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THE TRAMWAY SYSTEM OF HALIFAX, ENGLAND

The corporation of the city of Halifax in Yorkshire has owned its electric-lighting system since 1894, but about three or four years ago the city acquired its tramway system, and steps had to be taken to provide the necessary power from the existing stations. Several 500-volt direct-current units were installed, but the extent of the tramway system soon made it evident that a more economical method of transmitting power for the outlying lines would have to be adopted, and power is now being transmitted by means of high voltage, three-phase generators and rotary converters in the sub-stations. This portion of the plant has just been completed, and as it is said to be the first in England to be equipped in this way with apparatus of purely British manufacture, it possesses a peculiar interest. In view of the fact that the system itself has never been described in these pages, some particulars of it will also be given in the following article.

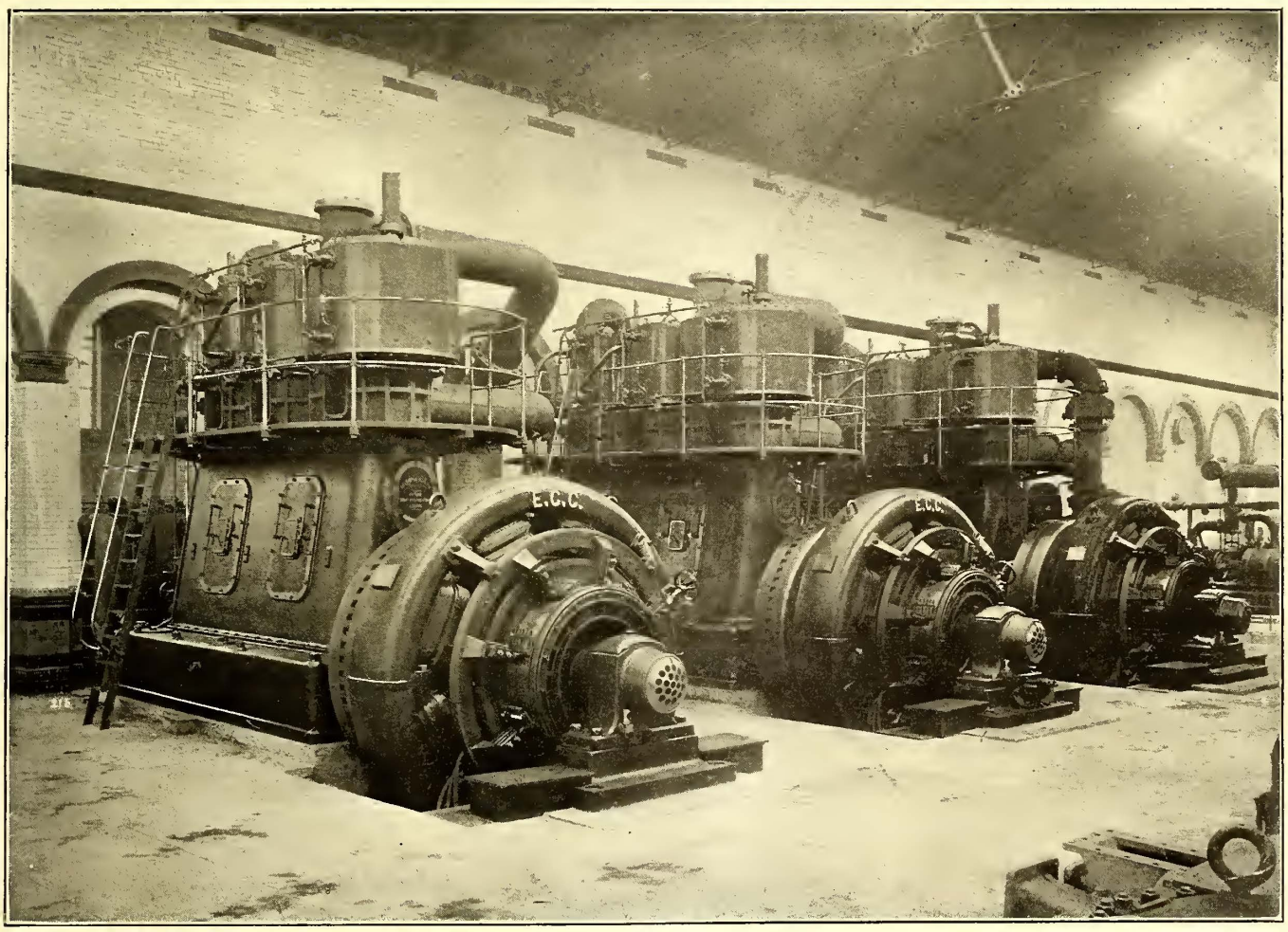


FIG. 1.—PORTION OF HALIFAX POWER STATION, SHOWING THREE 1000-HP DIRECT-CURRENT UNITS.

