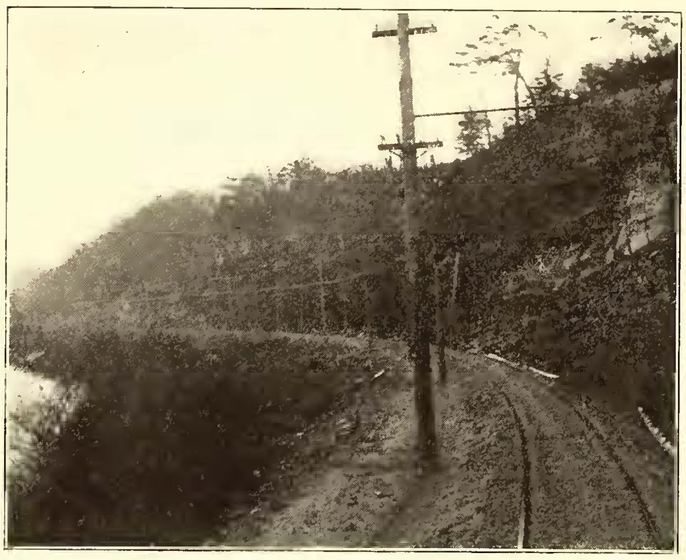
THE COLUMBUS, NEWARK & ZANESVILLE ELECTRIC RAILWAY

The Columbus, Newark & Zanesville Electric Railway, which was completed a few months ago, is an easterly extension of the Columbus, Buckeye Lake & Newark Traction Company's line from Columbus to Newark, one of the best known and most prosperous properties in Ohio. While separate from a financial standpoint, the two lines are operated under one management, and cars run through from Columbus to Zanesville, 65 miles. The Newark & Granville Railway and the Newark city lines were merged with the Columbus, Newark & Zanesville Electric Railway about the time the extension was ready for operation. The entire lines under the management of J. R. Harrigan, of Newark, embrace about 85 miles, and form important links in the chain of lines which Tucker, Anthony & Company, of Boston, are building in Ohio. The Columbus, Buckeye Lake & Newark property was thoroughly described in the STREET RAILWAY JOURNAL of Aug. 1, 1903, while the Canton-Akron Railway, Canton-New Philadelphia Railway and Tucarawas Traction Company's lines, also part of this chain, were described in the issue of May 28, 1904.

