that we are obliged to make from time to time for the information of the management during the progress of the business under review. All that I am saying is true, whether the books under consideration are those of a street railway or of a manufacturing or mercantile enterprise, or of any other business whatsoever. The one thing essential in opening a set of books is a balance sheet, or, in other words, a statement of assets and liabilities, or, to present the idea in bookkeeping terms, the debits and credits as they exist at the outset. At the end of the period when we come to close the books the result is a balance sheet. Again, that which we are called upon to present to the management during the progress of the business, in order to indicate the financial standing of the business, is a balance sheet.

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Now it seems to me clear, from these facts, that the balance sheet is the essential element or vital principle. It seems to me, without further argument, that it must be evident to the reader that what we are after is a balance sheet, and that, accordingly, all that we do in a ledger, whether it be conducted as a single unit or in several parts and divisions, is to complete the balance sheet. That is, the ledger is really a working out of all the details of the balance sheet.

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There is a radical difference between considering the balance sheet as something derived from the ledger, and the balance sheet as the vital principle of which the ledger contains the details. To my mind it is practically impossible to work out the details, such as expense accounts, revenue accounts and classification in general, until there has first been presented the skeleton of the balance sheet. With the balance sheet before me—that is, with the plan drawn that indicates how the accounts are to be conducted and what function each particular part is to perform—I am in position to decide the manner in which I want to handle the details and the bookkeeping dress or equipment that I want to provide for them.

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The distinction between accounting and bookkeeping is also covered in the questions that have been proposed. Accounting, to my mind, is the scientific principle—the "why" of the system, the vertebræ; while, on the other hand, bookkeeping is the dress, or perhaps it is better to say the muscles, flesh, blood and skin, by which the skeleton is enclosed. It is the "how." Accounting principles are inflexible. They cannot be changed. They cannot be bent. Whereas, on the other hand, bookkeeping details are plastic to the last degree, and can be adapted to meet any set of conditions that exist. The skeleton of an accounting system, the plan upon which the accounting scheme is to be worked out, is something that concerns the management. Items may be presented in one or another of several orders. Revenues may be in a single item, or they may be divided upon one or the other of several different plans. The reason for these subdivisions and the order and classification are something that the management, it seems to me, always has considerable to say about. On the other hand, the method of obtaining these details and bringing them into direct relationship is something that concerns only the accounting division and becomes mere bookkeeping details.

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Many who read these sentences will no doubt say that there is nothing new in them, and that what is indicated is that which everyone is doing, although, perhaps, the standpoint from which the plan is considered, so far as the description of the same is concerned, is different from that of the writer. And yet, after all, basing my assertion on what I have seen in actual practice, there does seem to me to be a more radical difference than this.

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The first effort that the average man makes in giving form to the accounts in any business whatsoever is to get into the ledger the personal accounts, and then afterward the expense accounts, revenues and other divisions, and then, as before stated, to produce from the ledger a balance sheet from time to time as the same is wanted. This gives the ledger the supreme position and makes it, as graphically described by a celebrated English author, "The king of books." Properly considered, the balance sheet should be the main or general ledger, and then auxiliary to it should be subordinate ledgers containing practically all that now finds space in the ledger. To proceed further, the criticism reduced to its lowest terms, is that accountants proceed upon a mere bookkeeping plan. They forget the "why" in their zeal to pursue the "how." In the multitude of bookkeeping details they apparently lose sight of the vital or underlying principle. For the accountants' association to jump at once into the consideration and classification of expense accounts has led many to feel that they thereby neglected the vital element of accounting.

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With this said there is no disposition upon my part to belittle the importance of the classification of expense accounts or the advantage of uniformity in all these details. Mere bookkeeping though such matter may be, still they very properly come within the province of managing accountants, auditors, controllers, or whatever the accountants may be called.

How to Make Non-Paying Roads Pay. XI. (and Conclusion)

BY H. S. COOPER

Policy and a Few Other Last Things

The policy pursued by the owners of any railway has a very large bearing on its success; in fact, as regards the autonomy of the managing head, the question of policy is a vital one, as, if the stockholders or their representatives (the board of directors) insist upon a policy that is unwise, uneconomical or unpopular, the hands of the manager are tied fast, and, if he cannot persuade the board to unloose them, the best thing for all concerned will be for him to resign. As a matter of fact, any manager who is worthy of his position should have a hand in the shaping of the policy of the company; if he is not sufficiently fit to do this he is not the man for the place. In any event he should be thoroughly informed as to what that policy really is; if he is not to be trusted in that particular he is not fit to be trusted in the duties and responsibilities arising out of it. The most cruel position for a competent manager is to be placed where he is working blindfold, and it is a position where both he and his company will suffer; it will develop into a case of "cross-purposes" which will not be remunerative for either party. This "hugger-mugger" policy is less frequent than it used to be, although —on the smaller roads and where the real manager is called "superintendent" and paid as such—there is still a great deal of it; if the directors really have a line of policy laid out, they lock it firmly within their breasts and the managing head stumbles along in darkness and ignorance, and, if his official acts happen to run counter to the ideas of the directors, he is well blamed for not knowing the unknowable.

Very often there is no policy at all, the property runs along without any special course being steered, and, in consequence, it is continually running into snags unnecessarily. Often, also, the policy is a "wobbly" one, the course is changed with every change of wind, the board of directors being a regular weathercock "veered around with every wind of doctrine," and the manager is "kept guessing" to occupy his mind when it should be otherwise engaged. This is especially the case with non or poorly-paying properties; as long as a fair dividend is declared the "old way" suffices, usage is accepted as policy, and matters drone along in the same old rut, but when the dividend shrinks and shrinks to invisibility and the deficit commences to be more than an "angel's visit," then there is generally a superabundance of opinions combined with a supineness of concerted action that prevents any policy being carried into effect at the very time that it is most needed. Many roads examined by the writer have simply drifted and "jibed" along until they have arrived between the devil of the sheriff and the deep sea of the receiver, when a vigorous and determined policy in any one of several directions would have brought the properties into a safe harbor.

As stated once before, anything in street railways that is not progress at this time is virtual retrogression. Communities are everywhere advancing, and the transportation company that does not "keep up with the band-wagon" will soon be left to "walk behind the calliope," and the only way to avoid such an ignominious position is for the owners, or their official representatives, to decide on a policy, pursue it firmly, but not obstinately, until it shows whether it is the right one, and then fix it or amend it as the results may determine. Such a policy may not at first be the very best one possible—omniscience is not generally an attribute of directors, although they sometimes fail to recognize that fact—but such an imperfect policy, if it has been honestly and candidly thought out and discussed, is infinitely preferable to the wobbly and jelly-fishy course of no policy at all.

The formation of a perfect line of policy, one that will give the best financial results both now and in the future, and at the same time gives the best satisfaction and carries the best opinion of the public and "the powers that be," is not the work of a minute, nor it is to be done on individual likes, dislikes or idiosyncrasies. It must be liberal within certain lines, and in others it must pare a paring; it must be elastic enough to admit of its fitting to changing outside conditions and yet be firm enough to withstand the blows and pressure of individual or selfish interests. In its making all interests must freely confer, and into this conference the managing head must not only come, but must be allowed—or compelled—to give his views and reasons for or against it. If the policy finally determined on is totally against his judgment or his experience, his best course, both for himself and his employers, has been suggested above, for no man can completely, heartily and honestly carry out any policy or line of action with which he is totally, or even greatly, at variance. If he is in accord with it, or even if he is simply in doubt as to it and is desirous of being convinced, he can enter into it heart and soul, and to keep up that enthusiasm the owners or directors should give him every incentive and should indorse it until it has been proved to them to be wrong. Many a good policy has been hatched full-fledged in the directors' room only to have its feathers plucked out, one after another, by its parents and, in this nude state, cold water thrown on it until it perished! Beyond the point of spending comparatively small sums for the improvement of the existing part of the property, often comes the question of investing large ones in additions to or extensions of the line or lines. The advisability, from an investing point of view, is always a question to be settled by observation, comparison and analysis of local conditions, but there are one or two fixed facts—they may almost be called "rules"—which are almost universally applicable, and the bearings of which must always be considered in the making of any additions or extensions, or in laying out any new line.

The first of these is, that in an urban or suburban line it is not a paying policy to run the line out to the furthest customer; in other words, the cars should never run into or beyond the edge of population—that straggling fringe of residences or small factories from which the first and last customers are recruited. The cars, and line, should always be stopped "an easy walk" (from two to five or more blocks) short of that point; any passengers from beyond this terminus will always walk to and from the cars as readily as if the latter ran in front of their doors, and in so doing will save the railway company the cost of many "car-miles" and an unnecessary and unproductive track and line investment, varying from $500 to $5,000. Even if the operation of this additional short run will give an even schedule run to the end of it, it is better to stop short and let the car have a lay-over of a few minutes, and, where such an extension is the cause of a lay-over at a terminus, it is additional proof of the insanity of so operating. Of course, any lay-over is undesirable—"it is the moving car that catches the fares"—but a lay-over is, from an economic standpoint, infinitely preferable to a "barren run," and any run to get customers that would surely come of themselves is a barren one and a needless cause of fixed charges, maintenance and operating expense. Many roads have run their lines not only to, but beyond, the edge of population, on the expressed idea that they would build up the traffic—out of the aching void they had invaded—and the fallacy of this line of argument is generally shown by the new management, or the receiver, stopping the running of the "dead-end," and making money by doing so.

Of course, if the road is unhappy enough to be harnessed up with a land scheme, the running to, and stopping in, a cornfield or a swamp may work out its salvation by the sale of corner lots, but such enterprises usually terminate in a cemetery, with the railway as the first occupant! Even when successful it does not alter the fact that, taken purely as a transportation question, it nearly always pays to stop the cars five minutes (or more) walk short of the edge of population. It is understood that if such "edge" consists of a manufacturing plant, or plants, a large public or educational institution, or any fixed and regular nucleus of patrons, the above principle may not apply, although the writer has seen many such termini given the regular car service of the line on which they were located, when a few special runs per day would have served their actual needs and have paid the railway company much better. Unless it is to hold a franchise, to conserve some valuable privilege, or to be remunerative in some way outside of operating, it does not always pay to run over a piece of track simply because it happens to be there.

The above remarks apply to urban and suburban traffic. The rule with interurbans—many of which are simply extended suburbans—should be "Stop at a natural terminus." A steam road, with its heavy freight traffic, its mail and express business and, above all, its irregular schedule and infrequent trains, can afford to stop in a cornfield or "the forest primeval" and make a terminus, but the electric railway has not, at the present time, arrived at the stage where it can do this; the absolutely different spirit and conditions of electric railway service compel it to have an established and remunerative terminus, a center or nucleus of population or traffic already made and at hand. Therefore, any electric line which simply sets out on a journey into the surrounding country, no matter how well-settled that country may be, without an objective point from or to which there is remunerative traffic, is either foredoomed to failure, or at any rate will not get the best results for its expenditure, and extensions or additions for such a purpose are nearly always an unwisdom. With an objective terminal point—a village, a small town, a cluster of factories or mines, a steamboat or steam railroad terminus or junction, a large public or educational institution—there is, with decently economical conditions of operating, a fair chance for remunerative service even if the route is a dumbbell—"everything on the ends and nothing in the middle"—but with everything on one end it is simply a "maul," which will nearly always beat all the profit out of the enterprise!

In "belt lines" in small or medium-sized towns it is absolutely necessary that they should run well within the edge of population if the best results are desired from their operation. There is a curious instinct or feeling in human nature that makes it dislike to go away from its intended destination, even to take a conveyance that will more quickly convey it there. Other conditions being equal, people will walk further and more willingly in a direction toward their destination to reach a street car that will take them there, than they will go in an opposite direction to take it. This is not so noticeable in a large city, where there are ample modes of reaching central points, but in towns and cities, where taking a car is a "Hobson's choice," a belt line, well inside the edge of population, will carry as many people at less cost of both fixed charges and operating expenses than the longer one which runs in, or beyond, that edge.

Many roads in the smaller towns and cities have laid out their routes with more regard to the comfort, prejudices or profit of the few than to the convenience of the many, and, in consequence, the many take their revenge by walking or riding bicycles. In other places, ignorance of traffic conditions, the mulish obstinacy of certain property owners and business men or the interested scheming of local politicians have been the cause of the lines being run in directions and through locations and localities where they serve no one. In such unfortunate cases there remains only the drastic remedy of an abandonment of the old route or routes and a relaying of them in places or directions where they will be remunerative. For some this is, through badly-arranged franchises or onerous general laws, a quick form of suicide, as such action will work an impairment of their charter or franchises, or will entail the loss of other and vitally valuable privileges, and they are between Scylla and Charybdis! The writer has, however, found few places so situated where the desperate condition could not be obviated by equally desperate measures, with much better chances of final profit to all parties than there were by continuing the existing conditions. The obvious remedy—a receiver or a commission or a foreclosure sale—were regarded as drastic, but in nearly all cases they were successful in the end; and a heroic remedy, or a "major operation," may entail grave risks and a long convalescence, but they are infinitely preferable to a slow and certain lingering to death. It is a reckless policy—worse than many so-called wildcat ideas—to continue the throwing of good money after bad in the hopeless earning condition of many railway properties, with a vain, Micawber-like idea that something will turn up to lift it out of the hole into which every day's operation plunges it a little deeper. It is the poorest of business enterprise to continue the same old course of losing operations when there is absolutely no certain hopes of betterment on such lines. Yet there are many small and medium-sized roads in just that condition in this year of grace, and when a businesslike but radical remedy is suggested to the owners they have a "blue fit" and reject the idea with horror, and often with contumely! Quick losses and small profits is a new business maxim, but there are plenty of cases in the railway world where it could be made applicable.

In many cases—not all—there is saving grace in an interurban run in connection, and as a component part of, the local road; in fact, in quite a number of roads in the Atlantic coast States and in the Middle West, the interurban child of the local urban road is "carrying" its parent. The fact that, in such cases, the interurban is virtually without office expenses, or those of management or superintendence, that its inception, construction and operation are free from the mistakes and expenses carried by the urban road, are often enough to make the difference between loss on the one and profit on the other. The inherent less cost of operation per car-mile due to higher speed and less stops, the ability to obtain revenue from other sources besides passengers, the freedom from high taxes and paving expenses, and the greater freedom from accident liability, are also factors that go to make an interurban extension of the local road a matter to be generally well worth consideration except in the case of peculiarly isolated towns or cities.

Such consideration is entirely a question of local conditions and localities, with the advantage in favor of the interurban being a success under conditions that would be prohibitory to the railway within the town. Given a terminus, as before stated, a fairly decent country in between and a not excessive cost of construction and operation, and with ordinarily good management, such an interurban will pay fixed charges and operating expenses, and will "build up a traffic," not only of people but of freight, express and mail. Parallelism of existing steam railroads is seldom now a question, except as to opposition to construction, for, as a rule, it is on or near the line of the steam railroads that the best population lies, and with at all decent service on the electric road the steam road is "not in it" for the ordinary and paying local traffic.

Because such a road runs through fields and woods, instead of streets, it must not be thought that it is free from any and all the rules that govern city railways. The writer has recently visited some interurban railways, the owners or management of which seemed to think that the freedom of the country run absolved them from many of the customs of the city—at least the behavior of all the employees in all departments seemed to hint that way—and he is waiting to see which will "tumble" first, the profits or the management. Not only is it absolutely necessary that the same rules which govern the successful operation of city lines be observed, but, to obtain the fullest success on an interurban, the successful solution of many new problems of construction, operation, maintenance, managing and discipline will have to be solved. For much of this solution we can look to our elder step-brothers, the steam railroads, for many of our new problems are old ones to them, but there are many remaining that will have to be "threshed out on our own barn floor" before we are sure that we are obtaining all the grain there is in the pile.

As a last resort, it is often desirable to sell out to, or become an integral part of, a syndicate, one of those benevolent combinations of capital and corporate skill that are creating little spreading oases of connecting or connected paying roads in the desert of hitherto non, or poorly, paying ones. The only objection on the part of many owners seems to be that these "octopi" often desire to obtain their property at what it is now worth, instead of at what it will be. These owners put up a plaintiff wail, that "we have carried this property along at a loss for all these years, and now these people want to get it for nothing!" Just as if there ought to be a premium on business imbecility! It is a curious fact—not entirely confined to non or poorly paying properties, however—that shares of stock appreciate more rapidly when someone wants to buy than when everyone wants to sell, but this fact has lately militated very strongly against the buying of certain properties, and has necessitated other—and to the owners not so pleasant or profitable—methods of obtaining, or obtaining control, of such properties. It is human nature to obtain all it possibly can, but it is sometimes not "good business" to try it on too far!