The power-house building is of gray stone and extremely substantial. The boiler house is a separate building with its own roof, and is equipped with four Lancashire boilers, 7 ft. 6 ins. diameter by 30 ft. long, with two 3 ft. flues in each, three being by Yates & Thom, of Blackburn, and one by Heaton, of Manchester. All the furnaces are equipped with patent self-cleaning furnaces and mechanical stokers by Thomas Henderson, of Liverpool. There are also six boilers supplied by Babcock & Wilcox, most of which are fitted with the B. & W. chain grate stokers. Superheaters are used, 100 degs. of superheat being obtained, and the boiler pressure used is 130 lbs. per square inch.

Adjoining the boiler house is the pump room, in which are four steam-feed pumps, two by G. & J. Weir, of Glasgow, and two by W. H. Bailey & Co., of Manchester, while a Tyler electric pump is also installed for use in case of emergency. The Weir pumps are of that company's patent direct-acting single type, 8 ins. diameter by 10½ ins. steam cylinder by 24 ins. stroke, each capable of delivering 6100 gallons per hour at 12 double strokes per minute.

Should occasion demand it, however, the pumps can easily be run up to a much higher speed to make up any abnormal deficiency in the feed supply. The pumps are of cast-iron, fitted with gun-metal liners, gun-metal buckets with special ebonite packing rings, manganese bronze rods, and valves of the Weir group type in gun-metal seats.

The Bailey's pumps have 8-in. steam cylinders, 5-in. pump cylinder by 7-in. stroke. The suction inlet is below and the delivery can be taken from either side. The valves, seatings and glands are of gun metal. The water pistons are packed with gun-metal rings and the steam pistons with broad cast-iron rings. A Bailey's compound duplex circulating pump is also installed, having a capacity of 60,000 gallons per hour. The steam piping is by Stewart & Menzies, of Glasgow; Lloyd & Lloyd, of Birmingham, and Babcock & Wilcox.

FIG. 2.—GENERAL VIEW OF INTERIOR OF POWER STATION, HALIFAX

The engine room, a general view of which is shown in Fig. 2, is 210 ft. long by 57 ft. wide, and is light and airy, and well adapted for the purpose. Various types of engines are used, though all the electric machinery (with the exception of the Parsons turbo-generator) has been manufactured by the Electric Construction Company. Nearest the main entrance door, and well shown in the illustration, Fig. 1, are three sets of engines and direct-current generators, consisting of Belliss patent self-lubricating triple-expansion engines working multipolar generators of the Electric Construction Company's make. The engines are designed to exert 1080 brake horse-power at 240 r. p. m. as an ordinary full load, and also 1296 brake horse-power as an overload for short periods of time, with a steam pressure of 150 lbs. per square inch, exhausting into a condenser. The sets have been running now for upward of twelve months, and have given great satisfaction in working, both as regards smooth running, governing and economical performance.

On a test, carried out at the makers' works before the sets were delivered, a steam consumption was registered of 15¼ lbs. per brake horse-power, equivalent to approximately 22 lbs. per kw. The engines are of very simple design and construction, and may be described as being of the ordinary triple-expansion marine pattern, with the working parts enclosed to permit of the application of forced lubrication to all the bearings.

There are three cylinders, high, intermediate, and low-pressure, working on cranks set at equal angles, the pistons being made of equal weight for smooth running, and so as to reduce vibration. Piston slide valves are fitted to all three cylinders worked by a single-eccentric valve gear direct from the crankshaft, and extremely simple in action. The lubrication starts and stops with the engine, and beyond an occasional glance at the oil pressure gage, requires no attention from the attendant. Each engine has a separate surface condensing plant, manufactured and supplied by Isaac Storey, of Manchester, and operated by electric motors, together with an Edwards air pump, also operated by E. C. C. geared motor. Fletcher automatic valves are also installed for automatically changing the exhaust into the atmosphere should anything go wrong with the condensing apparatus.