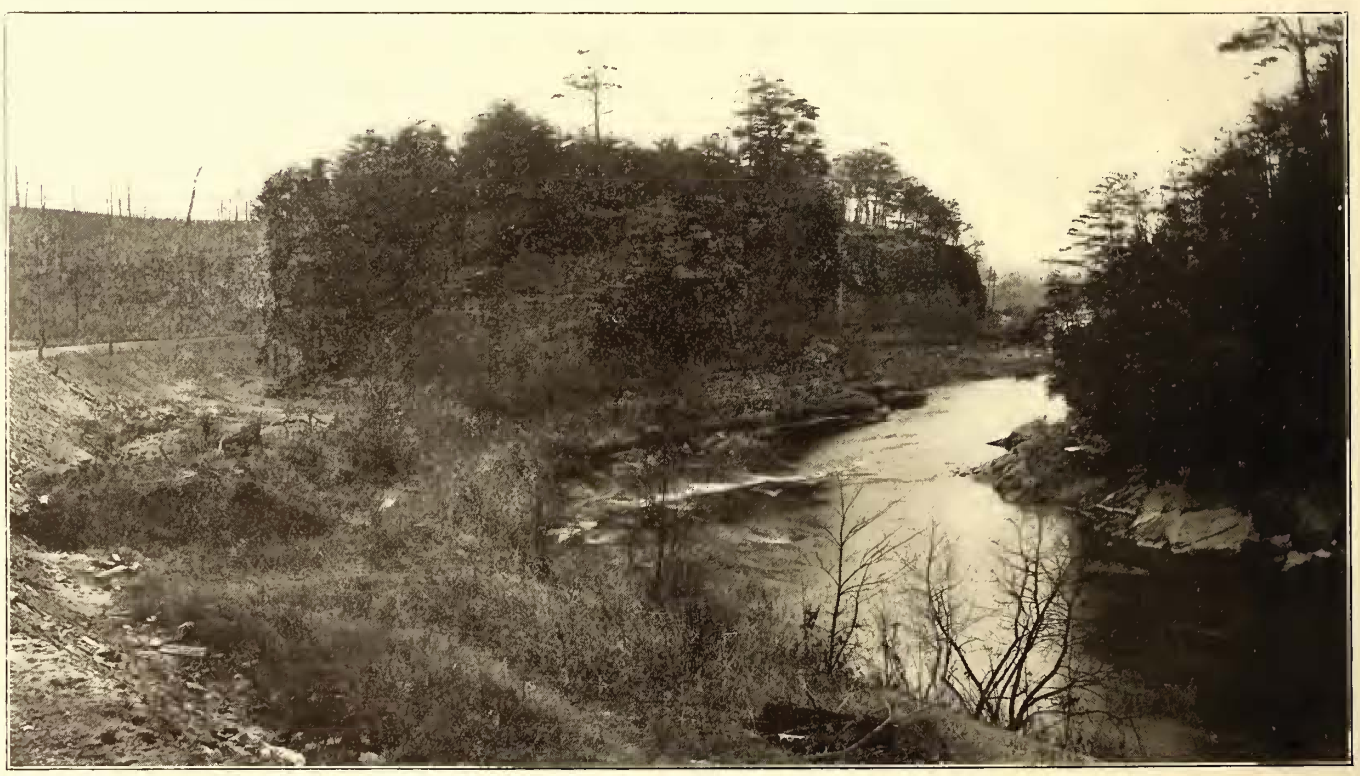


RAILWAY PARALLELING A BEND OF THE RIVER

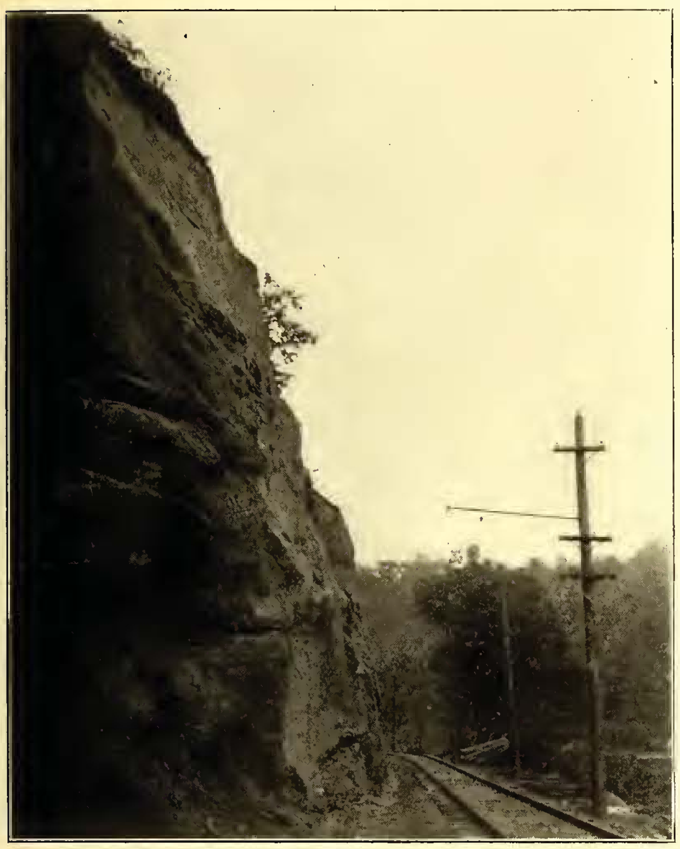
THE TUNNEL AT BLACK HAND ROCK

TERRITORY

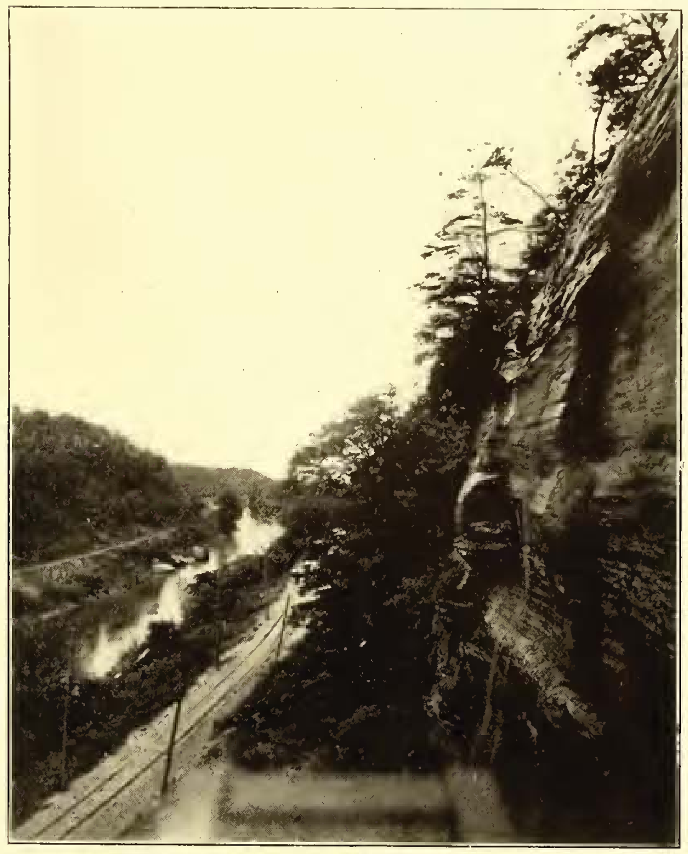
The building of this 27-mile extension presented engineering difficulties such as have seldom been encountered in the comparatively level country which is the rule in the Central West. The district was exceedingly rough, cut up by rocky hills, almost approaching mountains in extent. The engineers found it desirable, therefore, to follow the example of the Baltimore & Ohio Railroad, which the road parallels, and follow the valley of the Licking River. The steam road follows one bank, while the electric road parallels the other. The track was built on a natural ledge, and at all points it is above high water mark. Some filling was necessary at certain low points and a great deal of expensive rock cutting was done. The river occupies a deep canyon, and at many points the solid rock walls rise precipitately 300 ft. to 400 ft., giving the traveler the impression that he is in Colorado instead of in the generally



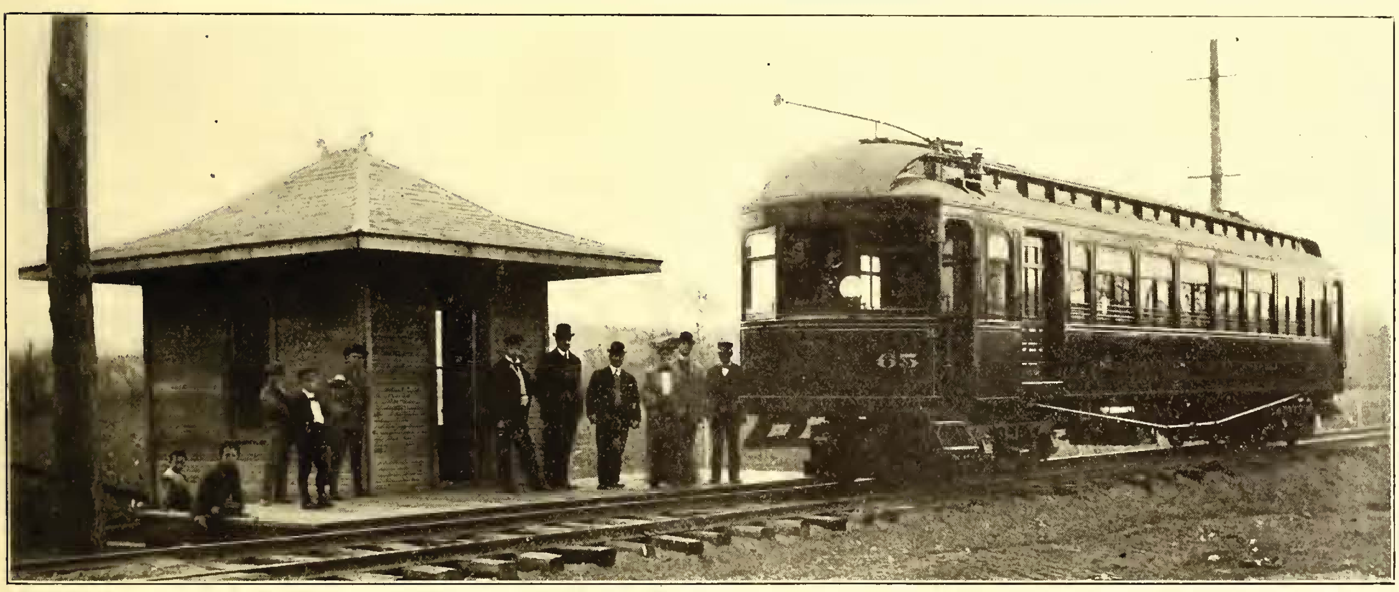
THE PASSAGE AT BLACK HAND ROCK—A CHARACTERISTIC EXAMPLE OF THE SPLENDID SCENERY ALONG THE LINE OF THE COLUMBUS, NEWARK & ZANESVILLE ELECTRIC RAILWAY level Ohio. The river makes frequent turns and the road has numerous curves, all of which, however, were laid out to permit high speeds. The scenery is beautiful, its equal being hardly offered by any other traction line in that part of the country. At one place an enormous jutting rock made it necessary to tunnel nearly 400 ft. through solid stone. Views of the tunnel and some of the river scenes are presented herewith.