And so, when all is said, it seems that there is no royal road to making non-paying roads pay or poorly paying ones pay better, neither is it entirely a matter of particular or technical knowledge. It is simply the application of good, sound, every-day horse sense, and business principles supplemented by practical technical knowledge and practical experience in the business. By technical knowledge is meant not only that of the sciences of electrics and mechanics, but also that of transportation, at all times a science, but now a recognized and appreciated one, one whose study lies not to any great extent in books, but in human nature in all its phases.

Successful passenger transportation consists in quickly, safely and comfortably carrying as many persons as is practicable, as short a distance as possible, with a maximum of income and a minimum of expense, and, while this, as a whole, is an end seldom attained, it is the end for which every road and every manager must strive if they wish to attain any modicum of success.

A thorough study and understanding of all local conditions, a liberal policy—fixed, yet elastic—a wise expenditure coupled with a wiser economy, a full understanding of and attention to the personal element of both the public and the employees—especially the latter—honesty, truth and directness in all dealings, and unwearying watchfulness of all matters, both small and great; these, with the technical experience spoken of above will "win out" any non or poorly paying property if there is a single living chance to do it.

CONCLUSION

The writer has endeavored in these articles to show a few of the things that have come across his experience in the class of roads to which he limited himself, viz.: those which were non or poorly paying by reason of the personal element of their owners, directors or managers. He has not intended—and is not able—to fully cover the subject; his aim was to simply take the points which he has found most prominent, clear them of irrelevant and extraneous matters and practically erroneous ideas; find the principles applying to the best results and, where possible, to give some concrete and practical examples. From much correspondence that has reached him in regard to these points he finds that many of them have been affecting much larger and better-paying roads than he aimed at, which only goes to show that in some hands a blunderbuss is sometimes a more effective weapon than a rifle. To those who have so kindly sent him hints, suggestions and facts with which to load he returns many thanks, and is free to say that but for their help he would have, in many cases, lacked both powder and shot when the game came in sight.

Speed Regulation of Prime Movers and Parallel Operation of Alternators*

BY CHARLES P. STEINMETZ

Regarding the effect of speed regulation of prime movers on the parallel operation of alternators therefrom, three features have to be considered.

1. The permanent variation of speed, due to a change of load.
2. The temporary change of speed, due to a sudden change of load.
3. The periodic change of speed during each revolution.

1. With a change of load on the alternator, the power supplied to the prime mover must be changed correspondingly. This is done by a regulating mechanism which is based either on the speed (speed governor) or the acceleration (inertia governor). The speed of the prime mover is a function of the load, usually decreasing more or less with the increase of the load. Since, however, alternators in parallel operation, and thus the prime movers driving them, must run in synchronism with each other, it follows that the division of load between alternators driven by independent prime movers depends on the division of power between the prime movers at (electrical) inequality of speed, but not upon the characteristics of the alternator, thus it cannot be changed by a change of excitation of the alternator, etc., but only by reacting upon the governor (or by a change of belt tension with alternators belted to the same shaft). Therefore, for parallel operation of alternators a certain drop in speed with increase of load is necessary, and with a governing mechanism maintaining absolutely constant speed at all loads, the division of load becomes indefinite and parallel operation ceases to be feasible. If the drop of speed with increase of load is not uniform, but the speed almost constant for moderate load, alternators may operate satisfactorily in parallel at load, but see-saw at light load.

2. With a sudden change of load, since time is required for the governor to act and for the flow of power to the prime mover to change to the condition corresponding to the changed load, a temporary change of speed occurs, larger than corresponds to the change of load, and to reduce this variation of speed, storage of energy by the momentum of the fly-wheel is necessary. With the steam engine the momentum of the steam as expansive fluid is usually negligible in its effect, and the temporary effect of speed depends mainly upon the rapidity of the action of the governor. With water power, frequently the momentum of the moving mass of water predominates as a cause of the speed fluctuation with sudden change of load, and the speed fluctuation thus depends upon the momentum of the total moving mass of water. Standpipes, relief valves and deflecting nozzles represent means to reduce or eliminate the effect of the momentum of the moving water column upon the regulation of speed at sudden change of load.

3. Most rotary prime movers, as water-wheel, steam turbine, etc., give a uniform supply of power, and thus uniform speed during the revolution. Others, however, as reciprocating prime movers, steam and gas engines, supply the energy by a number of impulses, and the torque, and therefore speed, of the prime mover thus periodically varies during the revolution. The resultant torque of these prime movers consists of the pulsating torque of the energy supply (indicator diagram), the alternating torque of acceleration and retardation of the reciprocating masses, the alternating torque due to the finite length of the connecting rod, with vertical engines, the alternating torque of gravity in the ascent and descent of the reciprocating masses, and in gas engines also the pulsating negative torque of the compressor. The speed variation resulting herefrom can be reduced by such a design of the prime mover that the differ-

* Paper read at the meeting of the American Institute of Electrical Engineers, New York, Oct. 25, 1901.

ent components of torque superimpose upon each other to a more nearly unifrom torque, or by the use of a heavy fly-wheel. The most objectionable result of this periodic variation of speed is, however, the hunting of alternators and synchronous apparatus (as motors and converters), and this tendency to hunting seems to be aggravated by the use of heavy fly-wheels on the prime mover.

Electrical motors as a rule are not considered as prime movers, although no reason appears for making a distinction between the supply of power through a hydraulic pipe line or through an electric transmission line. With electric motors the rate of rotation is uniform and the periodic variation of speed thus absent, and due to the practical absence of a time lag the temporary variation of speed at a sudden change of load absent also, constancy of the supply voltage assumed. With continuous-current shunt motors a cumulative series field may be necessary for parallel operation of alternators to secure the necessary drop of speed with increase of load. With induction motors, while the drop of speed under load may be considerably less than required for good parallel operation of engine-driven alternators, the speed variation with the load is so uniform that no difficulties are met.

In parallel operation of alternators driven by synchronous motors, due to the absolute constancy of speed under load, an entirely different set of phenomena occurs, similar in some respects to the parallel operation of rigidly connected alternators, but differing therefrom, due to the flexibility of the synchronous motors in their relative phases, but rigidity in frequency.

Difficulties with parallel operation of alternators driven from separate prime movers may be due to:

1. *Lack of synchronizing power,* due to excessive armature reaction. This is practically unknown with modern alternators, in which the synchronizing power is always far in excess of the requirements of keeping them in step.

2. *Surging or hunting* between the alternators. Regarding hereto, forced surging and cumulative or resonating surging may be distinguished. With prime movers giving a periodic variation of speed during the revolution, periodically varying cross currents flow between the alternators and between alternators and synchronous motors, in extreme cases even between alternator and induction motor, of an amplitude depending upon the amplitude of the speed variation. Under certain conditions this surging becomes cumulative, gradually increasing in amplitude so that the machines may break out of synchronism. The cause of this cumulative effect may be found in the electrical circuit in certain relations between the momentum of the moving mass and the electric constants of the circuit, or it can be found in the mechanical construction of the prime movers, foremost their governors. When due to the former cause, it can occur also with turbine-driven prime movers and synchronous motors, while the mechanical hunting of the governing device, which is the more frequent and serious phenomenon, is most frequently found in direct-connected engine-driven plants.

The cumulative hunting is overcome by eliminating its cause, that is, breaking the resonance condition of the electric circuit by interference, or by changing its constants and damping the governor so as to stop its ability to hunt, or by reducing the amplitude of the hunting by a damping device in the electric circuit, usually in the field of alternators or other synchronous apparatus.

Parallel Operation of Engine-Driven Alternators *

BY W. L. R. EMMET

There has been and is much diversity of opinion and practice among engineers in relation to the operating of alternators in parallel from steam engines. This paper explains a method of overcoming the difficulties of such operation which has been in successful use for three years in many important installations.

The problem to which it relates is one of the greatest importance, and the solution described is, or is believed to be, complete and universal. It is for every reason desirable to the whole fraternity of electrical engineers that differences of opinion and of method in such a matter be removed or reconciled. I hope, therefore, that this paper, with the discussions which may follow it, will serve either to establish generally the use of the methods proposed, or to bring about the general acceptance of other or improved means for accomplishing the same result.

The problem of operating engine-driven alternators in parallel arose in Europe before it attracted attention in this country. Our early alternating experience was, for well understood reasons, confined to small generators operated on separate circuits. The use of direct-coupled engine-driven alternators did not begin in this country until about 1893, and the cases of parallel operation were quite infrequent until three or four years later. During the years of '95, '96 and '97 I was concerned in the installation of a number of machines of this type which were operated in parallel, but, for various reasons, none of the troubles characteristic to the parallel operation of alternators occurred in these cases, so that up to the year 1898 I had not encountered the problem here discussed, and had done nothing toward its solution. In Europe the problem had arisen much earlier, and serious troubles had been encountered, which were described in the different electrical journals. These accounts of trouble, combined with our knowledge of phenomena of hunting in synchronous apparatus, led me to be apprehensive about the parallel operation of alternators under certain conditions, before the difficulty was actually encountered.

The first case of trouble which I encountered was in the fall of 1898, when two 800-kw, 60-cycle alternators, operated at 100 r. p. m. from McIntosh & Seymour engines, were put into operation in Cleveland. These machines, when thrown into parallel, immediately began to surge so violently as to render service impossible. About the same time we started two 1000-kw, 60-cycle machines of the same type in Philadelphia and four 1500-kw, 60-cycle machines at 120 r. p. m. in Boston. In both cases the same trouble appeared that had occurred in Cleveland, except that it was worse in both of the latter cases, particularly in the case of Boston, where parallel operation was at first impossible under any condition of load.

I happened to be responsible for the engineering of these three plants, and found myself confronted with a very serious problem. I carefully considered the available European information which bore upon the subject, and found that two remedies for this trouble had been there applied. One of these remedies was described in an article by Gisbert Kapp which came to my attention. This article explained that the period of oscillation in relative motion of parallel alternators was governed by two quantities, namely, the electrical synchronizing force and the weights of the moving systems. Mr. Kapp explained that these quantities could be estimated and compared, and an arrangement could be adopted by which the natural period of oscillation between machines would not conform to the strokes of the engine, or would be of such frequency that trouble was unlikely to result. The other method of cure I found described by M. LeBlanc, who advocated the use of deadeners in the form of windings or attachments to the field structure in which currents would be generated by the shiftings of flux, and which would so serve to consume energy and interpose an electrical friction, which must tend to kill the oscillations.

A careful consideration of both these remedies indicated to my mind that neither of them afforded an adequate solution of the difficulty with which we were confronted. Special design of dynamos to obtain certain synchronizing effects with certain loads was almost out of the question, since commercial dynamos should be adapted to operation under all conditions, so that the investment in them may not be lost when change of condition is brought about through growth or other circumstances. M. LeBlanc's method was also objectionable, since it introduced devices which must occupy valuable space and complicate the design of machines, and which must, under operating conditions, introduce more or less serious losses. It was furthermore reasoned that a simple deadener could not be complete in its effectiveness, since the deadening effect must increase in proportion to the oscillation, and must be very small where the angle of oscillation is slight. It therefore seemed that this disappearing quantity would probably limit the extent of oscillations, but could hardly be expected to entirely prevent them under all conditions. Our subsequent experience showed that both of these methods were sound in theory and practicable within certain limits, but also developed the fact that they could not be depended upon as a basis of commercial work under various conditions.

At the same time that these theories were being considered I started a set of investigations with a view to ascertaining the exact conditions which existed in engine and dynamo while these troubles were occurring. In conducting these investigations, I reasoned that there must be a powerful actuating force employed in keeping these oscillations alive, since the waste of energy incident to their maintenance must necessarily be large, even where no pole-piece attachments or other form of deadeners are used. Theory clearly indicated that the oscillation was a pendulum action, whose period was governed by the weight and by the synchronizing power. I reasoned that this pendulum continued to swing in spite of a heavy friction, and I conducted my investigation with a view to ascertaining the actuating force. I presumed that this actuating force must come from the steam in the engine cylinders, and I had careful sets of indicator cards made showing the impulses under

* Paper read at the meeting of the American Institute of Electrical Engineers, New York, Oct. 25, 1901.

successive strokes and in the different cylinders. The comparison of these indicator cards immediately showed that there was a large irregularity in the delivery of steam to engines, and that the differences of area in different cards or in cards which should be the same under fixed load were very great. It was further observed that these variations arose from periodic motions of the governor, and that they conformed in period with the swing of the machines, and with the fluctuations of electromotive force and current.

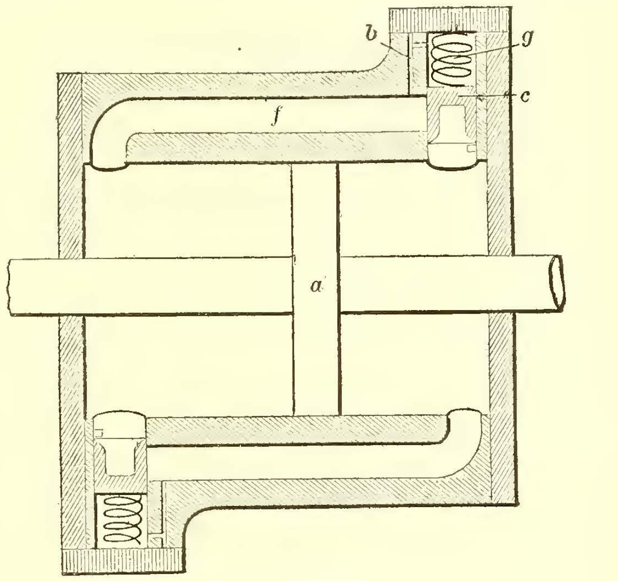
These facts, which were communicated to me by letter from Cleveland, led me to believe that the cure for the trouble must be sought in a prevention of a rapid periodic motion in the engine governors. I explained this in letters to the engine builders, suggesting to them that retarding dash-pots be used on their governors, which would prevent these sudden motions. The builders of the Cleveland engines in return replied that their governors were fitted with dash-pots, and that they were of the best anti-hunting type then known to the art. By such correspondence I soon discovered that the matter was entirely beyond the practical experience of the engine builders, and that we could hardly expect them to afford us a solution of the problem. I then went myself to Philadelphia, where the conditions for experiment were favorable, first communicating my theory in writing to the purchaser and to the engine builder as a matter of record. The governors of engines in Philadelphia were so arranged that dash-pots could be very readily attached to them, which would limit the speed of their motion to any desired degree. Our first experiment was to block the governors positively and run with fixed load. Under this condition no sign of oscillation appeared. We then operated the engines under various conditions of load and excitation, with and without dash-pots having various degrees of stiffness. These investigations showed that the tendency to oscillation gradually disappeared as the freedom of the governor was limited by the dash-pot. Under certain conditions a small dash-pot effect would kill the oscillation altogether, while under other conditions a stiffer dash-pot would be found necessary. In every case, however, the dash-pot effected improvement, and the cure seemed to be simply a matter of degree. In this particular case it was found that satisfactory parallel operations under all conditions of service could be obtained with dash-pots which were not so stiff as to materially interfere with the quick action of the engines, and such a cure was adopted, so that the investigations were not carried further in this plant.