Each of the three Belliss engines is direct-coupled to one E. C. C. continuous-current generator, each capable of a normal output of 750 kw at 550 volts, which are used both for tramway and lighting purposes, when running compound for tramway work, giving 580 volts, and when running shunt for lighting work, 480 volts.

The generators are the standard E. C. C. high-speed type, 8-polar, with high permeability steel magnets set in a massive cast-iron yoke ring, the latter being divided horizontally. The armature is the usual slotted and barrel-wound type, arranged with the E. C. C. system of ventilation by ducts in the armature communicating with air-way through the centre of the shaft. The armature spider terminates in a massive flange-coupling which bolts directly to a heavy fly-wheel on the engine shaft. In view of the comparatively high speed for the output involved, these machines run with a low-temperature rise, the armature windings being under 60 degs. F. after a six-hour run. The field windings are alternately both compound and shunt-wound, in order that they may be available for use on the lighting circuits, if required. The outer bearings are of the usual E. C. C. construction, white metal lined, and provided with oil rings, with extra large allowance of bearing surface.

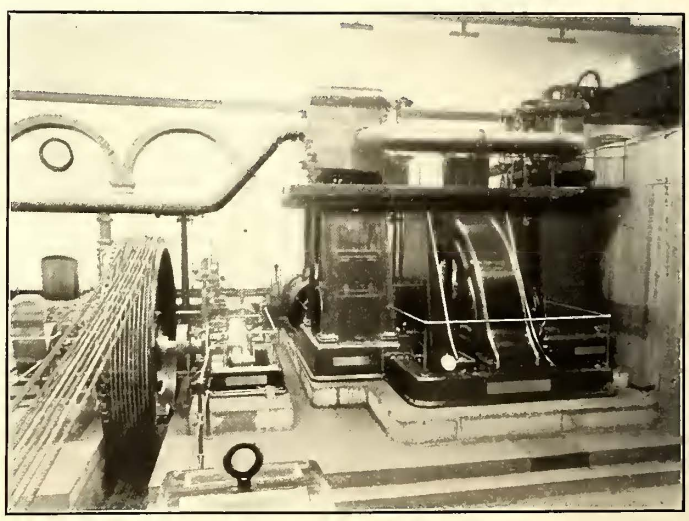


FIG. 3.—VERTICAL ENGINE AND 2200-VOLT ALTERNATOR

At the extreme end of the station is a vertical cross-compound condensing engine (Fig. 3), by Pallitt & Wig-

sell, of Sowerby Bridge, of 600 ihp, with cylinders 18 ins. and 35 ins. diameter by 30 ins. stroke, running at 127 r. p. m., and direct-coupled to an E. C. C. 2200-volt alternator. This engine is fitted with Corliss valves and patent trip gear to each cylinder, and is equipped with horizontal single-acting air pumps, made by the engine makers, but as this unit is now being converted, no further description is necessary. In addition, there is one rope-driven, direct-current, E. C. C. generator and one rope-driven, E. C. C. alternator (Fig. 4), driven by two Pallitt & Wigsell horizontal cross-compound condensing engines of 200 ihp, with cylinders 12 ins. and 27 ins. diameter, 24 ins. stroke, 110 r. p. m., and with fly-wheels 11 ft. diameter, grooved for ten ropes 1¼ ins. diameter.

The cylinders of both these engines are fitted with slide valves and cut-off valves, those of the high-pressure being automatically controlled by the governors. Pallitt & Wigsell patent single-acting air pumps are also attached to each engine, and each of these engines, including the two described later, are equipped with Hartnell's patent governors.