AN EXAMPLE OF THE LARGE ROCK CUTTING REQUIRED ON A 6-DEG. CURVE ONE-HALF MILE LONG



A PICTURESQUE SCENE ALONG THE BANKS OF THE LICKING RIVER. STEAM ROAD ON OPPOSITE SIDE



CAR STOPPING AT A WAITING ROOM ON THE LINE OF THE COLUMBUS, NEWARK & ZANESVILLE ELECTRIC RAILWAY

The plan of following the river made it impossible, of course, to strike the centers of towns, and the line is wholly on private right of way except in the terminal cities. The towns are back on the bluffs, and one seldom sees a house, although the line has considerable intermediate population. Station buildings are provided at towns and principal stopping points; one of these is illustrated. The wild country makes this a good district for hunting and fishing. So many hunters are carried that the company adopted the rule of requiring every hunter to take his gun to pieces before entering the car, thus relieving the passengers of the liability of being shot. There are several small parks and picnic grounds along the route, and with the better transportation facilities the district will undoubtedly become more popular for pleasure seekers. Black Hand Rock, where the tunnel mentioned is located, is rich in Indian legend, and it is said that the face of the rock formerly showed a huge black hand.

Zanesville, which has a population of about 25,000, is the seat of Muskingum County. The intermediate population between Newark and Zanesville is about 3000. Zanesville is an important railroad center and coal shipping point, with several large iron working factories. The interurban cars enter the city over the tracks of the Zanesville Railway, Light & Power Company, crossing the new concrete Y bridge, one of the attractions of Zanesville. This bridge provides facilities for turning the cars. The latter run to the business section on the main street, where there is a ticket office and waiting room.

SEATING ARRANGEMENT OF PARLOR CAR FOR LIMITED SERVICE

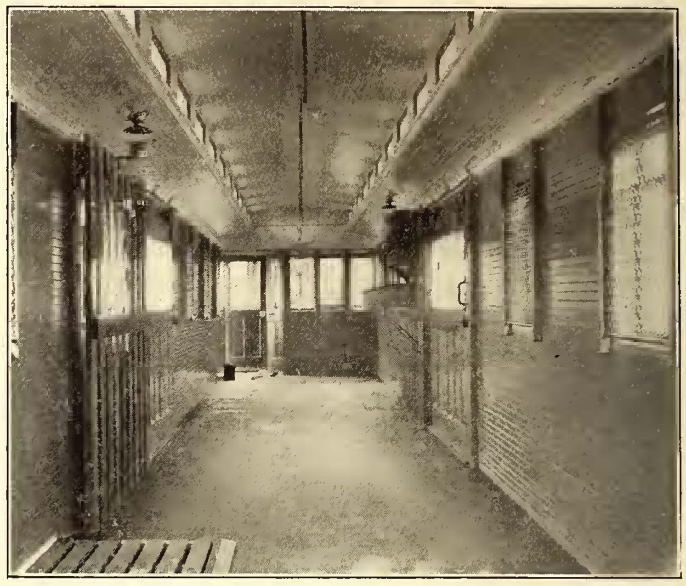
The city company has a franchise for a loop in the business district, and as soon as possible this will be utilized by the interurban cars, when it is probable that the company will have its own station, with a siding for freight.

Zanesville promises to become an important interurban center, as no less than seven roads have been projected out of the town in various directions. It appears reasonably certain that within a year or more a road will be built north from Zanesville to Coshocton and New Philadelphia, which will complete the chain of lines between Cleveland, Columbus and Cincinnati, and as the Columbus, Newark & Zanesville is in the direct route to the State capital and hundreds of points in Ohio and Indiana, it will benefit greatly by the feeders being built to Zanesville and the resulting through traffic.

TRACK AND OVERHEAD CONSTRUCTION

The track and overhead construction is of the most approved type. Located high above the river, the track drainage is excellent, and as the roadbed follows almost a water level the maximum grade is 1½ per cent, this being on a bridge crossing Licking River and over the Baltimore & Ohio Railroad approaching Zanesville; the bridge has a 1400-ft. timber approach and a 200-ft. truss steel span. The tunnel mentioned is 364 ft., and required an unusual amount of blasting and drilling, as the rock is very hard; it is 14 ft. high and 10 ft. wide. There are several long curves, one of them a 6-deg. curve 2600 ft. long around the face of a mountain of rock. This is illustrated, the same view showing the details of the overhead work.

The poles are 35 ft. with 8-in. tops. There are three cross-arms, all of them braced with iron. The upper arm carries two of the high-tension lines mounted on Hemingray triple petticoat glass insulators. The pin for the third insulator is set into the top of the pole. It has a weephole and a porcelain plate to keep out water. The high-tension wires, No. 4 hard drawn copper, are in a 36-in. equalateral triangle and are transposed at intervals. Two 330,000-circ. mil aluminum feeders are carried on the second arm, with pins for another set installed. The third arm carries two block signal wires and two telephone wires. The brackets are Ohio Brass wrought-iron pipe, 2 ins. in diameter and 11 ft. long, of the flexible suspension

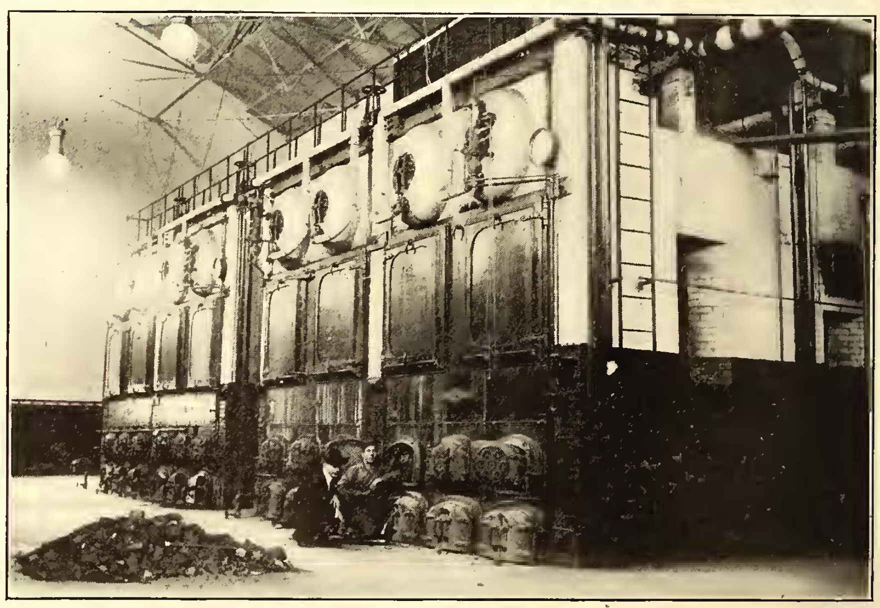


AN INTERIOR VIEW OF THE EXPRESS CAR USED BY THE COLUMBUS, NEWARK & ZANESVILLE ELECTRIC RAILWAY

type. General Electric type MD lightning arresters are placed on every twentieth pole and grounded with an iron rod. Rails are 70-lb., ties are standard white oak, and six-bolt fish-plates are used at the joints, with 8-in. 0000 Ohio Brass copper bonds. The trolley is 0000 grooved.