From my experience in Philadelphia, however, I reasoned that other cases would arise where such a cure could not be applied, since the dash-pots necessary to afford stability of parallel operation would be too stiff to admit of the proper quick governing of the engines. These anticipations were very soon realized in the operation of the machines above mentioned at Boston. In these machines the oscillating tendency was so strong that they could not keep in step at half load with dash-pots so stiff as to admit dangerous variations of speed with sudden load fluctuations. From this experience it was seen that we must find some means of deadening the motions of the governor occasioned by the oscillations, and at the same time we must leave the governor free to move where actual changes of load came upon the machine. A means of accomplishing this result was devised in Cleveland by the combined efforts of H. W. Buck, my assistant, and Harte Cook, of the McIntosh & Seymour Company. The device is shown in Fig. 1, which shows only one of many forms devised for accomplishing practically the same result. The main piston rod shown in this sketch is connected to the governor weights in such a manner as to be moved directly by them. The space on both sides of the piston and all the port spaces are filled with heavy grease. By-passes, *F*, are provided through which this grease can flow from one side of the piston to the other. Each of these by-passes is actuated by a small piston-valve *C*, backed by a spring *G*, and provided with a small by-pass *B*. The practical effect of this device is that the springs tend always to keep the gates of the main by-passes closed, and that the piston is thus virtually locked until the pressure at one end of it has forced the by-pass valve back. The first motion of the main piston is thus limited by the size of the small by-pass *B;* whereas its later motion, after the valve has been forced back, is limited only by the size of the main by-pass *F*. It will be readily seen that this dash-pot can be so adjusted that it will act as a temporary lock on the governor mechanism, and that it will release entirely after the tendency to govern has continued for a certain length of time.

Such dash-pots were first applied to the engines above mentioned operated in the plant of the Boston Electric Light Company, and it was found that they afforded a positive and complete cure of the oscillating troubles which had been experienced there. By their use, with proper adjustment, the engines can be operated under all conditions of load, and with any number in parallel, without the slightest indication of the oscillating trouble which was at first so difficult to prevent. In this case the tendency to oscillation was much more positive than in any other which has come to my notice, and the perfect success of the remedy has led me to believe that the method is universally applicable, and that all similar troubles can be cured by its intelligent application.

In order that this form of dash-pot may properly accomplish its functions in the most difficult cases, it must be made strong enough mechanically and hydrostatically to bear for a time the entire force imposed by the governor weights in their effort to assume a new position, and the period of such opposition must be such that the dash-pot will not unlock within the time of a single period of oscillation when the machines are operating in parallel. It is also necessary that the dash-pot be kept full of grease, so that there will be no lost motion through air spaces. If the dash-pot falls short in any of these particulars, the remedy which it affords will only be partial, and in difficult cases it may prove inadequate. It is only in certain difficult cases that we need use such complete preventives as were found necessary in Boston.

While discussing this subject, it may be profitable to briefly touch upon a few other facts which have developed in the course of my experience in the parallel operation of alternators. It is popularly



SECTION OF DASHPOT.

supposed that it is necessary to use very heavy fly-wheels in order that alternators may be successfully operated in parallel; it being the custom of some engineers to consider a guarantee of small angular variation as the equivalent to a guarantee for parallel operation. My experience has rather indicated that generators with light fly-wheels are most easy to operate in parallel. The frequency of natural oscillations in such machines is high, and the conditions of engine operation are generally unfavorable to their development. Large fly-wheels are desirable on direct-coupled alternators, because a steady frequency is a valuable feature in any system. The requirements of parallel operation, however, are rather unfavorable than otherwise to the use of heavy fly-wheels.

The peculiar periodic action of an engine's governor which I have before described is not confined entirely to the parallel operation of alternators, but also may occur and cause trouble where a single alternator is operating a load of synchronous apparatus. We may even have alternators which will operate together in parallel, but which will, through periodic action of the governors, give trouble with certain loads of synchronous apparatus. It is thus desirable in all cases to prevent this periodic action of the governors, and by this prevention many troublesome difficulties may be lessened or overcome.

The behavior of all parts of the system while this oscillating trouble occurred in parallel operation was very beautifully illustrated during our experiments at Philadelphia. The shafts of engines were in line, and the relative positions of poles could, at all times, be seen, the poles of one machine appearing to stand still when the machines were in perfect synchronism. The movements of the governor mechanism could also be seen by oscillations of a lever arm which was in the line of vision. Ammeters and voltmeters were also placed in the same line. It was possible at a glance to see the degree of angular displacement of the poles, the degree of motion of the governor, and the fluctuations of the current and voltage. An observation of these conditions showed very clearly the exact character of this phenomenon. It was found that under some conditions the oscillation was an extremely sensitive matter and had very little power of sustaining itself. A slight change in the field strength of one of the machines would sometimes break it up so that it entirely disappeared, after which the machines might remain steady for some time and then gradually begin to swing again. Under other conditions it was more persistent. Everything indicated, however, that it could not exist for any appreciable period without the actuating force afforded by the irregularity of steam impulses.

The Design of Engines for Operating Alternators in Parallel*

BY R. H. RICE

In designing engines to operate alternating-current generators in parallel, two features of the design must be carefully worked out. These are (1) the fly-wheel, (2) the governor.

(1) In determining the proper fly-wheel effect for any given case it is necessary to know the variation in polar distance allowable from mean or uniform rotative position in either direction. This information must be furnished by the designer of the generator. It is also necessary to know the form of indicator card expected to be realized and the weights of the reciprocating parts of the engine; also, for exact determination, the moment of inertia and center of gravity of connecting rod. Mr. Keilholtz has shown the method of obtaining curves showing velocity of any point on the fly-wheel at any position of the stroke, also any point in reference to mean position, or that due to uniform rotation. The writer believes, however, that graphic methods can be used to much greater extent in the determination of these curves, and had hoped to be able to submit diagrams showing the methods employed. The time allowed, however, has been insufficient to do this. The graphic methods give much greater clearness of perception in estimating the value of the various modifications of design; for instance, the determination of which crank will lead, the high or low pressure; and in difficult cases it is readily determinable whether some other crank angle than 90 degs. will prove sufficiently beneficial in reducing disturbances to make it advisable to adopt this arrangement.

It is usually the custom to deduce curves showing velocity variation and space variation for half and full load and 50 per cent overload, using, in determination of fly-wheel weight, that one of the three space variation curves which gives the maximum result. In determining this curve of space variation the mass of rotating parts can be conveniently taken as unity at the crankpin, and by simple proportion the maximum variations found can be reduced to the required amounts by the addition of mass at this point. It is then easy to reduce the mass at crankpin to an equivalent mass at the fly-wheel rim, and thus the fly-wheel weight is adjusted to the requirements of the generator. In practice, variations in steam distribution and other accidental causes introduce irregularities not allowed for in preceding calculations, to meet which an addition factor of 30 per cent to 50 per cent is used in determining the weight of fly-wheel.

(2) The type of governor used is important, because (a) it must be readily adjustable in characteristics to meet the varying requirements of different voltages and frequencies, and to provide for the closest regulation consistent with proper division of loading between two or more machines; (b) two or more governors must be readily brought into synchronism as regards rate of decrease of speed with increase of load; (c) the governor must be readily adjustable as regards dampening or dash-pot effect; (d) it must have sufficient power to retain control of the speed even under considerable dash-pot resistance; and (e) it must be adjustable for speed from the switchboard, to provide, first, for equalizing the speed of an unloaded unit with those carrying the load, in order to get the units into step; second, to make the unloaded unit assume its share of the load after putting into step; third, to permit of relieving a unit from load so that it may be put out of service.

As concerns the slow or medium-speed engine with automatic trip cut-off, the inertia governor, belted or geared to the engine shaft, seems to possess all the above characteristics in a marked degree, its great power and rapidity of action, even under considerable dash-pot resistance, permitting of reducing the fly-wheel to dimensions sufficient to meet the requirements of the generator as previously explained, no addition of weight to the fly-wheel being necessary to give time for the governor to act.

The lighter the fly-wheel, the less intensity of the pendulum effect described by Mr. Emmett, and the less the resistance necessary to apply to the governor in the shape of dash-pot resistance.

* Communication read at the meeting of the American Institute of Electrical Engineers, Oct. 25, 1901.

Dash-pots which release the governor in case of tendency to motion of the governor weights, continuing for an appreciable time, as described by him, are undoubtedly the most generally effective.

The apparatus most satisfactory for varying the speed characteristics of the governor consist of a simple reversing motor of the direct-current type, which screws up or down a spring attached to the governor weights, the motor being started, stopped or reversed from the switchboard by a simple switch. By this means the switchboard attendant is placed in entire control of the situation.

Of two crank engines, the twin engine, non-compound, operates in parallel most easily. The cross-compound engine, by reason of the impossibility of accurately dividing the loads between the two cylinders for wide ranges of load, is much more difficult to operate. This is, however, now the favorite type, and can be used without fear of necessity for excessive fly-wheels. The double-tandem engine does not give the good results which it would seem to possess, on account of the fluctuations in steam distribution. Vertical engines require larger fly-wheels than horizontals, as the weight of the reciprocating parts, acting vertically downward, introduces an irregularity in the rotative forces.

Three cranks theoretically give a great increase of steadiness, which is diminished in practice by difficulties of steam distribution. All in all, the horizontal cross-compound seems the best all round type, with the vertical form second. The difficulty of operating with reciprocating engines rapidly increases with increase of frequency, and it is probable that with frequencies not far above 100 such operation may be impossible.

Speed Regulation of Prime Movers

At the regular meeting of the American Institute of Electrical Engineers held in New York City on Oct. 25, the subject of speed regulation of prime movers, with special reference to the successful operation of alternators in parallel, was discussed at some length. Papers were read by C. P. Steinmetz, P. O. Keilholtz, W. L. R. Emmett, E. J. Berg and W. I. Slichter, and discussed by R. D. Mershon, C. F. Scott, J. A. Seymour, of McIntosh, Seymour & Company; Allan V. Garratt, of the Lombard Water-Wheel Governor Company, and many others in attendance, and communications were read from R. H. Rice, of the Providence Engineering Works, and B. A. Behrend, of the Bullock Electric Manufacturing Company. Several of these papers are printed elsewhere, but many of the interesting points brought out in the discussion are necessarily omitted. The meeting was one of the largest which has taken place at the institute's rooms in some time, and the prominent engineers present show the great amount of interest which is taken in this subject by electrical men. The practice of operating street railways from rotary converters, which is becoming so universal on both small and large systems, makes the operation of alternators in parallel a problem of peculiar interest to street railway engineers.

Mr. Slichter's paper was entitled "Angular Velocity in Steam Engines in Relation to the Paralleling of Alternators," and contained a thorough analytical discussion of this service in relation to some practical tests which had been made on an engine at the General Electric Company's Schenectady works. The paper dealt more particularly with the functions of the governor on direct-connected engines in alternating-current operation. The paper by Mr. Keilholtz was on "Angular Variation in Steam Engines." The author goes deeply into the theory of the subject, and the results are given in analytical, tabular and graphical form of his investigations in determining the angular variation of a cross-compound McIntosh & Seymour engine direct connected to a 500-volt railway generator. In the tests a water rheostat was used as an artificial load, simultaneous readings of current and efforts being made and indicator diagrams taken. An ingenious method of using a tuning fork for registering the angular variation in speed was described, and the results obtained by this means were exhibited at the meeting, as well as being reproduced in the paper. In calculating the turning effort, the fly-wheel rim and spokes, the crank disc and armature were reduced to the crankpin, and the indicated effort at the pin was corrected for accelerating and retarding forces due to these and the connecting rod, the radii of gyration in each case having been determined for this purpose. Mr. Berg gave an analytical discussion of "Parallel Running of Alternators," in which he pointed out that two machines of the same e. m. f. and armature reaction running in phase will share the load evenly. It is possible to change the load by change of field excitation by sacrifice of current, since this method involves wattless current between the generators. He advocated proper dash-pot arrangements at the governor of the engine to prevent a periodic fluctuation in the flow of steam which tends to sustain an accumulated hunting.

Strange Behavior of Flexible Copper Bonds on the Baltimore & Ohio Belt Line

The Baltimore & Ohio uses on its belt line electric locomotives weighing 97 tons each to move all trains going east through its tunnels, up the heavy grades and around sharp curves.

Since many of these trains require as much as 1200 amps. to 1500 amps. to start and move them, the return current carried by each rail is very heavy. To this service should be added the current supplied to the local street railway company, and which is still larger than that required by the electric locomotives.

The railway company has about completed the laying of new 100-lb. rail A. S. C. E. section over the tracks used by the electric locomotives. Standard A. S. C. E. angle-bars were used and Harvey grip-thread bolts. It was desired to bond these rails to their full carrying capacity with a type of bond that could not be stolen. The stealing of exposed bonds on distant parts of the system has heretofore been so serious as to cripple the service and involve great expense for renewal of bonds. The bonds selected were flexible copper conductors, with 7/8-in. terminals, 14 ins. between centers, and of about 400,000 circ. mils section.

To lay rails of this weight through tunnels, across bridges and on heavy curves, and with frequent train service, was naturally a most difficult job. The number of crossings, cross-overs and switches is very large. The third-rail installation somewhat restricted the space for setting up the rail, since from the inside guardboard to the outer edge of the rail was about 18 ins.

Great care was taken to obtain a perfect job in applying the bonds, and about a third of them was applied after the rail was already laid and in service. A test of some of the bonds that were applied under the most favorable conditions possible showed the resistance across the joint to be ten times that of an equal length of continuous rail. These measurements were taken within a few weeks after the bonds were applied and where the track was in A1 condition.

The behavior of the bonds on certain sections of the line is most peculiar, and a puzzle to all who have seen the accompanying cuts. Although there is ample room between the rail and angle-bars to accommodate the conducting portions of the bond without crowding it, on a very large proportion of the joints the metal of the bond squeezed out over the top of the angle-bar and below the head of the rail. The metal is forced out in irregular sheets about .005 in. and over in thickness. In some cases these ribbons are 8 ins. or 10 ins. long. In other cases, as in Figs. 2 and 3, four or five strips out. Fig. 4 shows a bond after only ten days' use.

The metal ribbons are formed on both sides of the rail, and occur mostly on tracks of heaviest train service, although the same action is taking place on the other tracks. It has been suggested that the movement of the rails during train service has caused the trouble. However, the road is rock-ballasted, and the ties were all well tamped before new rail was laid. All old ties were removed and replaced with new ones, and the rails were most carefully respiked when new tie-plates were put on after the rail was laid and bolts tightened. The accompanying engravings are from photographs kindly supplied by Charles M. Hobbs, inspector in the electrical department of the Baltimore & Ohio Railroad, who makes the following recommendations for applying bonds of the protected type on steam-road tracks and under steam-road conditions of operating heavy train service:

1. In double bonding for this service, it is necessary to secure the full carrying capacity of the rail, and four holes must be drilled or punched in the web of the rail in addition to the bolt holes already there. This produces a serious weakening of the rail at its most dangerous point—the joint.

2. Additional labor is required to place the new rails in line before the bonds can be applied. Before the rails are bolted together they do not lie in sufficiently true surface and alignment to apply the bonds properly without a great deal of leveling, or temporary shimming. Unless this is done the body of the bond will be subjected to great mechanical strain and often twisted out of shape.

3. On bridges, platforms, at most special work, and also around third-rail installation, there are many places where it is impossible

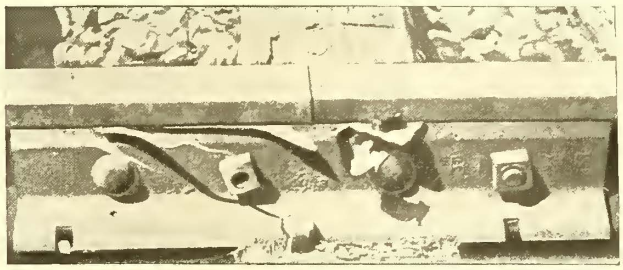


FIG. 3

to use a bond compressor or a bonding hammer. In these cases the bonding cannot be done until the old rail is shoved aside, the new rail placed in position, and the angles removed. The bonds are then applied and the angles replaced. As usual in work of this character, the track is blocked, a very large force of men is employed, and the work is done with a rush. Where the bonding men cannot do their work properly and keep up, the rail must be left unbonded until some future time. The bolts and angles must then be removed, flagmen and trackmen must be employed in addition to the bonding men, and the work can only be done between train service. This entails serious results to track bolts when the Harvey grip-thread bolt is used, and the periods when bonding can be done are few and far between.

4. The bonds can be used only once. After one application their removal so destroys the terminals as to make them valueless as bonds. Therefore, all temporary connections between new and old rails or the removal of a defective rail means a destruction of the bonds.

5. To replace a defective bond on a road of this kind requires a force of not less than four men. It will require one to look out for trains and the others to remove the bolts, angle-bars and bonds. At certain busy sections of the road this may call for a blocking of the track. Any serious trouble in removing the bonds may involve a delay to train service, a thing always to be avoided.