Besides the above units, situated in the far corner of the

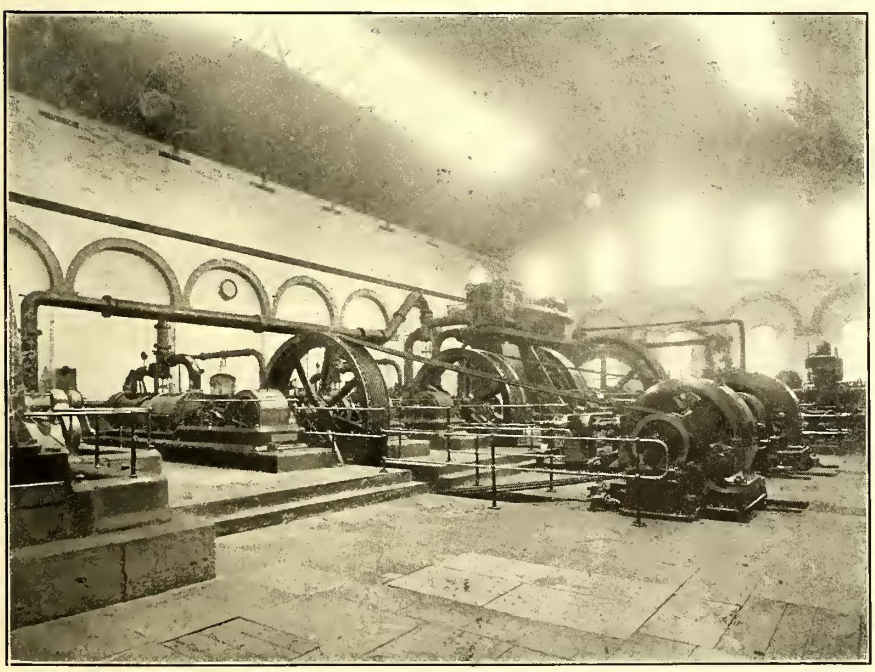


FIG. 4.—ROPE-DRIVEN DIRECT-CURRENT GENERATOR AND ALTERNATORS WITH HORIZONTAL ENGINES

building, and shown in Fig. 5, are two turbo-generators supplied by C. A. Parsons & Co., of Newcastle-on-Tyne, and which are used both for tramway and lighting purposes. Each unit consists of a steam turbine coupled direct to a dynamo of 200-kw output, the whole mounted on a surface condenser which forms the bedplate for the turbo-generator. The air and circulating pumps are erected on the same level as the condenser, and are driven by worm-gearing from the turbine shaft, making the whole plant self-contained.