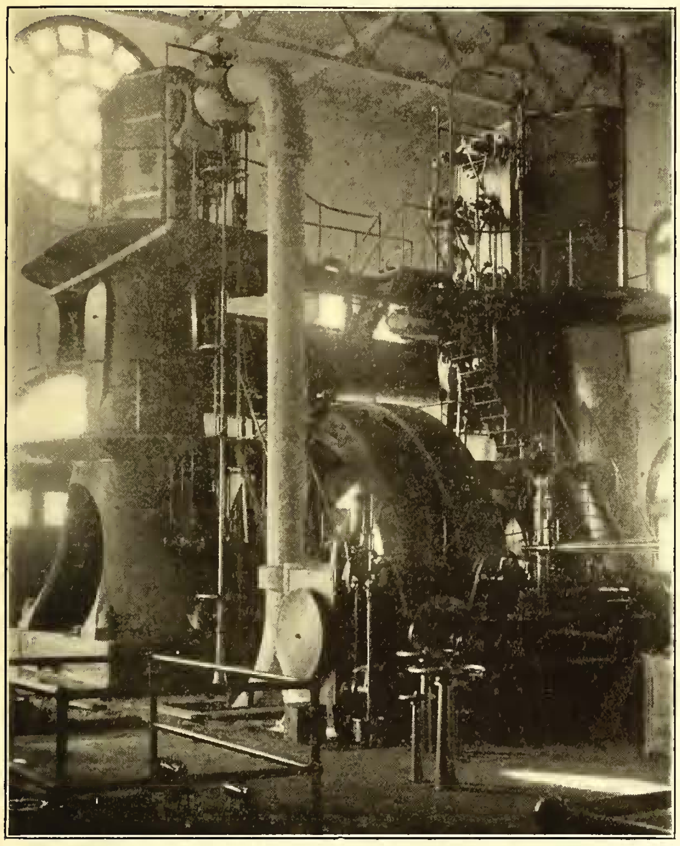
ROLLING STOCK

To provide for the extension, the company bought four sixty-

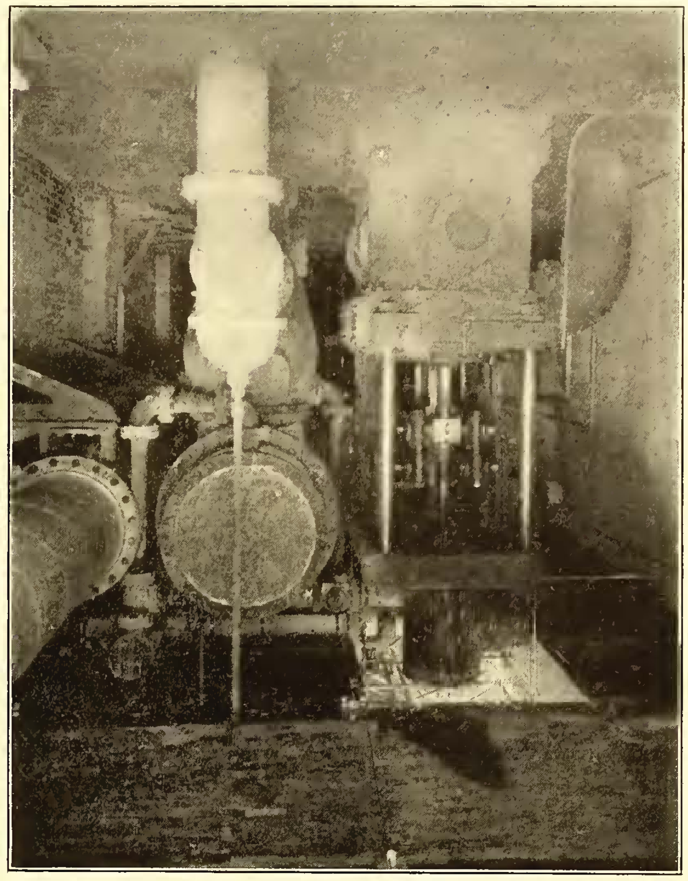


A VIEW OF THE BOILERS, SHOWING THE FUEL GAS SUPPLY PIPES

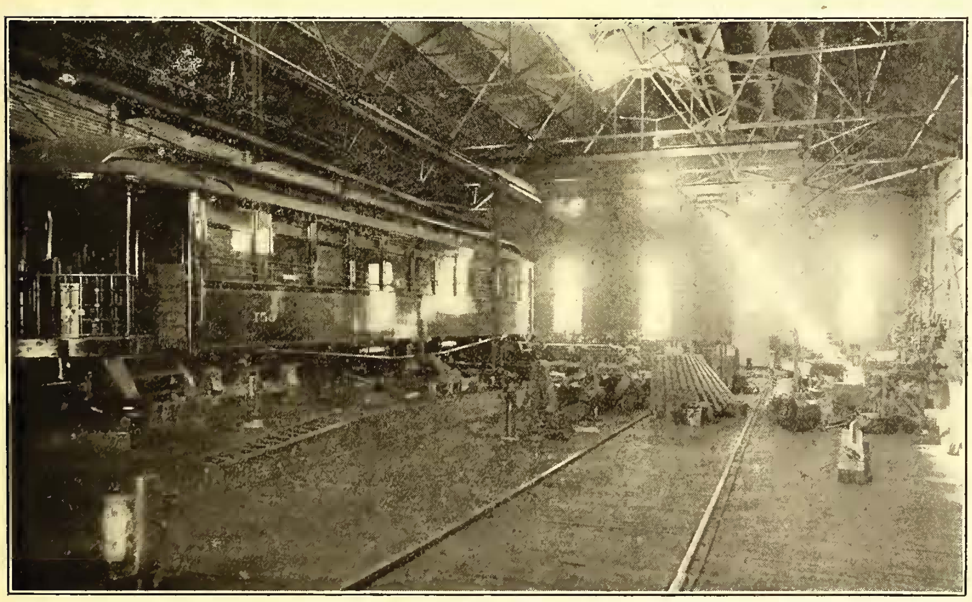
passenger coaches and one freight car built by the Jewett Car Company, of Newark, Ohio. The passenger cars, which have three compartments—baggage, smoker and passenger—were described in the July 2, 1904, issue of this paper. The cars are used interchangeably with those of the Columbus, Buckeye Lake & Newark Traction Company, and all cars run through to Zanesville, giving hourly headway. As outlined in an article on "Limited Service and Interline Business," in the issue of Feb. 1, the companies operate limited cars between Columbus and Zanesville, giving two trips each way a day. For this service is used a fine 55-ft. chair car built by the Barney & Smith Car Company. The aisle is at one side of the center, and there are two rows of chairs on one side and one on the other, thus giving a maximum seating capacity of thirty-three passengers in the car. The rear end has an observation extension and a dozen passengers may be seated on camp stools; this space may be also used for carrying baggage. Excess of 15 cents to Newark and 25 cents to Zanesville is charged, and the cars are well patronized. It is probable that another car will be installed and the service increased to four daily trips each way.