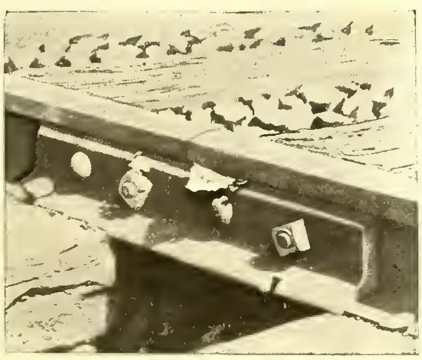


FIG. 1

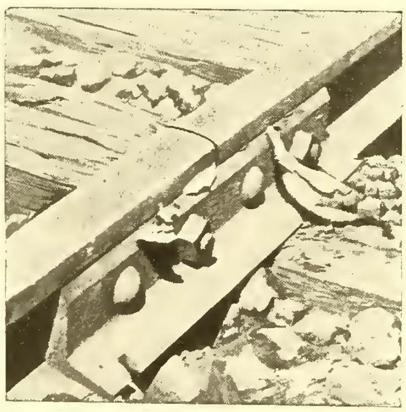


FIG. 2

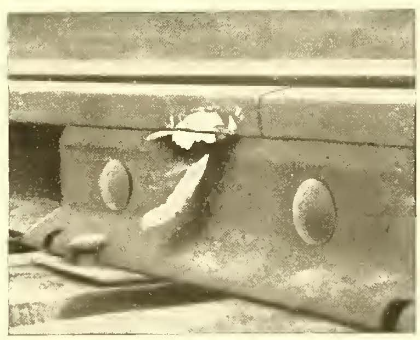


FIG. 4

6. This replacing of defective bonds also involves meeting the difficulties incident to the expansion and contraction of the rails. The creeping of rails on the tracks on grades and curves will also produce similar results. These causes at times produce serious effects when bolts and angle-bars have been removed. In hot weather the ends of the rails, especially on curves, will be forced out of alignment after the angle-bars are removed, and it is a most difficult thing to realign and replace the angles. In fact, it sometimes occurs that a section of the rail must be cut off before the rails can be brought back into proper position. In very cold weather, on the other hand, where the bars are removed, the rails separate, and it is difficult, if not impossible, to replace the bolts, and equally difficult, if not out of the question, to use the same length of bonds.

7. The contact surfaces of the terminals of the bonds are limited to that afforded by the cylindrical surface of the hole in the rail, and depends entirely on the manner in which the expanded copper meets this surface. In practice it is found that the type having solid terminals, on whose ends the compression is applied, will flare out, forming an enlarged section outside the web of the rail, while the pressure is not effective in properly swelling the terminal at the opposite end, nor does it properly fill the hole nor make contact. This allows corrosion to take place between the terminal of the bond and the rail.

8. On a bond using a conical pin driven into the terminal the expansion of the terminal is limited by the difference in diameters of the hole and pin. This does not insure the requisite amount of expansion of the terminal in the hole itself, since it drives the copper before it and produces a flare on the opposite side of the rail. This permits corrosion of the contact commencing at the driving side of the bond. An inspection of a very large number of terminals of this form that had been applied over five years ago outside of the angles showed a continuous corroded surface around the terminal. In fact, the cases were very numerous where the corrosion had been so great that the terminals were lying loose in the rail.

9. The action of gases in tunnels from steam locomotives on all things metal is very marked, and the corrosion effects are far-reaching. Bolts and spikes have been so greatly reduced on this account alone as to require their replacement. Bonds of this character and type are no exception. The necessity of perfect contact between the bonds and rails is absolutely imperative.

The De Laval Steam Turbine

The improvements made in the steam turbine by De Laval are known in a general way to steam users in this country, but up to the present time the machines have not been placed on the market for commercial work. The announcement has been made, however, that the American De Laval Steam Turbine Company has recently been organized to build these turbines in America. The company owns shops at Trenton, N. J., and will construct turbine motors of from 1½ hp to 300 hp, condensing and non-condensing. This makes the machine a commercial one for railway service, and it is thought that an explanation of some of De Laval's improvements in the design of these machines, together with a description of the actual construction and practice, will prove of interest.

The steam turbine is one of the oldest, perhaps the oldest, heat motor recorded in the history of steam engineering, and has always possessed many advantages over the ordinary reciprocating engine. Its very serious defects, however, in other respects, especially in the fact that it has been very wasteful of steam, has never made it a serious rival of the reciprocating engine. The general principles of the turbine are so well known that they will not be discussed here, but mention will be made of the two very radical improvements introduced by De Laval. One of the principal reasons for the low economy of the machine had always been that complete expansion of the steam was not obtained. De Laval's first improvement was the use of the diverging nozzle which he patented. By this, it is claimed, complete adiabatic expansion of the steam is obtained, and the conversion of its entire static energy into kinetic. The

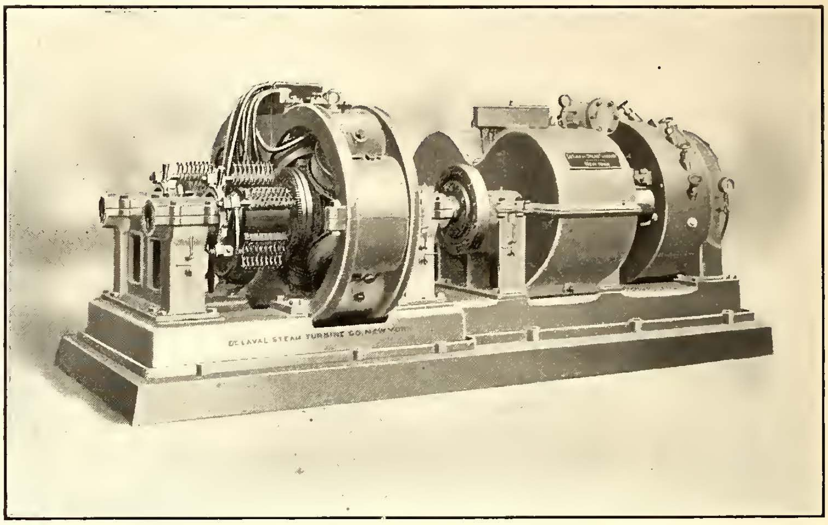


FIG. 2.—DIRECT CURRENT TURBINE GENERATOR

second improvement was the introduction of a flexible shaft, to overcome the impossibility of producing a wheel accurately enough balanced to revolve about its center of gravity at a velocity sometimes as high as 1350 ft. per second without causing a side pressure destructive to ordinary bearings. A valuable feature of the turbine is also that none of its parts is subject to the full pressure of the steam, as the latter is fully expanded in the nozzles before it reaches the turbine wheel. Moreover, considerable increase in economy can be obtained by using superheated steam, as the turbine has no rubbing parts requiring lubrication or packing glands in contact with the superheated steam.

Some of the special points claimed for the turbine as a result of the tests and use of the machine abroad are the economy and high efficiency with variable loads. Regarding the latter, it is claimed that the efficiency of the turbine is practically the same between one-quarter load and 20 per cent overload. Below one-quarter load the steam consumption per boiler horse-power rises gradually, but not, of course, anywhere near so sharply as with the reciprocating engine. The steam consumption as shown by numerous tests made by prominent steam experts abroad, are as follows: 50 hp, 23.98 lbs. of steam per brake horse-power hour; 63.7 hp, 19.73 lbs. of steam; 150 hp, 17.35 lbs. at full load, 18.43 lbs. at half load, and 22 lbs. at 20 per cent of load; 300 hp, 13.96 lbs. at full load, 17.02 lbs. at quarter load. The De Laval Separator Company has installed during the twenty years 250,000 centrifugal cream separators, operating creameries with excellent results.

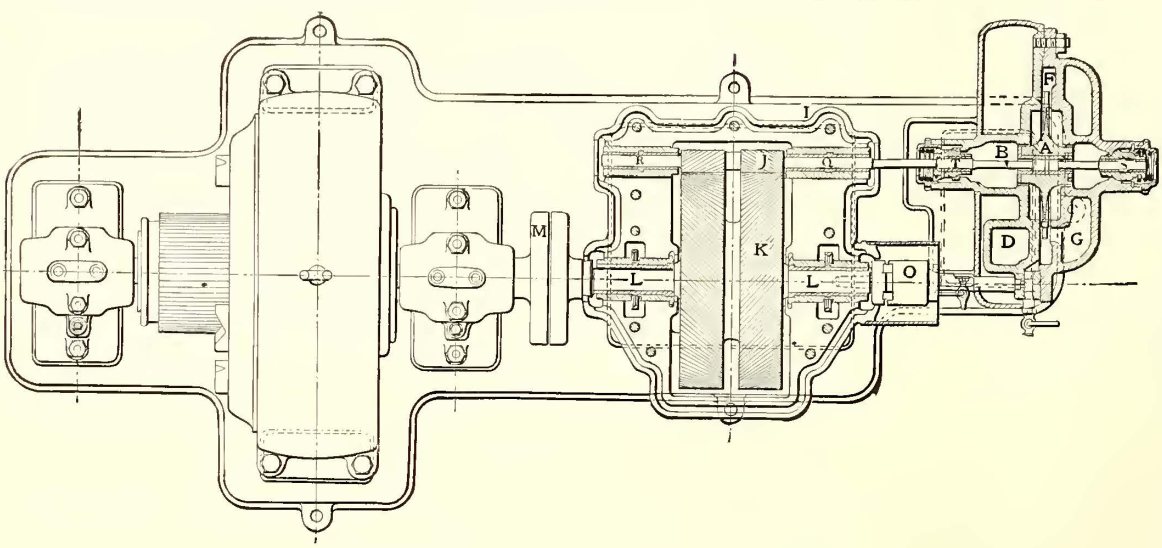


FIG. 1.—SECTIONAL PLAN OF DE LAVAL TURBINE

The general construction of the De Laval steam turbine will be clearly understood from the sectional plan, Fig. 1, in which *A* is the turbine-wheel mounted upon the slender flexible shaft *B*, and in such position relative to the wheel case as to revolve entirely free, liberal space being allowed on each side, as shown. The wheel case and the wheel case cover are so shaped as to form "safety bearings" around the hub of the wheel for the purpose of catching and checking its speed in case of an accident to the shaft.

The steam, after passing through the governor valve, enters the steam chamber *D*, where it is distributed to the various nozzles. These, according to the size of the machine, range in number from one to twelve. They are generally fitted with shutting-off valves, by which one or more nozzles can be cut out when the turbine is not loaded to its full capacity. This allows steam of boiler pressure to be almost always used, and adds to the economy on light loads.

After passing through the nozzles, the steam, as elsewhere explained, is now completely expanded, and in blowing through the buckets *F* its kinetic energy is transferred to the turbine wheel.

After performing its work, the steam passes into the chamber *G*, and out through the exhaust opening.

The velocity of the turbine wheel and shaft, in most cases too great for practical utilization, is considerably reduced by means of the spiral gear, usually made 10 to 1. The gear is mounted and

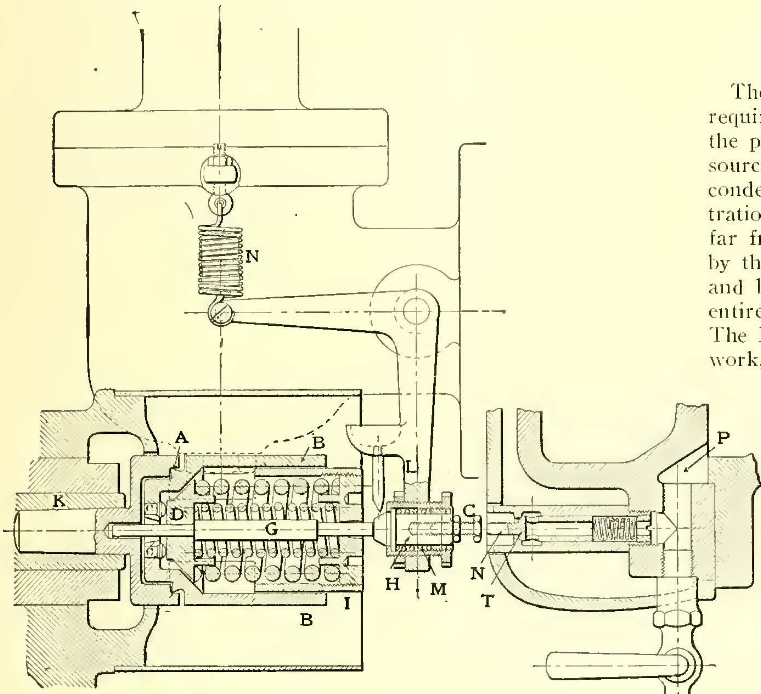


FIG. 3.—SECTION OF GOVERNOR VALVE

enclosed in the gear case *I*. *J* is the pinion, made solid with the flexible shaft and engaging the gear wheel *K*. This latter is forced upon the shaft *L*, which, with couplings *M*, connects to the dynamo or is extended for pulley. *O* is the governor, held with a taper-shank in the end of shaft *L*, and by means of a bell-crank operates the governor valve.

The flexible shaft is supported in three bearings. *Q* and *R* are the pinion bearings and *S* is the main shaft bearing, and carries the greater part of the weight of the wheel. This latter bearing is self-aligning, and is held to its seat by the spring and cap shown. *T* is the flexible bearing. This bearing is entirely free to oscillate with the shaft, and its only purpose is to prevent escape of steam when running non-condensing, or air from entering the wheel case when the turbine is running condensing. All the bearings of the flexible shaft, as well as the gear-wheel, are lubricated from a central oil reservoir, mounted upon the gear case; all other bearings are self-oiling.

The gear-wheels are made of solid cast steel, or of cast iron with steel rims pressed on. The teeth, in two rows, are set at an angle of 90 degs. to each other. This, while insuring smooth running, at the same time checks any tendency of the wheel and shaft to move lengthwise, thereby making a troublesome trust bearing unnecessary. The gears are cut on automatic machines designed specially for this purpose, and a degree of accuracy has been attained not heretofore approached in gear wheel construction. Owing to the high speed of gearing and the perfect alignment, the stress on the teeth is said to be extremely small, and gears which have been examined after a continuous operation of seven or eight years show no appreciable wear.

The turbine wheel is made of forged nickel-steel, and will withstand more than double the normal speed before showing any signs of distress. In the smaller sizes the wheels have a hole through the center, and are forced upon a taper sleeve shrunk on to the shaft. The larger wheels are made solid, with the shaft in two pieces, screwed to the flanges of the wheel. The buckets are drop forged, and made with a bulb shank fitted in slots milled in the rim of the wheel. By this method the buckets can easily be taken out and new ones inserted, should occasion require, without damage to the wheel.

The governor shown in detail (Fig. 3) is compact and simple in construction. The two weights *B* are pivoted on knife edges *A*, with hardened pins *C* bearing on the spring seat *D*. The governor body is fitted in the end of the gear-wheel shaft *K*, and has seats milled for the knife edges *A*. It is afterward reduced in diameter to pass inside of the weights, and is in its outer end threaded for the adjusting butt *I*, by means of which the spring and eventually the speed of the turbine is adjusted. When the speed exceeds the normal, the weights, affected by the centrifugal force, spread apart and, pressing on the spring seat *D*, push the governor pin *G* forward, cutting off part of the flow of steam.

An Efficient Steam Separator

The design of a steam and oil separator which will meet the requirements of all up-to-date central station practice is one of the problems which has given to engineers all over the world a source of much study. In the purification of exhaust steam from condensing engines, successful results have been obtained by filtration of the condensed steam, but these results, however, are far from satisfactory, as the filtering material soon becomes foul by the grease retained, requiring constant attention and cleaning, and being in many cases so difficult to maintain as to cause the entire abolition of any means of re-using the water in the boilers. The Baum oil separator has been designed to cover this particular work, and in its "vacuum" style is an appliance which is guaragreed to do this work perfectly, so that when properly placed between engine and condensers the water from the hot well will be entirely suitable for boiler feed and can be be used continuously without leaving any deposit of oil in the boilers. Another type of the separator is made for introduction between the boiler and engine, and is claimed to positively separate all moisture and water, the result of either condensation or priming, from the live steam. The only positive protection that can be afforded an engine against the influence of water is to keep it out, and the many serious accidents which have resulted from water in the boilers causing breakage or the system's entire destruction of the engine are frequent indications of the necessity for an efficient device of this kind. In its various forms, the Baum separator fills, therefore, a position of great importance to the engineering profession. The Baum Separator Company, of Reading, Pa., which makes the device, is sure that when properly placed the Baum separator will separate from live steam all water and the highest percentage of moisture separable by mechanical means, and will also purify exhaust steam, cylinder oil, grit, greasy water, etc. This otherwise waste product will be valuable for heating buildings, dry-rooms, dye waters, etc., or for any purpose where heat is required, and the condensed and pure hot water may be returned to the boilers as the best possible boiler feed, being free from scale-forming matter, and can be used continuously.