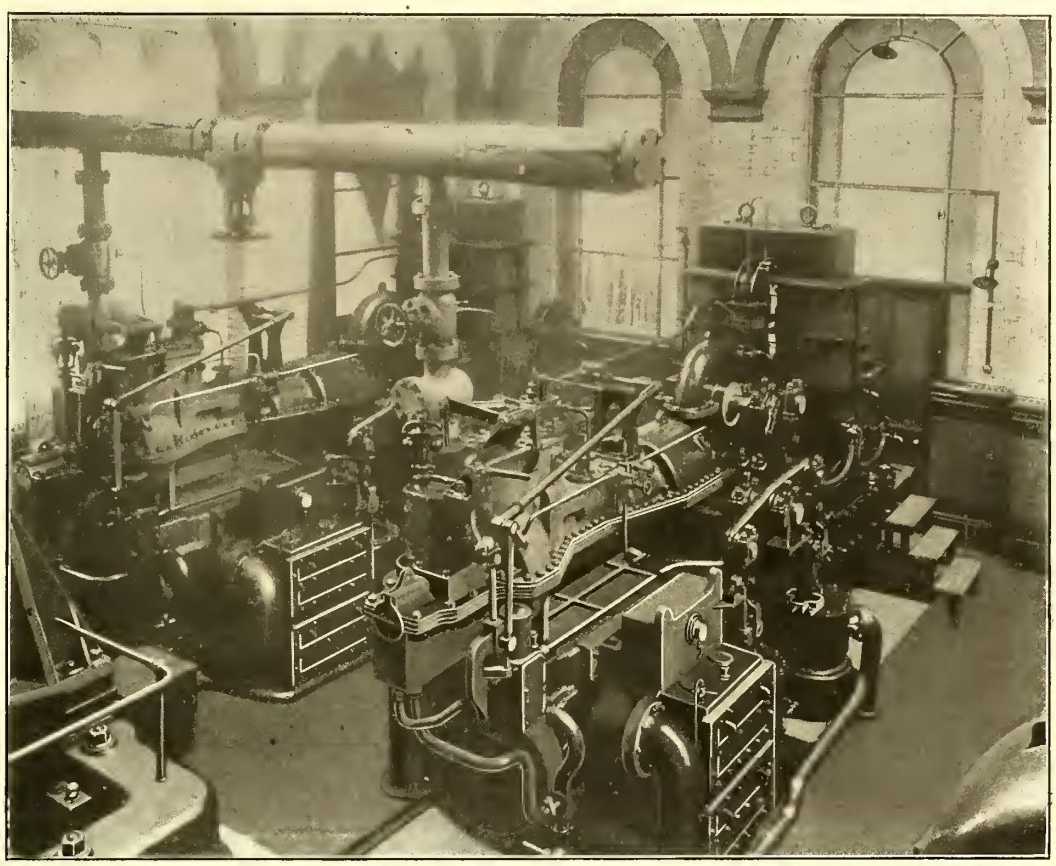


FIG. 5.—PARSONS TURBO-GENERATORS

The normal voltage is 500 volts, and the machines are fitted with the Parsons electrical solenoid governor, which maintains a constant voltage on the supply mains. Mechanical safety governors are also fitted for the purpose of coming into action when the speed rises to a certain height and entirely cut off the steam. The plants are designed for a steam pressure, at the stop valve, of 135 lbs., and are complete with oil coolers, oil trays, etc.

We now come to the most important part of the new work which the Halifax Corporation has been carrying out, referred to at the beginning of the article, namely, the installation of the new three-phase generators for the suburban tramway service. Two of these generators, of 300-kw capacity each, have been installed, and these are driven by two Pallitt & Wigsell engines, one unit being clearly shown in an illustration, Fig. 6. The engines are horizontal cross-compound condensing, of 570 ihp, with cylinders 17 ins. and 34 ins. diameter, 3 ft stroke, 100 r. p. m., with Corliss valves, and patent trip gear to the high-pressure cylinder, and slide-valve and cut-off valve to the low-pressure cylinder, and patent single-acting air pump. Each engine has separate condensing plant, one having a jet condenser and the other a surface condenser.

These two three-phase generators are used for supplying current to sub-stations, described later, at a pressure of 5000-5500 volts, this being transformed down to 320 volts, and then being transformed by rotary converters to continuous current at 500-550 volts for tramway purposes and the supply of current in bulk.