THE 2500-HP GENERATING SET INSTALLED IN THE HEBRON STATION



THE CONDENSER AND AIR-PUMP APPARATUS FOR THE 2500-HP ENGINE



INTERIOR OF THE NEWARK CAR SHOPS, SHOWING THE EXCELLENT LIGHTING ARRANGEMENT

POWER STATION AND DISTRIBUTION

The Hebron power station of the Columbus, Buckeye Lake & Newark Traction Company was enlarged to provide power for the new line. The old equipment consisted of two 800-kw generators operated by Hamilton-Corliss cross-compound engines. To economize space it was decided to install a vertical unit having a capacity about equal to that of the other two machines. The building was extended 40 ft. and built with a monitor roof. The engine is a Reynolds-Corliss vertical cross-compound type built by the Allis-Chalmers Company. The cylinders are 34-in. and 68-in. x 48-in. stroke, and the engine revolves normally at 98 r. p. m. The fly-wheel is 20 ft. in diameter and weighs 125,000 lbs. The shaft is 26 ins. at journals and 29 ins. at fly-wheel. On the shaft is a General Electric revolving-field type 1500-kw generator, producing alternating current at 13,200 volts. The engine has Reynolds-Corliss automatic valve gear, with double eccentrics on both sides for operating steam and exhaust valves independently. The main bearings are water-jacketed. The eccentrics are encased and oil drips over them. Automatic sight-feed lubricators lubricate the cylinders and exhaust valves. There is a safety stop governor which operates on the throttle at 8 r. p. m. over speed. The speed variation is guaranteed not to exceed 2½ per cent when working at any range between minimum and maximum speed. The guarantee provides that when the engine is running 94 r. p. m. with 150 lbs. steam at throttle with condenser maintaining

26 ins. vacuum in low-pressure cylinder, that it will require not more than 13 lbs. steam per indicated horse-power per hour when developing 2300 hp, not including steam for the condenser. The engine will develop 3500 hp maximum. The condenser system was kept separate from that of the old portion of the house. The condenser is a Blake vertical twin jet condenser, steam cylinder 16 ins., water 40 ins., with 21-in.

THE REPAIR SHOP AND CAR HOUSE AT NEWARK

stroke, and is designed to give 27 ins. vacuum. There is a primary heater between the exhaust and the condenser. Between the engine cylinders is a reheater receiver with a capacity approximately one and a half times that of the low-pressure cylinder. The exhaust to the atmosphere is provided with a 26-in. hydraulic relief valve. Spiral riveted pipe is used for the exhaust line.

Two 310-hp Sterling water-tube boilers were installed to take care of the new engine. Natural gas is used for fuel, the furnaces being fitted with Gwynn gas burners. Each member consists of two tubes, one inside the other, with perforations on the inner tube. The arrangement gives the gas a rotary motion, and the air and gas are thoroughly mingled. Both the air and the gas can be regulated. Owing to the low cost of fuel, gas at 8 cents per 1000 cu. ft., the excellence of the equipment and careful management, the Hebron station has been considered one of the most economical interurban stations in this district. The advantages of a larger output with but comparatively little increase in labor, together with the superior efficiency of the new unit, has brought the cost of current down considerably lower than it was before. The following statement for August, 1904, was before the new unit was installed, and the second statement is for January, 1905:

AUGUST, 1904

Total generated output kw-hours	609,210
Total gas used, cubic ft	29,256,300
Cost of gas used	$2,340.50
208 gallons cylinder oil at 49½ cents	102.96
248 gallons engine oil at 18 cents	44.64
250 lbs. waste at 5¼ cents	13.12
Repairs and supplies	21.00
Pay roll	492.00
Total	$3,014.22
Cost per kw-hour	.00494

JANUARY, 1905

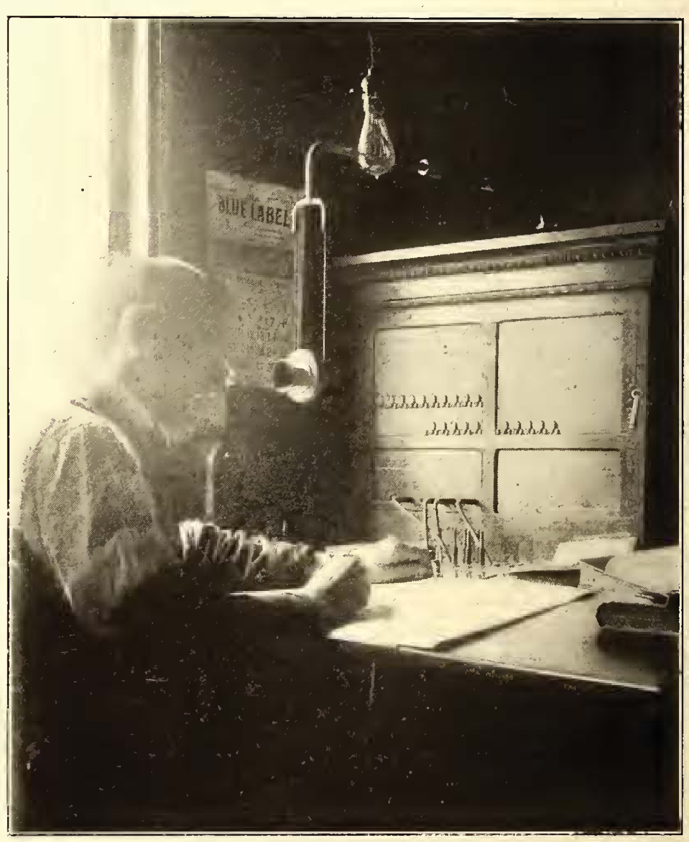
Total generated output kw-hours	586,504
Total cost of gas used (21,020,000 cu. ft.)	$1,681.60
260 gals. cylinder oil, at 44 cents	114.40
118 gals. engine oil, at 18 cents	21.24
203 lbs. waste, at 5¼ cents	10.65
100 lbs. rags, at 3 cents	3.00
Repairs and supplies	53.98
Water for steam and condensers	41.66
Pay roll	555.00
Total	$2,481.53
Cost per kw-hour	$.0042

NOTE—In previous report cost of water was not figured.