New Transfer in Cleveland

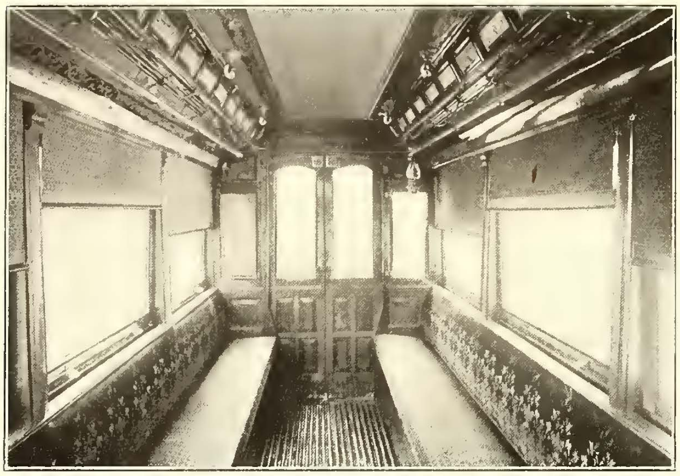
The Cleveland City Railway Company will shortly issue a new style of transfer. Universal transfers have been given, and transfers on transfers have been allowed. The time limit has been so long that the transfers amounted practically to stop-over checks to those who desired to go from one side of the city to the other. It has been found also that small boys have made a practice of dealing in transfers and have procured them regularly from certain passengers, who would ask for transfers but would not use them. The new form of transfer will reduce the time limit, and only one transfer will be given on a cash fare.

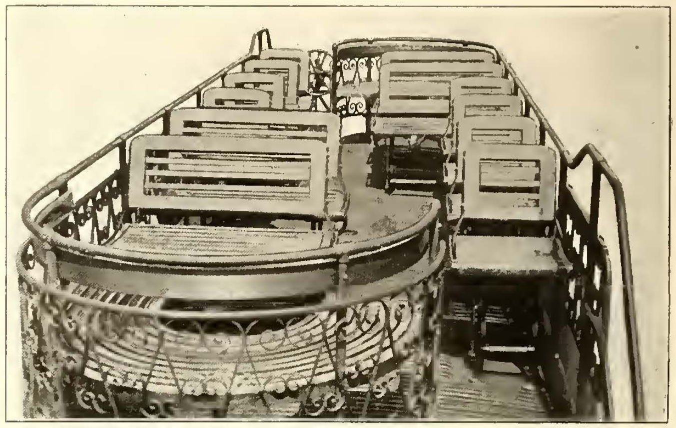
Laying Cornerstone at Niagara Falls

His Royal Highness the Duke of Cornwall and York, during his recent visit to Niagara Falls, locked the box which will be deposited within the cornerstone of the big new power house about to be built by the Canadian Niagara Power Company. The ceremony took place on the private car "Ondiara," specially fitted up by the Niagara Falls Park & River Company, while it was standing on a portion of the track which is upon the site of the proposed works. The box is of Flemish oak, bound round with bands of solid silver, and was locked by his Royal Highness in the presence of A. Monro Grier, secretary of the company. The box contained photographs of the Duke and Duchess and their eldest son.

Some New Cars from the Brill Works

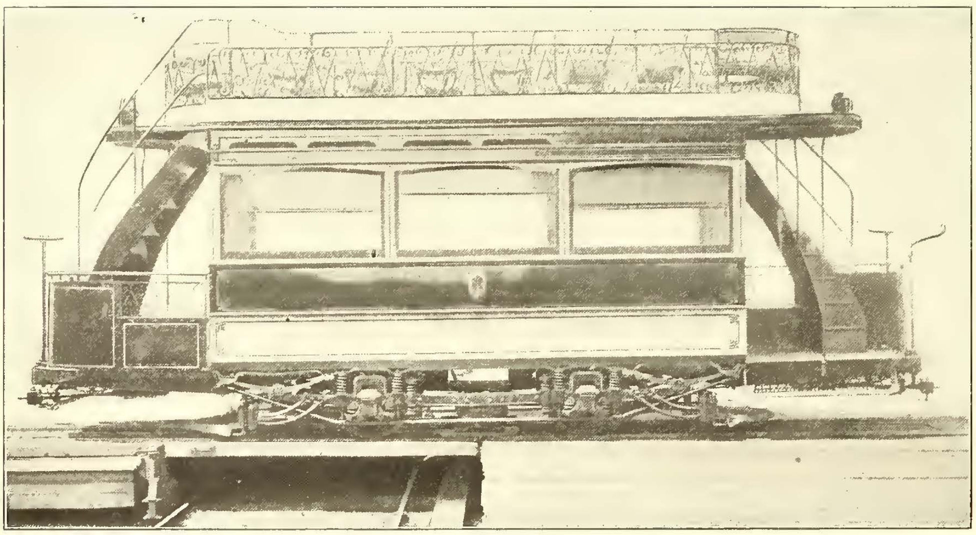
On this and the succeeding page are illustrated some handsome cars recently furnished by the J. G. Brill Company, of Philadelphia,





INSIDE AND OUTSIDE SEATING ARRANGEMENTS OF DEVONPORT CAR

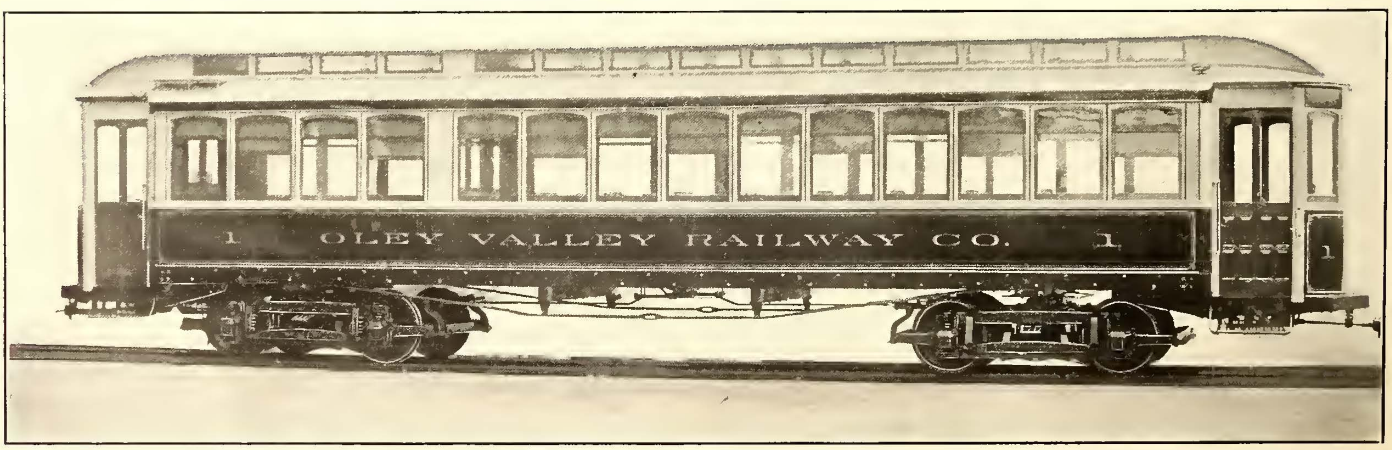
to railways in England and this country. The types shown each present many novel features, and their extremely different styles



DOUBLE-DECK CAR FOR DEVONPORT, ENGLAND

illustrate the wide variety of work with which the company is familiar.

It has recently furnished the tramways of Devonport, England,



LONG, TWO-COMPARTMENT CAR FOR OLEY VALLEY RAILWAY COMPANY

with the type of double-deck car shown in the illustration. This car was limited in width by the local conditions to 6 ft. The total width at the sills is 5 ft. 5¼ ins., and at the belt rail 5 ft. 9¼ ins. The length over end panels is 16 ft., and the platforms are each 5 ft. 6 ins. long. The cars are of very handsome appearance, both inside and out. Having but four posts on each side, extra large windows are provided, and double doors at each end give ample means for ingress and egress. The inside finish is of cherry, with three-ply veneer ceilings, artistically decorated, and spring roller curtains are placed in the windows. The seats in the box part of the car on the lower deck are covered with Wilton carpet, which also forms the material used for the backs. On the upper deck are two rows of seats, one double and one single, arranged as shown in the illustration, so that half of the long seats are on one side and half on the other. The trolley pole base is placed in the center of the roof. The trucks used on these cars are the Brill 21-E type, having a wheel base of 6 ft. 6 ins. These trucks have a solid wrought-iron forged frame, and are equipped with two motors, wheel brakes and Brill track brake. The platforms are closed on one side. Two Dedenda gongs, with 12-in. bells, and two electric headlights are placed on each car. In shipping these cars to England, the top seats and platforms were packed inside of the body, and the trucks packed separately.

The United Power & Transportation Company has recently purchased from this company a number of cars for the Oley Valley Railway, near Reading, Pa., which have many features of special interest, and which are also important as showing the general direction of progress in street railway car construction. The accompanying engravings show the exterior of a combined passenger and smoking car, and give an interior showing the arrangement of seats, curtains, head linings, etc. These cars are 40 ft. long over the end panels and 49 ft. over all. The platforms, each 4½ ft. long, are completely enclosed by vestibules. The roof is of the steam-car form, but built on street-car lines of construction. The side sheathing is vertical. The cars are 8 ft. 6 ins. wide, and are mounted on No. 27 trucks, with 6-ft. wheel base, the wheels being 33 ins. in diameter and having 2½-in. tread and ⅞-in. flange. The

INTERIOR OF OLEY VALLEY CAR

gage is the Pennsylvania standard for street railways—5 ft. 2½ ins. There are two truss rods, with the usual needle beams; in addition to this, the side sills are plated with steel plates. The car is divided into two compartments, the one for smokers being about 11½ ft. long. The partition between the two compartments is fitted with doors which swing into the smoking room. The sash are in two parts, the top being stationary and the lower one dropping into the side of the car. The seats are of spring cane, and are reversible in the passenger end, but longitudinal in the smoker end.

COMBINED PASSENGER AND BAGGAGE CAR, CHICAGO AND JOLIET

There are parcel racks in both the passenger and smoking compartments. Two trolleyboards are placed on each car, each set to one side of the center line. The inside trimmings are of bronze.

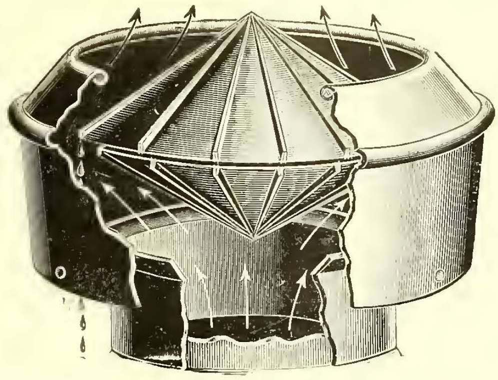
This road has been supplied with baggage cars similar to those sent to the Chicago & Joliet line, and illustrated herewith. The type of baggage car on the Chicago & Joliet road is of the same length, width and general outside design as the two-compartment cars just described, but has, instead of the smoking compartment, a baggage room, which, however, answers the purpose of a smoking compartment, since it is fitted with seats hinged against the walls, and can thus be used for both purposes. In these cars the baggage compartment is 12 ft. long. It is separated from the passenger end by a wooden partition having a single swinging door. There are 40-in. side doors and one window on each side of the baggage compartment. Both types of cars last described are finished with three-ply decorated birch veneer in the passenger compartment, with advertising moldings and cherry finish over the windows. Dedenda gongs, angle-iron bumpers, bronze trimmings and wooden grab handles are some of the leading features of the equipment.

"Poor's Manual" for 1901

The 1901 volume of this well-known book, judging from the advance sheets which have been recently issued, promises to be as valuable an acquisition to a railroad man's library as the previous editions. Among the interesting steam railroad statistics compiled are the following: The increase in the railroad mileage of the United States for the fiscal year of 1900 was 4160 miles. The total mileage was 191,861 miles, and the total revenue from traffic aggregated $1,501,695,378. Operating expenses were $1,018,447,852, and net earnings were $483,247,546. The total available revenue was $551,020,469, and from this sum there was deducted for interest, rentals, dividends and similar purposes $458,460,571, leaving a surplus over all charges and miscellaneous payments of $92,559,889. The total assets of all railroads were $12,768,910,837. The stock capitalization was $5,804,346,250, and the bonded indebtedness $5,758,592,754. The stock, bonds and unfunded debt, representing approximately cost of road and equipment, was $61,884 per mile. The average gross earnings per mile were $7,826, and net earnings $2,519. The average interest paid on the bonded debt was 4.24 per cent, and the dividends paid on the combined capitalization aggregated 2.42 per cent.

Correct Ventilation

One of the engineering difficulties encountered in the construction of power houses is their efficient ventilation. The Pancoast



AN EFFICIENT VENTILATOR

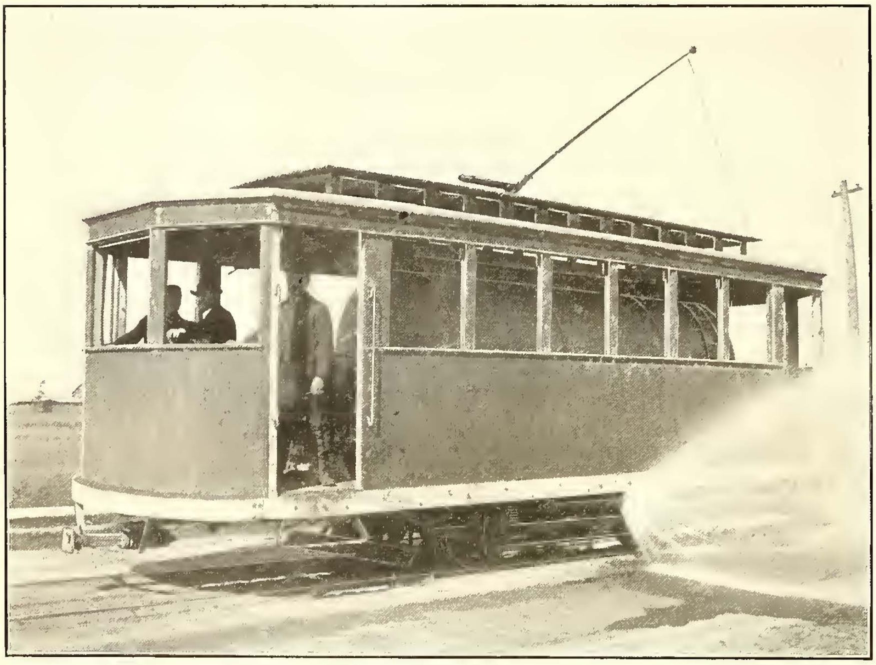
International Ventilator Company, of Philadelphia, is having great success with its improved development in ventilators for large buildings, and is making some important installations in some of our most extensive manufacturing plants and central stations. The accompanying engraving well illustrates the design of the Pancoast Company's apparatus, part of the metal being shown cut away so as to disclose the features upon which the ventilating principles depend. The requirements of a ventilator have long been understood, but the correct means of obtaining the desired result was not so readily ascertained. In the popularity of the ventilators made by the Pancoast Company, however, is found an attestation of the serviceability of this type in the ventilation of large buildings.

The ventilators are easily started by a wind velocity of 3.2 miles per hour, but as the wind gains in velocity the ventilating effect increases in far greater proportion. As will be seen by the illustration, a rain drip is provided at the side of the cone-shaped cylinder, which allows the water to escape between the outside shell and ventilating neck, perfectly protecting the interior of the building from moisture during the heaviest storms. The simple construction of the apparatus, although making it extremely durable, reduces the cost to such an extent that a most economical device, both in first cost and maintenance, is produced.