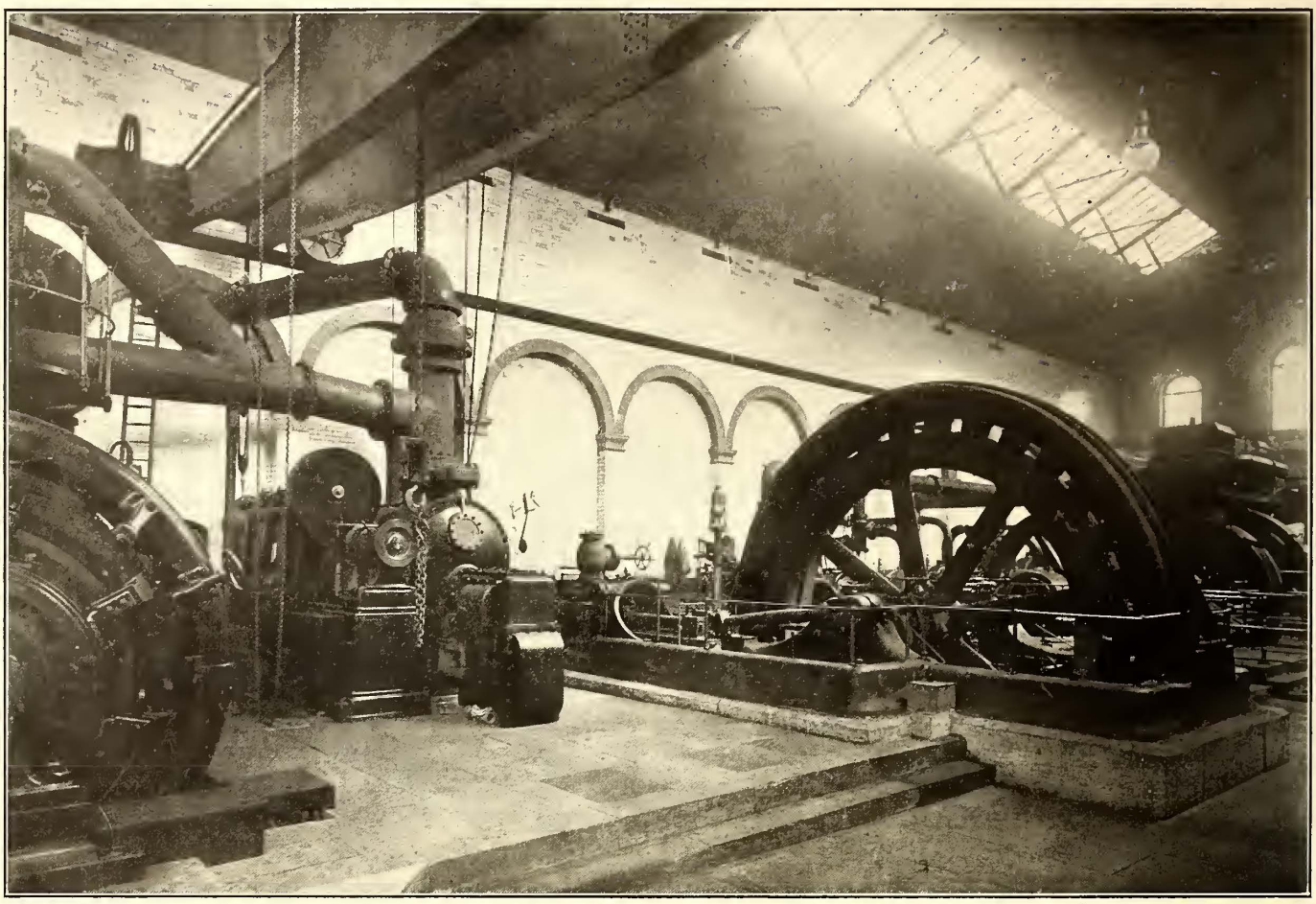


FIG. 6.—5500-VOLT THREE-PHASE GENERATORS AND ENGINES, HALIFAX

The two generators are of the Electric Construction Company's standard slow-speed type, each giving 350 kw at 6000 volts as three-phase current of 25 periods, at 100 r. p. m. One machine was built entirely new, while the other was converted from a single-phase alternator working at 80 periods into a three-phase machine at 25 periods. The armature coils are former wound, thoroughly insulated before fixing in the core slots. The windings were tested with 12,000 volts, between the separate phases and to frame. The steel magnet poles are bolted to a steel shaft, which is further bolted to the rim of the cast-iron flywheel, which, together with the magnet, weighs 26 tons. The efficiency of the alternator is 95 per cent, while the exciting energy is only 1¼ per cent, although the regulation is 95 per cent from no load to full inductive load. The tested temperature rise was less than 25 degs. C. after eight hours' working at full load.

FIG. 7.—THREE-PHASE SWITCHBOARD IN POWER STATION

In a suitable room adjoining the engine room are the various switchboards for controlling the current, both for the tramways and the lighting. The switchboard for the new high-tension, three-phase work has been supplied by Messrs. Ferranti, Ltd., and is shown in Fig. 7; the remaining boards, as shown in Fig. 8, for the direct-current supply, having been manufactured by the electric department of the Halifax Corporation in the workshops adjoining the electricity works. The lighting network is fed from several sub-stations, and the mains are laid partly on the solid system run in with bitumen, and partly armoured cable laid direct in the ground; some portion is also pulled into

conduits. The cable is chiefly Callender and British Insulated Wire Company's makes.

The general construction of the Ferranti board, which is of the cellular type, consists of a set of 2-in. slates fixed in a horizontal position and solidly grouted into the wall. Between these slates vertical divisions are provided to divide the whole framework into a set of pigeon-hole recesses. Each of these recesses contains individual apparatus, the whole being assembled in such a way that parts of opposite potential are absolutely divided from one another by insulating material which serves not only to prevent the chances of fire and consequent damage to the gear, but also renders accidental contact with two parts of opposite potential practically impossible. Fig. 7 shows a general view of the gear, which contains generator panels to the right and feeder panels to the left, with a connection in between for a wattmeter, which is made to read the total energy generated by all the machines.