In providing current for the extension, a sub-station outfit was installed in a new car house erected at Newark and a substation built at Pleasant Valley. The general scheme is the same in both places, the high-tension lines entering through a tower and passing down over a tubular rack through hand-operated oil switches. Each station has two 300-kw General Electric rotary converters of the standard type; two 330-kw air-cooled transformers, reducing the current from 13,200 volts to 370 volts, with reactive coils for each; two Buffalo Forge Company's fans driven by 2-hp induction motors, together with necessary switching apparatus. The basement below is sealed off for an air chamber for cables and for ventilation of rotaries and transformers.

POWER HOUSE, REPAIR SHOP AND EQUIPMENT

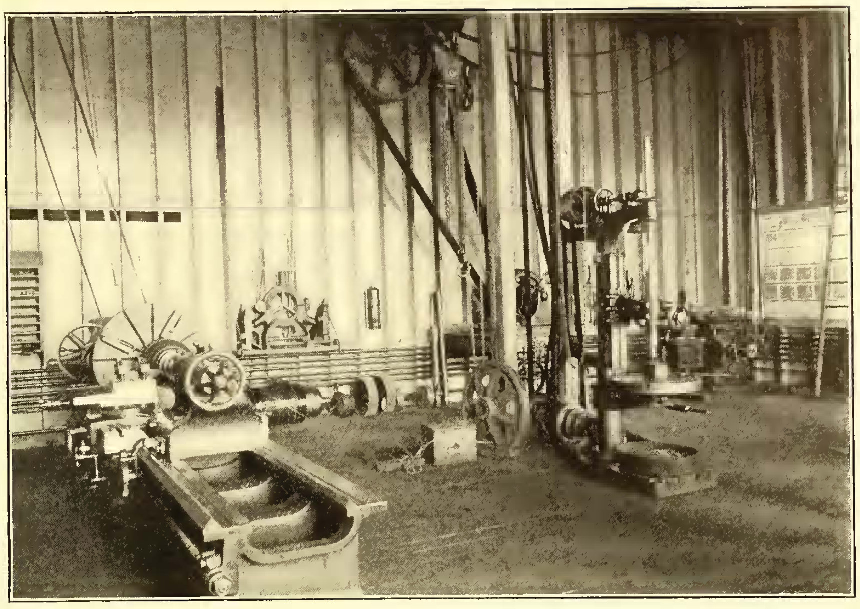
The preliminary plans for the car house and repair shop were given in our issue of Aug. 1, 1903. Exterior and interior views of the building are shown herewith. It is designed to take care of both the city and inter-



ARRANGEMENT OF DESPATCHER'S TELEPHONE BOARD

urban cars. The wing at the right contains the sub-station, stock room, lounging room, lockers and bath for employees and offices of master mechanic and superintendent. The repair shop is on the right and the car house on the left.

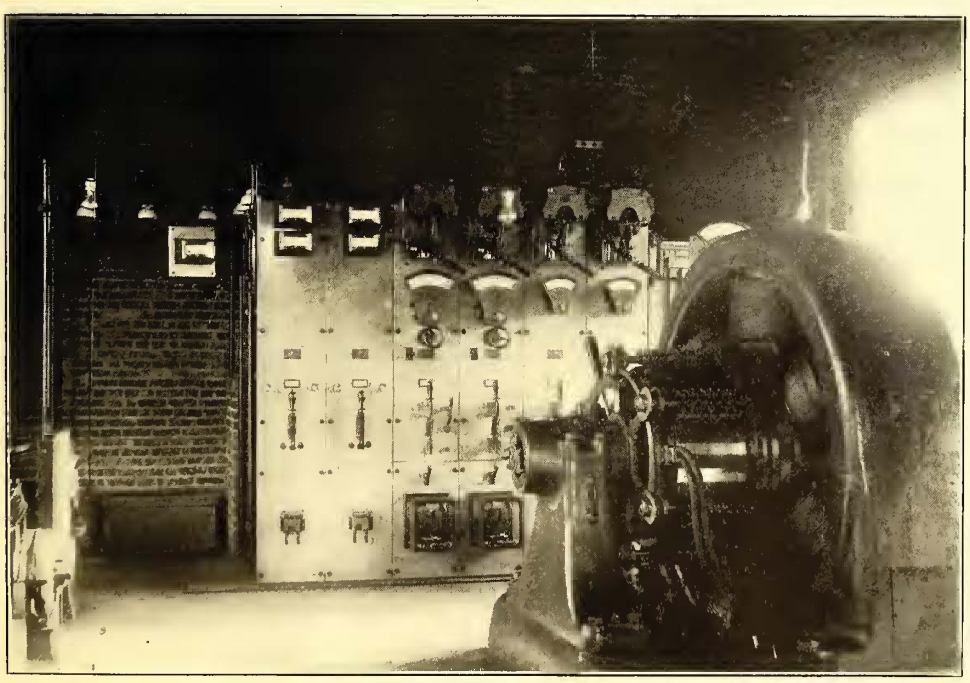
The repair shop is divided about the center with a brick wall and fireproof doors, and the front portion has three pits for pit work and a wash rack for car cleaning. In the repair shop section is a transfer table connecting three tracks. In one of these tracks is a 75-ft. pit, on either side of which are 2-ton Garry Iron & Steel Company's pneumatic air lifts, so that the end of the car can be raised and the trucks transferred to another track for repair work. Covering the other two tracks with a range of about 50 ft. is a 2-ton hand crane, with an air hoist, built by the Chicago Pneumatic Tool Company. In one corner is a forge with cement floor around it. Adjoining is a J. T. Sheafer 150-ton wheel press. A 20-in. American drill press is next to this, and the two are driven by a 5-hp motor. The drill press is used for small shop work and saves interrupting the machine shop men. A swinging crane serves the drill press and wheel press. It was originally intended to place all tools in this shop, but it was found more desirable to partition off a room from the corner of the car house and do all machine work here. A line shaft extends through the center of the shop and is operated by a 30-hp Crocker-Wheeler motor, all machinery being operated by this. The equipment includes a 36-in. x 16-in. engine lathe built by the Springfield Machine Tool Works, Springfield, Mass., used for wheel turning, armatures, axles and all heavy work; a 28-in. American Tool Works' shaper; a 16-in. x 8-ft. American Tool Works' lathe fitted with quick-change gears; a 28-in. American drill press; a hack saw; a No. 10 Wells Brothers' nut and bolt machine for tapping and threading pipe; a grindstone; a Yankee drill grinder, and an emery wheel. On a shelf is a 4-ft. x 16-ft. tank supplied by a D-4 Christensen compresser outfit, the same as used on the cars, which supplies air for the hoists and for blowing out armatures and car seats. The machine shop is served by a 1½-ton chain hoist. There is a small paint shop outside, but no woodwork is done, as the shop is but a short distance from the plant of the Jewett Car Company, where it can have all work of this character attended to without delay. The plan of eliminating the woodworking and paint shops from the main building, of course, reduces insurance.