On November 1 the Chicago Boiler Cleaner Company, of Pittsburgh, Chicago and St. Louis, was succeeded by the "Liberty Manufacturing Company," with offices at the same places as heretofore. The new company will continue to manufacture cleaners, filters and other specialties under the same management, and with practically the same officers as formerly. This company's business has grown until it extends not only to nearly all the best firms in America, but to leading European manufacturers, and, in fact, to all parts of the world.

A New Sprinkler Car

The use of a tank with a sprinkling attachment for wetting down the streets and tracks of both city and suburban lines is coming into general practice on many roads. The accompanying engraving shows an electric railway track and street sprinkler car which has



IMPROVED SPRINKLER IN OPERATION

been recently perfected by the Studebaker Brothers Manufacturing Company, of South Bend, Ind. This car, as will be seen by the illustration, has to all outward appearances the resemblance to a large vestibuled baggage car, and it is equipped complete with motors, controllers, wiring and the necessary switches required in use. At the sides are two sprinkler heads, the stream from which can be adjusted. A system of levers at each end of the car gives the operator perfect control of this apparatus, enabling him to grade the amount of water in the spray from the finest mist necessary for sweeping purposes to a heavy stream for flushing the track or laying the dust. There are two rotary pumps, each piped direct to the sprinkler heads and driven by a separate motor, which take the water from the main tank and discharge it under pressure. A separate adjustment, easy of access to the operator, is used for flushing the track itself and sprinkling the right of way. Besides the uses enumerated, the sprinkler will be found convenient when it is desired to flush asphalt streets or similar pavements.

The company has aimed in building this machine to have a car and body suitable for all requirements, and, after many years of experience, has developed the one shown. The sprinkler heads used are fully covered by patents owned by the company, and contain many novel features. In some recent tests made on the Indiana Street Railway tracks, of South Bend, the street experimented on was sprinkled on each side of the track, the distance covered varying at the will of the operator from 15 ft. to 60 ft. The apparatus was at all times, even under the severest conditions, under perfect control of the operator, and the manufacturers were satisfied that its practicability was fully demonstrated. One of these sprinklers was also recently furnished for use at Colorado Springs.

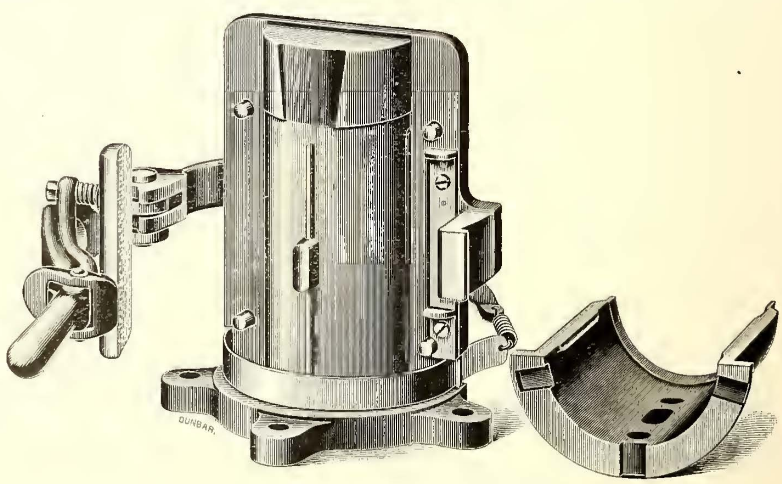
Tests on Conductivity of Streams of Water

Some very interesting experiments have been made recently at Milan, Italy, by Guido Semenza, in company with the Edison Illuminating Company of that city, to determine to what extent the employees of the fire department working in the proximity of trolley wires are exposed to danger. It is assumed that the current from a live wire touched by a stream of water would follow the water down to the nozzle held by the firemen. The experiments were conducted in the following manner:

A metal plate, insulated by means of a triple-petticoat porcelain insulator, was electrically connected with one pole of a source of electricity. The other pole was grounded. In the neighborhood of this "ground" stood a man holding a metal nozzle which was connected to a hose, which in turn led to a fire engine, and a stream of water was directed through the nozzle against the plate. In order to obtain a continuous stream of water, the water pressure was increased to 13 kg per square centimeter (185 lbs. per square inch). The man holding the nozzle wore a suit the lower portion of which was thoroughly drenched. The pressures used were from 2 to 500 volts direct and from 40 to 3600 volts alternating and 42 periods per second, and the pressures giving shocks were noted for each distance of the nozzle from the metal plate. In the case of the continuous current, in order to receive a shock with a pressure of 200 volts, the nozzle had to be brought up to within 12 mm (½ in.) of the metal plate, and in order to perceive the current at all the stream had to play on the metal plate uninterruptedly. When the pressure was increased to 500 volts the nozzle and plate had to be brought within 6 to 7 cm (24 to 28 ins.) of each other. The diameter of the stream of water was 12 mm (½ in.). When the diameter was increased the distance between nozzle and plate was also increased. For a diameter of 50 mm (2 ins.) and a pressure of 500 volts shocks were perceptible at a distance of about 1 m (39 ins.).

Using an alternating pressure of 40 volts, shocks could be perceived when the distance between the nozzle and the plate was about 25 mm (1 in.), the stream being 12 mm (½ in.) in diameter. For a pressure of 500 volts, the distance at which a sensation could be perceived was 19 cm (7½ ins.), and for 3600 volts about 3 m (10 ft.). Using the latter pressure, persons with average sensibility could hardly endure the pressure at a distance of 1 m (39 ins.).

Tests were then made with a stream 50 mm (2 ins.) in diameter. With this stream 500 volts alternating could be felt at a distance of 2½ m (8 ft. 2 ins.), and 3600 volts at 8 m (26 ft.). The latter pressure could hardly be endured at a distance of 4 m (13 ft.). It was also found that for the same distance the effect was more pronounced the less the velocity of the water. This is explained by the fact that then the stream is more solid. These experiments show that the danger with continuous currents is almost nil, while alternating currents are only dangerous at high pressures and for small distances.



BABBITTING MACHINE, OPEN

A Novel Babbitting Device

One of the new articles exhibited at the recent street railway convention was a device for babbitting the iron boxes, or shells, used for motor axle bearings. This device turns out the bearings complete, ready to be used, without the necessity of finishing them with machine work, and should be particularly useful on small roads having no lathes or boring mills, while on the large roads it should be as valuable, because of the increased output that may be obtained. It has been customary to cast bearings on arbors and in molds so as to fit any size axle, but owing to variations in flange sizes this part has never before been successfully cast completely finished.

The illustration shows the apparatus ready to receive the iron shell, which is set in and squared up to the gage on the right-hand side, and lifted until the flange touches the bottom of the gage. The handle of the device is then brought around and latched. This holds the shell firmly in place, while the flexible band at the bottom clasps tightly the outer edge of the flange. A gate is then set on the top of the iron shell, and all is ready for the reception of the molten metal. As soon as the metal sets the handle is unlatched and pulled toward the operator. This automatically throws the babbitted shell off the arbor, and the operation is completed. There is a tendency sometimes noticed for bearings cast on arbors to cling to the arbors in cooling, and it is sometimes necessary to use hammers and cold chisels to free them. This trouble is claimed to be entirely overcome in this machine.

The device particularly appealed to the practical men on account of the quickness and ease with which it could be operated, and the fact that there is no waste of metal. It is known as the Weld babbitting device, is manufactured under letters patent, and was exhibited by the Frank Ridlon Company, of Boston, Mass.

Metropolitan Power House at Kansas City

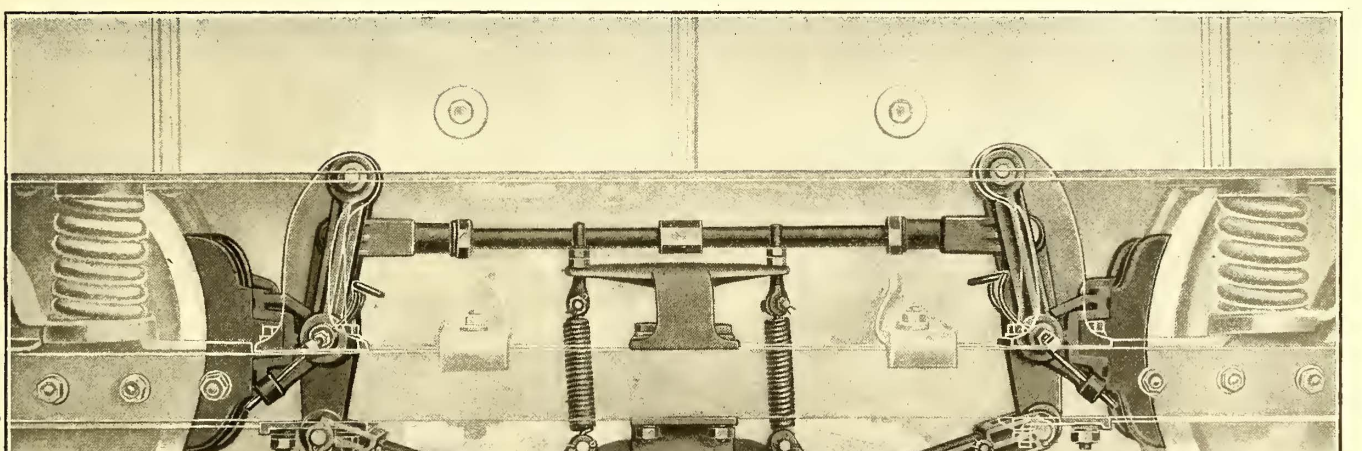
Some months ago it was noted in these columns that the Metropolitan Street Railway, of Kansas City, was to build a large alternating-current power house. While the location for this power house has not as yet been selected, the apparatus has been contracted for under the supervision of Pierce, Richardson & Neiler, consulting engineers, and Charles Grover, electrician. The engines to be used in this plant are the largest single engines yet contracted for. The units in the Manhattan elevated power house at New York will be considerably larger, but those units consist of double engines. The engines for the Metropolitan Street Railway, of Kansas City, will be vertical cross-compound, condensing, made by the Allis-Chalmers Company, and similar to those in the Metropolitan Street Railway Ninety-Sixth Street power house at New York. The cylinder dimensions for the new engines, however, will be larger. The high-pressure cylinders are to be 46 ins., the low-pressure 96 ins., and the stroke 60 ins. At 75 r. p. m. and 175 lbs. steam pressure these engines are rated at 5200 hp. They differ mainly from the Metropolitan power house in New York by the use of low-pressure cylinder 94 ins. in diameter instead of one 86 ins. diameter. It is believed by the engineers in charge of this installation that this higher piston area in the low-pressure cylinder in proportion to that in the high-pressure cylinder is desirable. They point to the fact that since the load on such large units is nearly constant there is not the necessity for allowing for fluctuation of loads that there would be on smaller units, and that the use of a small low-pressure cylinder for such large railway units is a relic of conservatism borrowed from the days of small units and violent fluctuation of loads. Three engines of the previously given dimensions have been contracted for, and the power house will be laid out to contain three more. The generators will be 3500-kw, 25-cycle, three-phase, 6600-volt, furnished by the General Electric Company.

It is expected that the Metropolitan Street Railway Company will exchange current with the Kansas City Electric Light Company, which is controlled by the same stockholders and is now building a station on the Kaw River, almost opposite the Metropolitan Riverside plant. The Metropolitan Street Railway has also contracted for eighteen Babcock & Wilcox water-tube boilers of 500 hp each and Green Engineering Company's traveling link grates to go under them.

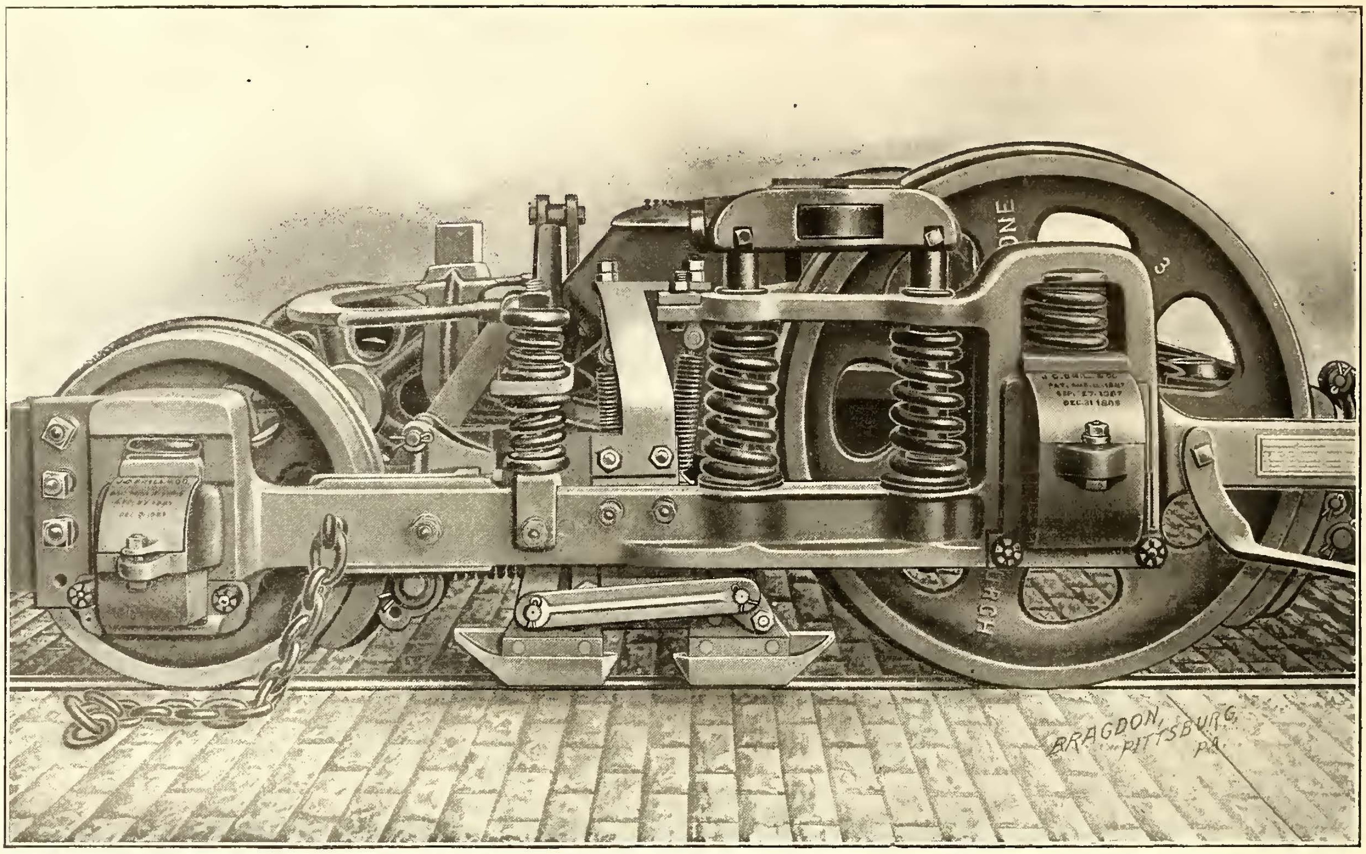
The capacity of the Metropolitan Street Railway Company's present direct-current Riverside plant, about which mention has frequently been made in these columns, is being taxed to handle the present load, and two rotary converters will be put in one of the company's old cable plants and run as generators the coming winter from the cable engines. When the new alternating-current power house is built these rotaries will, of course, be put in service in one of the sub-stations.

Some Improvements in the Newell Magnetic Brake

The Standard Traction Company, of New York, has recently announced that a few slight improvements have been made in the Newell magnetic track and wheel brake, which was described in these pages a few months ago. The accompanying illustrations show on a large scale the details of the device as applied to single trucks and maximum traction trucks. The latest form of brake differs but slightly from that previously described, the making of several minor changes having been thought advisable. One of these is the introduction of a ball and socket joint at the end of the link connecting the track-shoe with the wheel-shoe lever giving a desirable addition to the flexibility of this connection. The support



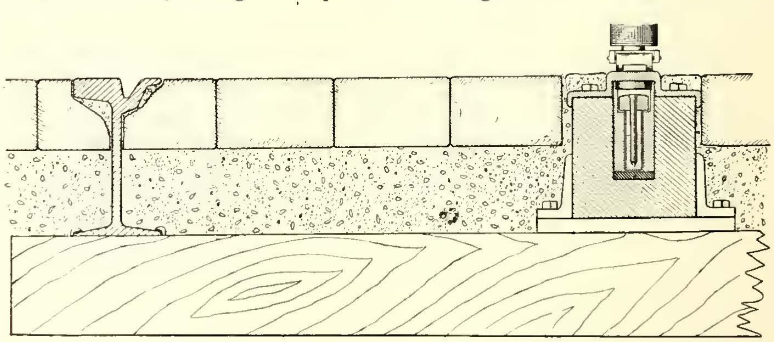
MAGNETIC BRAKE. TRANSPARENT VIEW, SHOWING METHOD OF ATTACHING BRAKE TO CAR FRAME AND TRUCKS for the springs from which the track-shoes are suspended has been lowered so that the bolts at the top of these springs are entirely independent and slightly removed from the side sill of the car. The track-shoe has been improved somewhat in design and greatly strengthened thereby, the yoke being so made at present as to more evenly distribute the strains coming upon it. In the brake, as applied to maximum traction trucks, the compactness of the apparatus is shown in the engraving. The circuits have been left as formerly, the electrical part of the apparatus being unchanged by the slight mechanical improvements mentioned above. The exhibit of the brake in operation, with the accompanying heaters in the car, which are a feature of the system, in conjunction with the Westinghouse Electric & Manufacturing Company's exhibit at the recent convention of the American Street Railway Association, attracted more attention from the delegates than has been given to any individual exhibit for some years. The novelty of the device itself and the combination of a magnetic brake and heater which use only the energy of momentum contained in the car for operation appealed as strongly to the engineers of power stations as to the superintendents of rolling stock and equipment. In the improvements described and illustrated above some few mechanical objections have been overcome, and the Standard Traction Brake Company feels confident that in its system as it is now manufactured both mechanical and electrical perfection have been closely approached.



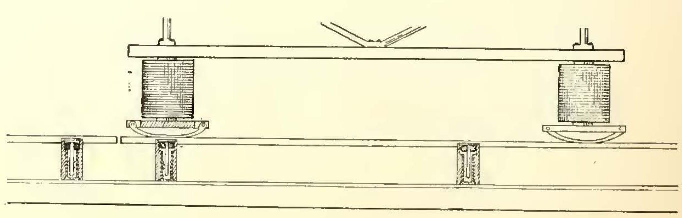
MAGNETIC BRAKE APPLIED TO MAXIMUM TRACTION TRUCK

A New Type of Surface Contact System

The accompanying engravings show the details of an ingenious system of electric traction, which is the invention of L. M. Maxham. The inventor has endeavored to improve on the numerous plans of the many engineers who have attacked this problem, and has incorporated in this system several interesting features. The main principle is to have a centrally, or otherwise, located third rail, midway between the traction rails, sectionalized in lengths of about 10 ft. This rail is normally disconnected from the feeder circuits, but whenever a car is over it the section immediately below is electrically connected with the feeder system. The means by which this is accomplished is shown in the cross section of the device. Attached to the bottom of the car by a spring suspension are a pair of strong electromagnets, which are energized by a small amount of current. Under the rail, about every three or four feet, are placed the small circuit closers, of which a cross section is shown. These circuit closers consist of a deep cup made of copper or aluminum containing mercury, in which rests an aluminum or copper pin having an iron head. When the magnet is above one of the sections of the third rail, which is of iron, it magnetizes this rail and causes it to attract the iron heads of the pins in the circuit closers, raising them up and connecting the bottom of the rail to the mercury in the cup. The cup is placed in a porcelain receptacle, but is directly connected to the feeder system, represented in the engravings as a rectangular bar running along below the series of cups, and the third rail is therefore made alive. In order that no sticking of the plunger may occur either from residual magnetism or from the fusing of the iron head to the bottom of the rail, a piece of carbon is introduced, against which the plunger impinges, and in this way, although good electrical contact can be made, there is no



CROSS SECTION, SHOWING CIRCUIT CLOSING DEVICE



LONGITUDINAL SECTION OF THIRD RAIL

danger of the rail remaining alive after passing over it. The stringer which supports the rail, and which forms the insulation for the feeder running under the cups, is made of some insulating material, such as reconstructed granite, which not only forms a firm support, but thoroughly isolates the electrical system. A form of shoe which can be used for collecting the current is shown in the illustrations, but, of course, this may be modified to suit the requirements of local engineers.

The height of the top of the third rail above the bottom of the stringer is less than that of a 9-in. girder-rail, so that the system can be installed on a road without cutting or interfering with the roadbed. As only the section under the car is alive, there is no appreciable loss from leakage, no matter what the conditions of the pavement may be. In order that all danger from leaving a section alive may be obviated, a brush is provided at the end of the car, which is grounded to the axle, so that should a section be alive when it is reached by this brush, a short-circuit is produced between the third rail and the traction rails, and the circuit breaker on that division is opened immediately, cutting out the dangerous portion. This, of course, is very unlikely to occur, however, for as soon as the magnetic influence on the third rail has ceased the plungers immediately return to their lower position. A single cell of storage battery is placed on the car in order to energize the first section of rail, but after the car is once started a small amount of current is taken from the working current to operate the plungers.

One of the engravings shows the device on a car traveling from one section to another, the section about to be left having all of its plungers in contact with the third rail, while that about to be entered is shown with the plungers in their normal condition. The new system is being put upon the market by the Bay State Traction Company, of New York, of which L. M. Maxham is the president and F. W. Toppan the secretary and treasurer.

The Bay State Traction Company, besides promoting the above-described ingenious device, is also entering the electric railway construction field in all its branches. In the personnel of the firm there are found both engineering and commercial ability, so that contracts of any magnitude can be accepted.

New Publications

The High-Speed Car of the Allgemeine Elektricitäts Gesellschaft. 40 pages. Illustrated. Published by the Allgemeine Elektricitäts Gesellschaft.

This is a full description of the three-phase car built for the experimental Berlin-Zossen line, and is the paper presented by O. Lasche, of the Allgemeine Company, before the International Engineering Congress, of Glasgow. Some particulars of this car were published in our issue of September.

Electrical Engineering Formulæ. By W. Geipel, M. I. E. E., and M. Hamilton Kilgour, A. M. I. C. E., M. I. E. E., M. I. M. E., etc. 844 pages. Price, $3. Published by "The Electrician" Printing & Publishing Company, Limited, London. (D. Van Nostrand Company, New York.)

This is a new and enlarged edition of Geipel and Kilgour's pocket book. The authors have been highly gratified by the demand for this book, but their successful compilation of the most important facts and figures relating to heavy electrical engineering has received no more success than it deserved. The section devoted to electric traction has been considerably increased in size and brought up to date, giving as large an amount of valuable information as a book of this character can be expected to contain. Many of the numerous tables have been recalculated, and such corrections as have been suggested by users of the first edition have been made, so that the book is increased both in reliability and usefulness.

Report of an Investigation on the Electrolysis of Water-Pipe Systems. By Edwin A. Fisher, City Engineer of Rochester. 88 pages, with numerous diagrams.

In this report, which has recently been rendered to the Commissioner of Public Works of Rochester, Mr. Fisher includes not only the results of his own investigation of the subject, but two reports by Stone & Webster on the conditions as they exist in that city, as well as a brief compendium of the experience in other cities on this subject. This latter is made up of reports made directly to the author, as well as extracts from and abstracts of articles which have been published on the subject in various technical papers. Mr. Fisher believes that the steps now being taken by the company in his city, particularly that of electrically welding its rails, will ameliorate the situation. He states that while the quantity of current discovered in the mains of Rochester is not of such magnitude as has been found in some other cities, it is large enough to demand a better condition of the railway returns than existed at the time the measurements were made. He advocates track construction, where possible, on concrete foundations, for the purpose of securing insulation between the rail and the subsurface pipes, and the draining of the subgrade by the use of clean gravel or broken-stone ballast. He also suggests the removal, as far as possible, of all hydrants, stop gates and other fixtures connected with the water-pipe system, as far as possible from the rail, and where it is impossible to remove them to a proper distance, to encase them in vitrified tile or other conducting material. He also believes it desirable wherever practicable, especially in wide streets, to have a separate water pipe laid on each side of the street, and thus avoid the crossing under the tracks of service pipes.

J. L. Greatsinger

One of the new faces at the convention of the American Street Railway Association this year was that of President J. L. Greatsinger, of the Brooklyn Heights Railroad Company. Although a street railway man for scarcely six months, Mr. Greatsinger has become well known in the field on account of being the executive head of one of the most important traction organizations in the country, and it was with a great amount of pleasure that the delegates greeted this recent addition to the street railway forces. During his half-year of presidency Mr. Greatsinger has ably carried out the plans of reorganization which had been formulated for the development of the mechanical side of his road, and has

J. L. GREATSINGER

so familiarized himself with the various conditions, obstacles and limitations which are inherent to the operation of his system that he now stands among the prominent railway presidents of the country upon an equal footing. Having for many years been noted for his ability to handle men, gaining their confidence and esteem, his influence has already become felt throughout the entire system, and both rank and file of the Brooklyn Heights Railroad Company are placing that confidence in their president which is so important in the elimination of factional and other disagreements and disturbances. In commenting on the article by President Greatsinger in the Street Railway Journal for Oct. 5, in which he brought out some of the problems that he is solving, the *Brooklyn Eagle* speaks editorially as follows: "The whole paper shows that the situation is in the grip of a railroad man who appreciates the size of the problem. It shows that long foresight has been used to meet conditions before they arise, so that when the demand comes upon a particular line from the opening of a new bridge or a change of connections, the preparation shall have been made to meet it so far as possible. * * * Railroading for a town placed as Brooklyn is, is a tremendous job, but Mr. Greatsinger's article shows that he appreciates the difficulties long before the public who grumble about the service dream of their existence." The cordial geniality with which he made the acquaintance and obtained the friendship of a large number of the recent visitors to New York will be remembered by them all, and they will be pleased to learn, therefore, that in the city which he has recently adopted as his home his efforts in perfecting a railway system which presents almost innumerable obstacles are being appreciated.

NEWS OF THE WEEK

The Scranton Strike

The employees of the Scranton Railway Company, of Scranton, Pa., went on strike Oct. 1, and up to Oct. 27 no settlement had been reached and much damage had been done. The difficulty between the company and its employees is said to have resulted from the discharge of two dishonest conductors, and when demands for the reinstatement of the discharged men were made the company agreed to arbitrate the matter, in the hope of avoiding a strike. Reinstatement was the demand of the employees, not arbitration, however, and as a result the men went on strike.

First Meeting of the Everett-Moore Managers' Association

The recently organized Everett-Moore Managers' Association met in Toledo a few days ago as the guests of General Manager L. E. Beilstein, of the Toledo Railways & Light Company. Among those present were: Charles Wason, president of the Cleveland, Painesville & Eastern Railway, and purchasing agent for the syndicate properties; A. E. Lang, president of Toledo Railways & Light Company; Charles Currie, general manager Northern Ohio Traction Company; C. A. Carr, general manager London (Ontario) Street Railway; I. A. McCormack, general manager Cleveland Electric Railway; E. J. Bechtel, superintendent Toledo Railways & Light Company; Joseph Jorden, general sperintendent Cleveland, Painesville & Eastern Railway; A. H. Stanley, superintendent Detroit Citizens' Railway; F. W. Brooks, manager Rapid Railway System. Plans for the adoption of certain types of interurban and city cars as standard were discussed, and such cars will be designed to be used on all the various city and interurban roads owned by the syndicate, thereby making it possible to buy in quantities and reducing the cost of maintenance. It is probable that yellow, as used on the Cleveland cars, will be adopted as a standard for all city cars owned by the syndicate.

The New York & Port Chester Railroad

The hearing on the application of the New York & Port Chester Railroad Company for permission to construct an electric railway through the upper Bronx and Westchester County, connecting Port Chester, which is on the Connecticut State line and about 25 miles from the City Hall, New York, with intermediate points, and joining the Rapid Transit Tunnel at 177th Street, in the Bronx, will be resumed by the Railroad Commissioners Nov. 11. The plan of the company is to build a four-track third-rail system, and as the territory to be served by the new route is now reached by existing steam lines, the application of the company is being bitterly opposed by these interests. The New York, New Haven & Hartford Railroad Company has been foremost in opposing the application of the company, and has displayed the usual alacrity in its efforts to choke at the outset a proposition that gives every indication of successfully competing with it. The original application of the company for permission to construct the road was made in July last, but for technical reasons the hearing by the Railroad Commissioners was delayed until Sept. 30. The hearing continued for one week, and during that time the officers of the company were continuously plied with questions regarding the company's plans. Among those who testified before the Railroad Commissioners were Chief Engineer William Barclay Parsons, of the Rapid Transit Commission, and John B. McDonald, the contractor for the Rapid Transit Tunnel. The identity of the interests behind the company is what the opposition is desirous of having disclosed, but its efforts were frustrated at the meeting. That the company has not the requisite financial backing is questioned only by the opposition. The plan for the construction of this new line is certainly a gigantic one, and it is not difficult to see why the New York, New Haven & Hartford is particularly solicitous regarding the new road. Connecting, as it will, with the New York Rapid Transit Tunnel, and extending through Mount Vernon, Pelham, New Rochelle, Larchmont, Mamaroneck, Rye Neck, Rye and Port Chester, the new line will enter a territory heretofore served almost exclusively by the New York, New Haven & Hartford Railroad.

Illinois Tax Decision

One of the most important decisions handed down for some time by the Supreme Court of Illinois was that filed Oct. 24 at Springfield. The decision is, in brief, that the capital stock and bonds of corporations in Illinois must be assessed at their market value. Heretofore it has been customary in that State to assess corporations on the value of the real tangible property owned by them. This, of course, left out of account the value of the franchises under which public corporations operate. The recent decision makes it necessary to assess companies on the basis of the market value of their stocks and bonds. The decision is one, of course, which will make a great difference in the assessment of most of the larger public service companies operating under franchises in the city of Chicago, and will add much to the revenue of the city of Chicago. The decision had a depressing influence on the stock of some of the large Chicago companies, including Chicago Union Traction. While the inherent justice of such a decision can hardly be questioned, it is to be regretted that matters should have taken such a course. It would have been better had assessments been made on this basis always, rather than to have the assessments suddenly raised after years of assessment on a lower basis. The disturbing effect that such an increase in taxation has on the earning power and consequent stock values of many corporations cannot be otherwise than bad, and is in the nature of a hardship to many investors who purchased the securities in good faith.

Mayor Harrison and the Chicago Street Railway

Mayor Harrison, of Chicago, is said to have flatly declared that the city of Chicago must have the right of assuming ownership and control of its street railway before the franchise question will be settled, and the following statement of the Mayor, if he has been quoted correctly, is typical of the officeholder or officeseeker who feels that his strength lies in severely arraigning all corporations, especially the street railways: "I will not even consider the settlement of the extension question until the traction corporations waive all claims to rights under the ninety-nine-year act. The traction question will not be settled until the Legislature gives the city the right to own the street railway systems. If undue influence were not used with members of the Legislature, the municipal ownership bill would find an easy passage in the General Assembly. It is this so-called undue influence which prevents not only legislators, but aldermen, from being on the side of the people. This same undue influence is responsible for our legislators not voting right. The people want municipal ownership, and they have a right to secure it. It is impossible to settle the franchise question until the powers of the city have been enlarged. We would get the authority to control and own our car lines if the street railway companies were not fighting the proposition. Municipal ownership is the ultimate settlement of all questions of public utilities. It is the greatest step toward pure city government. It removes the power of so-called 'graft.' It means an honest government."

The Reading Sunday Persecution

Reference has already been made in these columns to the decision given Oct. 19 by Judge Endlich in what has popularly been known as the Reading Sunday case. So much interest has been felt in this decision that it is published in full below. It will be remembered that the attempt was made to enforce against the United Traction Company, of Reading, an old blue law against work on Sunday, the prosecution being instigated not primarily to stop the operation of the cars on Sunday, but avowedly as an attack for ulterior reasons against the railway company.