AN INTERIOR VIEW OF THE MACHINE SHOP, SHOWING MODEL ARRANGEMENT OF TOOLS AND SYSTEM OF ELECTRICAL DRIVING

THE PLEASANT VALLEY SUB-STATION

The company uses a trolley wheel supplied by the Edna Smelting & Refining Company, Cincinnati, and gets from 3000 miles to 3500 miles on high-speed interurban service. Oil and waste lubrication is used for the armature bearings, which average 160,000 miles. Solid steel gears weighing 240 lbs. are used. The company has been using steel-tired wheels with tires 2½ ins. thick, which have been giving from 30,000 miles to 40,000 miles without requiring returning, and which have a life of about 140,000 miles. At present, tires 3½ ins. thick are being put on to allow five turnings. Diamond S brake-shoes are used on steel tires, giving a life of from 18,000 miles to 20,000 miles.



THE PLEASANT VALLEY SUB-STATION OF THE COLUMBUS, NEWARK & ZANESVILLE ELECTRIC RAILWAY

A rather novel line car has been built recently by the Jewett Car Company. It has a substantial body 35 ft. over all, and has a 3-ft. 6-in. door on either side at a corner, and a door at each end, so that poles and line material can be carried. A tower in the center is fitted with a

MOTOR-DRIVEN DERRICK LIFTING CAR TRUCK

sliding table and provided with a pivoted searchlight of high power to locate wire troubles at night.

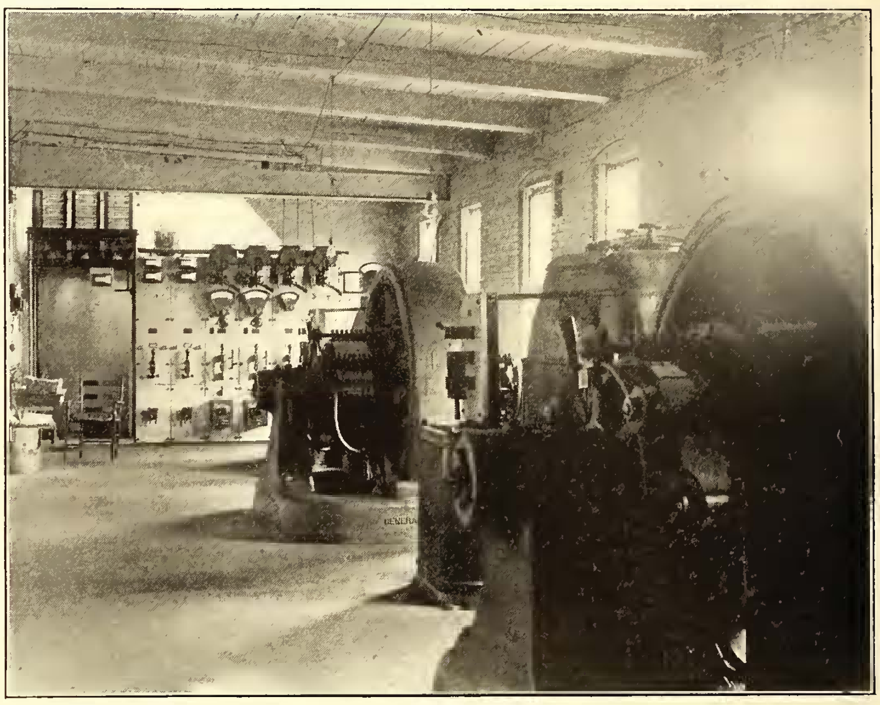
DESPATCHING SYSTEM

The despatching system has recently been improved. A 20-drop switchboard, built by the North Electric Company, of Cleveland, has been installed in a special room in the general offices at Newark. The Columbus division has one line, the Granville spur line another and the Zanesville line a third. In addition to the telephone boxes at sidings, the operator has communication with all sub-stations, freight stations, ticket offices, car house, repair shop, superintendent's office, superintendent's house and an emergency 'phone. The board is equipped with a night bell, and when a drop falls this bell rings until the drop is raised. The standard despatcher's sheet is used. Cars must have clearance orders at terminal points, and if on time they do not call for orders unless the block is against them or if it fails to light. The United States block signal system is used at all sidings. Sub-station attendants report all cars as they pass, and have a block signal to stop cars. Orders are written on a manifold blank, three copies being made, one for each of the crew and the third is dropped in a box provided for the purpose. Orders are collected at regular intervals and checked with train sheets.

GENERAL

The company is preparing to erect a seventy-five-room hotel with all modern conveniences at Buckeye Lake at the park of the same name near Hebron. This resort, which the company is making immensely popular, was described and illustrated in the previous article on this system.

The engineers for the power station were Sheaff & Jaastad, of Boston. Acknowledgment is due to J. R. Harrigan, general manager, and A. M. Frazee, superintendent of motive power of the system, for the details of the improvements. The Zanesville line, as well as the balance of the system, was built by the Great Northern Construction Company, of which C. A. Alderman is chief engineer.

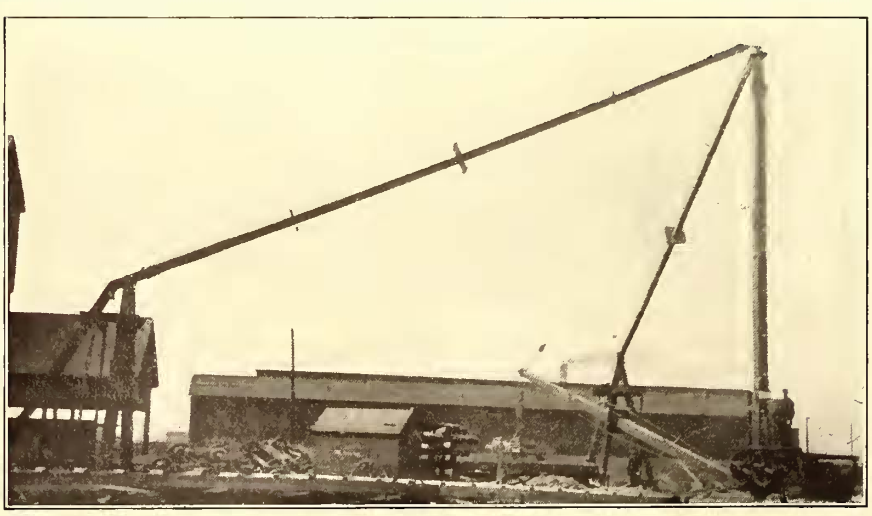


INTERIOR OF THE SUB-STATION ROOM AT THE NEWARK CAR HOUSE

MOTOR-DRIVEN DERRICK IN DETROIT

Through the courtesy of John Kerwin, superintendent of tracks, Detroit United Railway, the accompanying views of a motor-driven derrick are shown. The derrick is used at the yards of the Detroit Company for hoisting heavy material, as trucks, etc., and finds its particular application in unloading material from steam railroad flat cars, in which work it has made itself indispensable.