OPINION

On Oct. 14, 1901, informations were laid before a magistrate of the city of Reading against seventy motormen and conductors of the United Traction Company, a corporation of this State conducting the business of operating street cars in the city of Reading. In these informations the defendants were charged with violation of section 1 of the Act of 1794, 3 Smith Laws, 177, in working the company's cars on Sunday, Oct. 13, 1901, between the hours of 5 a. m. and 12 p. m. in the city of Reading. The object of these prosecutions, as frankly stated by counsel for the prosecutors, was not to stop the running of cars on Sunday, but to punish the defendants for their participation in the operation of the street car line. The defendants were admitted to bail, but on Oct. 18, 1901, the sureties for four of them—William H. Baum, Clarence Brown, Hiester Obold and William Gottshall—without the knowledge of those parties, threw up their bail, took out a bail-piece, and these defendants were committed; thereupon on the same day they applied for writs of habeas corpus, which were issued, the hearing being fixed for Oct. 19, 1901, at 10 o'clock a. m. In the meanwhile the hearing before the magistrate had been appointed for 2 o'clock in the afternoon of Oct. 18, 1901. At the time appointed the relators did not personally appear before the magistrate, neither did any of the other defendants, but there was an appearance by counsel, which was misunderstood by the magistrate as being an appearance for the relators as well as for the remaining sixty-six defendants. The magistrate, who had notice of the pendency of the four writs of habeas corpus and of the time fixed for the hearing of them, under this misapprehension proceeded to hear testimony as to all of the defendants, the inclusion in their number of the relators having apparently passed unnoticed by their counsel, who also represented the remaining sixty-six, and on the evening of Oct. 18 the magistrate rendered judgment against the entire number of defendants. In the absence of any distinct, actual and voluntary submission by the relators to the jurisdiction of the magistrate, the proceedings, so far as they are concerned, were clearly irregular, and do not stand in the way of a disposition of these writs now. In that disposition the controlling question is whether the act charged against the relators is a violation of section 1 of the Act of 1794, or whether it comes within the exception made by that act as to works of necessity.

On that question there is no decision pointed out conclusively determining it one way or the other. The case most closely touching it is that of Sparhawk *v.* Pass. Ry. Co., 54 Pa. 401. In that case, however, the court was passing upon the question whether private property owners alleging that the operation on Sunday of street cars in the streets upon which their properties fronted had a standing to complain of it as constituting such a nuisance as entitled them to ask for an injunction restraining their operation, and the Act of 1794 was brought into the case only incidentally as bearing upon that question, because of its supposed effect in rendering the operation of the cars on Sunday unlawful. The decision of the Supreme Court was that the running of cars as complained of did not constitute such a nuisance as gave the plaintiffs a standing to ask for the injunction prayed for, and that, granting the unlawfulness of the business under the Act of 1794, that circumstance did not aid their complaint. The decision, therefore, cannot be understood as involving an adjudication of the question whether the operation of street cars upon Sunday is a violation of the Act of 1794 or not; and the expressions of opinion on that question by the various justices who delivered opinions in that case do not appear to be controlling. In the case of Com. *v.* Matthews, 152 Pa. 166, it is said by the Supreme Court, at page 169:

"The Act of 1794 is a wise and beneficial statute, and we would regret to see it interfered with. We must, however, be allowed to express the fear that too literal an interpretation and enforcement of it may create an antagonism that may lead to its repeal, or at least, serious modification. There may be such a thing as excessive zeal in invoking its penalties in extreme cases. The act is in more danger from its friends than from its enemies."

Looking at the statute in the light of this authoritative declaration, it is evident that the question whether a given act is a work of necessity or not depends not upon conditions and situations as they existed in 1794 or fifty or thirty-five years ago, but upon conditions as they presently exist. What was deemed a necessity generations ago may not be looked upon as a necessity to-day; and what was not thought of even as a convenience no more than a generation ago may very well be, and is in some instances, a necessity to-day. The universal usage of the present time is valuable testimony upon the question whether a thing is presently a necessity or not; and the most enlightened opinion, based upon conditions as they existed thirty-five or fifty years ago, is not at all conclusive of that question to-day. Having regard to conditions as we know them to be at the present time, the necessities of the people of a large city, the necessities of persons residing in the suburbs, and so many other obvious considerations that it would be a waste of time to enumerate them, I am of the opinion, and so decide, that the running of street cars on Sunday is not a violation of the Act of 1794; and for that reason, it being apparent from the information and commitment that these relators were arrested and committed for no offense, they will now be discharged, and the costs of these writs of habeas corpus will be imposed upon the prosecutors.

Injunction Against Pickets

Judge C. C. Kohlsaat, of the United States Circuit Court at Chicago, last week issued a permanent injunction which is of considerable interest to all who may be so unfortunate as to be connected with a strike. The injunction was issued to prevent the picketing or patrolling of the streets, alleys or approaches to the premises of the Allis-Chalmers Company's plants by the striking employees. This injunction was, of course, served against each striker individually. The main provisions of the injunction are as follows:

That the defendants and each of them, and all other persons associated, combined or confederated with said several lodges or unions, or with said individual defendants above named, or either of them, and all persons heretofore, now, or hereafter aiding, co-operating or combining, or acting in concert with said defendants, or either of them, in committing the acts and grievances complained of in said bill of complaint, be, and they and each of them are hereby ordered and commanded to desist and refrain, and are hereby enjoined from in any manner by violence or threats of violence interfering with, hindering, obstructing or stopping any of the business of the complainant, the Allis-Chalmers Company, or its agents, servants or employees, in the operation of its several plants or factories in the City of Chicago, Ill., or elsewhere, to wit: The Fraser & Chalmers and Gates Iron Works plants, and from entering upon the grounds or premises of the complainant against its wish, for the unlawful purpose of interfering with, hindering or obstructing its business in any form or manner, and from compelling or inducing, or attempting to compel or induce, by threats or intimidation of any sort, or by force or violence, any persons to leave the employment of said complainant, or not to enter its employ if desirous of so doing, and from doing any unlawful act or thing whatsoever by any of the means or methods aforesaid in the furtherance of any combination or conspiracy or purpose to hinder, interfere with, or prevent the complainant, its officers and employees, in the free and unhindered conduct and control of said company's business, and from ordering, directing, aiding, assisting or abetting, in any manner, any person or persons to commit any or either of the acts aforesaid.

And the said defendants and each and all of them, and all persons heretofore, now or hereafter associated, combined or confederated with them, or either of them, now or hereafter, are ordered to desist, and are hereby enjoined from congregating at or near the aforesaid respective plants or factories of the complainant, the Allis-Chalmers Company, to wit: The Fraser & Chalmers plant and the Gates Iron Works plants, with the purpose or in such manner as to intimidate, or obstruct, surround or impede, or in any manner calculated to intimidate, or for that purpose, any of the employees of the complainant, or any person or persons seeking employment from it, in going to, remaining at or coming from the aforesaid respective premises of the complainant; and each and all of said defendants, and all persons heretofore, now or hereafter associated, are enjoined from in any manner interfering with or molesting any person or persons who may be employed by or who may seek employment from said complainant in the operation of its said business by an act of violence or any act calculated to intimidate such persons, and from in any manner interfering with the complainant in carrying on its business in said respective plants or factories in the usual and ordinary way by and in the manner aforesaid.

And the said several lodges of the International Association of Machinists, the officers and members thereof, and the said several local unions of the Iron Molders' Union of North America, the officers and members thereof, and the said individual defendants above named, and all persons heretofore, now or hereafter associated, combined or confederated with them, or either of them, are, and each of them is hereby restrained, enjoined and forbidden, either singly or in combination with others, from picketing, guarding, obstructing, impeding, besetting or patrolling the streets, alleys or approaches to the aforesaid several premises of said complainant or ordering the same to be done, for the purpose, or in such manner as to intimidate, coerce, or by any act or language tending to intimidate, or induce any other employee of the complainant from remaining or continuing in such employment, or for the purpose, or in such manner as to intimidate, coerce or induce any person seeking employment of complainant from entering such employment, and from intimidating, molesting or interfering by either of the means aforesaid with the employees of said complainant in going to and from their daily work at either of said plants of the complainant, and from interfering by either of the means aforesaid with any such persons anywhere because of such persons being in the employ of the complainant or because of their seeking such employment.

And said several lodges of the International Association of Machinists, the officers and members thereof, and the said several local unions of the Iron Molders' Union of North America, the officers and members thereof, and the said individual defendants above named, and all persons heretofore, now or hereafter associated, combined or confederated with them, or either of them, are, and each of them is, enjoined and restrained from going or directing anyone to go, either singly or collectively, to the homes, boarding-houses or places of habitation of employees of complainant, or any of them, or of persons seeking employment, for the purpose of intimidating or coercing any or all of them to leave the employment of complainant, or from entering complainant's employment, and as well from intimidating or threatening in any manner the relatives, wives and families of said employees, at their said homes, boarding-houses or elsewhere.

The attorney for the strikers has asked for an appeal. While it is possible that the strike will be practically at an end before the Court of Appeals passes on the points in dispute, still the decision is expected to be of value as a precedent in similar cases.

ENGINEERING SOCIETIES

THE BROOKLYN ENGINEERS' CLUB.—An informal meeting of the club was held on the evening of Oct. 24, and the subject of the electrical operation of the Brooklyn elevated railroads was discussed. The subject was introduced by C. B. Martin, of the Brooklyn Heights Railroad Company, who described the various multiple-unit systems of control now used by his company in the electrical operation of elevated trains, including the Sprague, General Electric and Westinghouse systems. Mr. Martin illustrated his remarks by the aid of portions of the apparatus, which were exhibited, and numerous diagrams and curves.

PERSONAL MENTION

MR. H. K. SURBECK has been appointed passenger agent for the Lake Shore Electric Railway. His territory will extend from Sandusky to Toledo.

MR. FRANK DALLETT, of Philadelphia, was in New York last week, and completed the purchase of a large quantity of steel rails, which the company will place upon the market at once.

PROFESSOR GUSTAV GILLON, of the University of Lourain, Belgium, who has been in America for the last three months on behalf of the Belgian Government for the purpose of inquiring into our latest methods of electric railway construction, has sailed for Europe.

MR. EDWARD WHITAKER, formerly president of the St. Louis Transit Company, has returned from Europe, where he has been for some time on a pleasure and business trip. Mr. Whitaker visited St. Petersburg while in Europe, and it is said that he is interested in the plans of the Pittsburgh syndicate that proposes to establish electric railway lines in the Russian capital.

NEWS NOTES

SAN FRANCISCO, CAL.—An ordinance has been introduced in Council to compel the companies operating street cars within the city to grant a 3-cent fare.

INDIANAPOLIS, IND.—During the fall carnival held in this city last week the interurban lines demonstrated their ability to provide transportation for a large number of passengers, thus relieving the steam roads of much traffic. Special schedules were maintained on all lines.

INDIANAPOLIS, IND.—The new city administration is taking steps to settle the status of the interurban lines entering the city. The old board and the companies twice agreed on franchises, but the Council rejected their terms. It is now proposed to allow the interurban cars to charge a 5-cent fare on outgoing cars to discourage city traffic, which crowds these cars to the discomfort of the interurban passengers.

CHICAGO, ILL.—George F. Harding, Jr., who came prominently before the public recently with a proposition to buy the street railways when their franchises expire in 1903, has taken legal steps to compel the city to sell the railways at the expiration of the franchises to the highest bidder for cash. Mr. Harding has filed a petition for an injunction in the Superior Court to restrain the city from adopting ordinances or resolutions extending the franchises of the street railway corporations and to prevent it from selling or letting the franchises, at their expiration, to anyone except the highest cash bidder.

NEW ORLEANS, LA.—The conductors, motormen and other employees of the New Orleans & Carrollton Railroad Company, which operates about one-third of the street cars in New Orleans, went on strike Oct. 27, to compel the company to reinstate a motorman who had been discharged. The entire system of the road is tied up.

GREENFIELD, MASS.—The annual meeting of the Greenfield & Turner's Falls Street Railway Company was held here a few days ago. It was voted to increase the number of directors from seven to nine, and the following were elected: Major Fred. E. Pierce, Joseph W. Stevens, N. S. Cutler, Albert T. Hall and C. W. Clapp, of Greenfield; D. P. Abercrombie and D. P. Abercrombie, Jr., of Turner's Falls; Isaac Chenery, of Montague, and John A. Taggert, of Miller's Falls. Two semi-annual dividends of 2 per cent were paid.

ST. LOUIS, MO.—The City Counselor holds that the St. Louis Transit Company has no right to place poles and string wires on Pine Street east of Twenty-Second Street. This brings before the court for settlement a controversy between the company, owners of the Central Traction franchise, and the Board of Public Improvements. The company claims the right to construct a trolley system on Pine Street, on the ground that such a right is conferred by the consolidation law giving the company the right to use the overhead trolley system on all lines which it owns or might own.

NEW YORK, N. Y.—The Philadelphia News Bureau says: One of the lawyers who is prominently identified with the franchise tax case at Albany gives us the following: "I am positive that a final decision will not be reached in the franchise tax case before the early spring. A mass of testimony must be gone over, and then the question must be considered first, by the referee, second by the Court of Special Terms, and third by the Court of Appeals. I feel certain that it will ultimately be determined to grant a substantial reduction in the franchise tax."

SCRANTON, PA.—Rioting in the street car strike was reported here until Oct. 27, where several serious outbreaks occurred.

SEATTLE, WASH.—J. P. Morgan, on his return trip from San Francisco, accepted an invitation to look about the city on an observation car furnished by General Manager Dickinson, of the Seattle Electric Company.

CONSTRUCTION NOTES

BIRMINGHAM, ALA.—The Birmingham Railway, Light & Power Company has withdrawn its application for a franchise of over seventy-six blocks of the city's streets, because of the decision on the part of the Council to limit the grant to thirty years. The company made the offer for the franchise some time since, depositing $7,600, the stipulated charge of $100 a block. The company asks for the franchise in perpetuity, announcing its determination to spend $2,000,000 in improvements as soon as the matter is settled. The officers allege that this amount of money is too much to spend on so limited a contract. Citizens owning property along the lines, established and projected, have joined in a petition to the Aldermen to grant a franchise of at least ninety-nine years.

LITTLE ROCK, ARK.—The Little Rock Traction & Electric Company will build 3½ miles of new line.

LOS ANGELES, CAL.—The Los Angeles & Pasadena Electric Railway Company has begun the construction of its Alhambra and San Gabriel extension.

BENICIA, CAL.—An ordinance has been passed granting J. W. Hartzell a franchise for the construction of an electric railway here.

CHICAGO, ILL.—E. W. Farnham, superintendent of car service of the Chicago, Burlington & Quincy Railroad at Chicago, has denied to a representative of the STREET RAILWAY JOURNAL the newspaper story to the effect that his company is about to operate its suburban service at Chicago electrically, using a third-rail system of Mr. Farnham's invention, or any other electrical system. A number of engineers and others interested have been invited to witness a demonstration of Mr. Farnham's third-rail system, which is termed "the electric traction power feeder," at the Burlington yards at Clyde, west of Chicago, on Saturday, Nov. 2.

KOKOMO, IND.—The Union Traction Company has applied to the City Council for a franchise to build an electric railway from Indianapolis to Kokomo via Noblesville and Tipton. The Tipton Council has granted the company a franchise through that place, and Mr. McCullough hopes to have a complete right of way in a short time and begin building the road early in the spring.

LOGANSPORT, IND.—The Cass County Surety & Investment Company has been organized to do a general bond and stock sale business, but its principal purpose is to deal in the securities of electric railways. The company will incorporate with G. W. Seybold as president.

FRANKFORT, IND.—The Frankfort & Indianapolis Electric Railway Company has been organized to construct an electric railway from Frankfort to Indianapolis. The company was organized by local men, and $13,000 of stock has been subscribed.

DES MOINES, IA.—Material for the construction of the new electric lines for the interurban company between Des Moines and Nevada and Des Moines and Colfax is being unloaded along the Northwestern & Great Western tracks, where they will be crossed by the new lines. Material enough to construct the line from Flint Valley to the railroad tracks has been unloaded on the company's grounds in East Des Moines, but this is so crowded now that more material cannot be put there. It is the intention of the company to hold most of this material for use in the construction of the Indianola line, and to divert all material arriving in the future to a supply yard to be established north of the city, where it will be close to the Flint Valley line. All of the engineering work will be carried on this fall, so that everything will be in readiness for rapid construction work in the spring. The work of securing the right of way along the various lines will also be pushed during the winter months.