The derrick is operated by a 30-hp type "D" steel motor, and is capable of hoisting 7 tons at the rate of 60 ft. per minute. The hoisting machinery is connected to the mast of the derrick and travels on a circular track. There is a pinion underneath which meshes into a large bull-wheel that is fastened to the foundation and serves to swing the derrick. All the levers are on the platform above the drums. There is one lever for hoisting the boom, one for hoisting the load and one for handling the reversible gear for swinging the derrick. The mast is 45 ft. high and the boom is 58 ft. long.



THE MOTOR-DRIVEN DERRICK AT WORK IN THE YARDS OF THE DETROIT UNITED RAILWAY

It will be noticed the mast is braced by means of two heavy beams reinforced by truss cables, and there are no guy ropes, as these would be in the way in yards of this nature.

IS A UNIVERSAL TYPE OF RAILWAY MOTOR ADVISABLE?

BY A. H. ARMSTRONG

Electric railway engineering has been referred to as being a case of following the fad or fashion in vogue at the time, and many installations would seem to bear testimony to this accusation. Undoubtedly there are many cases of Jones purchasing a given motor because Manager Smith has been having good results with the same motor on his road, entirely ignoring the fact that the operating conditions upon the two systems may be totally dissimilar.

When the need was felt for a generating and distributing system of wider scope than the d. c. 600-volt system, thus giving rise to the development of the rotary converter, it was thought the converter system was proposed and installed in many instances because the tide of railway engineering fashion was turning in that direction, rather than on account of its superiority over the d. c. system. While some managements have been slow to avail themselves of the advantages of a. c. generation and transmission for this reason, it is a noteworthy fact that d. c. systems continue to be replaced by the a. c., but no instance has come to the writer's notice of the management of a road abandoning the a. c. transmission system after trial and readopting the d. c. system as being superior.

The introduction of high potential a. c. transmission to the rotary converter made possible the suburban and interurban electric roads of to-day, and greatly broadened the possibilities of electric railroading. In the development of the single-phase a. c. motor, now in successful commercial operation, we have a new influence at work of a far-reaching character. As the field of the railway motor has expanded, so the requirements of the motive power have become so varied as to make it difficult for any one motor system to meet successfully all the conditions imposed. The d. c. series motor is a highly developed and efficient piece of apparatus, and, moreover, very adaptable to the diversified character of general railway conditions. The large sums spent in developing the different types of alternating-current motors are not due to any dissatisfaction with the direct-current motor as such, but because it has become necessary to reduce the cost of the secondary distribution system, which is still high with direct current, even with the advantage of the rotary converter. The advantages of high potential transmission are now evident to all, and it is proposed to carry this advantage still further, reduce the cost of the secondary distribution by raising the potential and dispense with the rotary converter.

The case is not quite analogous to the introduction of the rotary converter, as the adoption of the latter did not interfere in any way with the motive power question itself. The change from a direct-current to an alternating-current motor is more radical, and is advocated only on account of the lesser first cost of the trolley distributing system, and is not due in any way to any superiority of the alternating-current motor itself.

The alternating-current single-phase motor with its attendant step-down transformer constitutes a heavier, more expensive and less efficient equipment than is offered by the direct-current motor with the series parallel controller. The alternating-current motor is also less flexible in its design, gives a pulsating torque and is restricted to a commutator potential of about 200 volts, but, nevertheless, its adoption for certain classes of railway service may be well justified. The car equipment constitutes but one link in the system of transmitting power from engine to car axle, and while the limitations of the alternating-current motor are regrettable, they do not in every instance introduce objections sufficiently serious to outweigh the considerable reduction in expense of the distribution system which the adoption of the high potential trolley affords. Limitations in design are reflected in the cost and bulk of the apparatus employed, but the copper and sub-station economy effected by the use of a 3000-volt trolley may outweigh the extra expense of installing an alternating-current car equipment for certain classes of service.

Perhaps it is too early in the history of the alternating-current railway motor to attempt to define its precise field of usefulness, but some of its advantages as well as some of its limitations stand out so prominently as to make possible some general comparisons with its direct-current competitor.

Both the single-phase commutator and three-phase induction types of motor have been proposed for city service. This class of service demands frequent stops and high schedule speed, thus calling for successive overloads on the motors in order to obtain the high rates of acceleration required. The schedule speed of frequent stop service is always the result of a compromise between the rate of acceleration permissible without discomfort to the passengers and the frequency of stops required to pick up and drop the passengers.

The chief requirement of the motive power is that it shall be able to commutate heavy applications of current at very frequent intervals without experiencing a rise in temperature above the 65 degs. to 70 degs. C. permissible with reasonable life of the insulation. The method of control must permit of a high "efficiency of acceleration"—that is, all losses external to the motor, such as starting resistance losses, must be eliminated so far as possible. The requirements for frequent stop service are most exacting upon the motive power and its control, and the direct-current series motor and series parallel controller may be looked upon as the survival of the fittest, having proved superior to the horse, cable and steam locomotive for such work.

The three-phase induction motor has been proposed for rapid transit frequent stop service, but has fortunately never had an opportunity to demonstrate its unfitness for the work. Aside from the complication of double-trolley construction in cities, the induction motor system is inherently inefficient during acceleration, even though concatenation of motors be resorted to. Being a motor of synchronous characteristics, no motor curve running is possible, and the external resistance losses during acceleration or fractional speed running are necessarily large. The absence of the commutator does not compensate for the extra energy consumption required with induction motors operating on frequent stop service, due partly to the poorer efficiency of acceleration compared with that possible with direct-current motors, and partly due to the increased weight of the induction-motor equipment itself. The induction motor is inherently a constant speed, constant duty motor, and does not possess the qualifications of a successful motor for rapid transit service.

The single-phase commutator motor possesses all the advantages of variable speed characteristics enjoyed by the direct-current series motor, which, together with the possibilities opened up by potential control, led to many predictions being made that the direct-current motor was destined to be superseded for frequent stop service. An examination of the efficiency curves published of the single-phase motor indicate a curve rising rapidly at light loads, but drooping on overloads, the qualification of a motor adapted to infrequent stop service. In accelerating, the larger part of the motor duty is performed on the drooping portion of the alternating motor efficiency curve, thus giving rise to an internal motor loss considerably in excess of that experienced by a direct-current motor with its sustained high overload efficiency. In order that the single-phase motor may dissipate this excess energy loss without an