The generator panels are of the Ferranti standard pattern, suitable for dealing with a capacity of 600 kw per phase. Each three-phase panel contains section of bus-bar, bus-bar plugs, 1 ammeter, 3 oil break switches coupled together, 3 oil break fuses arranged with duplicate contacts, a cable receiver for receiving and sealing the ends of a three-core cable and complete regulating table equipped with the Ferranti well-known open type regulating resistances and carbon break field switches. The feeder panels contain similar fittings to the machine panels, but are minus the regulating table.

The synchronizing instruments and voltmeters are conveniently placed at the top of the board, and make contact by resting on metallic fittings insulated from the framework. Thus, there are no screws or bolts to adjust or disconnect for the purpose of removing instruments from the board.

The only sub-station for long-distance transmission at present erected is at Hebden Bridge, over 7 miles from the generating station, a view of which is shown in Fig. 9. Two single high-tension cables are laid to this station, consisting of three-core 19-17 cable made by the Land-und Seekabelwerke, Cöln, Nippes, Germany. The plant in this sub-station consists of three 100-kw rotary converters, manufactured by the Electric Construction Company, of Wolverhampton, the static transformers having been made by the British Electric Transformer Company (Berry patents), of London. The high-tension switchboard is also by the Electric Construction Company, the low-tension board being made by the electrical department of the corporation. The three rotary converters, which are seen in Fig. 9, showing the sub-station, are each rated to give 100-kw direct-current output at 550 volts when supplied with three-phase current at 350 volts, 25 periods, the speed being 500 r. p. m. These machines work well in parallel with each other. The efficiency, as tested, is over 94 per cent, and the temperature rise is less than 25 degs. C. after working for eight hours at full load. Each rotary is started by means of a direct-coupled 4-pole induction motor, speed being adjusted for synchronizing by applying a variable voltage from an auto-transformer. There are voltage regulators in the secondary circuit of the static transformers varying the direct-current voltage from 500 to 550 volts; these regulations consist of variable ratio transformers connected to a rheostat of the battery type. The rotaries have a series-winding, which enables them to give a further increase in voltage with increase of load due to the leading current re-acting upon the ten miles of transmission line.

The switchboard (Fig. 9) in connection with the incoming high-tension three-phase current, and the low-tension supply to the rotary converters, consists of six

FIG. 9.—SUB-STATION AT HEBDEN BRIDGE

panels of enameled slate carried on a fireproof framing, and was manufactured by the Electric Construction Company. The two panels on the left-hand are for the two high-tension feeders, 40 amps. each. Each panel is fitted with an ammeter, three-pole double-break switch and three fuses of the expulsion type, the latter being placed above all the other gear. They are plugged in circuit and can be renewed with safety. The whole of the high-tension gear being at the back of the board, it is impossible for an attendant to come into contact with any high-tension circuit from the front. All the instruments are low-tension, each having its own reducing transformer. The main switches, each of which are operated by a handle, passing through to the front of the board, have six arms shielded from one another by substantial slate diaphragms; the quick break on each phase being 2 ft. 4 ins., gives a total, on the three phases, of 7 ft.; the final break is on carbon contacts. Between the above panels and those for the converters is the synchronizing panel. The synchronizing, which is done on the low-tension side, and on all three phases, is so arranged that the lamps, which are in duplicate, indicate whether the in-coming machine is running too fast or slow. There are the usual voltmeters, plugs, switches and fuses.

FIG. 8.—DIRECT CURRENT SWITCHBOARD AT MAIN STATION

Coming to the three rotary-converter panels, the current is delivered from the bus-bars through fuses and switches, similar to those on the feeder panels, to step-down transformers; the low-tension current returning to the three-pole switches, fuses and ammeter on the front of the lower portion of the panels, and thence to the converters. A battery of 270 cells is installed by the Chloride Electrical Syndicate, the output being 200 ampere-hours. At present this sub-station will feed into the tramway network which extends out to Hebden Bridge.

Having described the power house and the sub-station, a few words about the outside construction may be interesting. Halifax is a very hilly town, and the cars which run outside the town have many long and heavy grades to overcome. One of the views (Fig. 10) shows one of the routes along the valley, and a car can be seen ascending the long grade.

The overhead equipment of the tramways is under the control of the electricity department, a workshop being erected close by the generating station. The workshop contains the usual machine tools, and most of the overhead fittings are made here.

At present there are about 30 miles of tramway single track, and all the overhead equipment for the last two years has been done by the electricity department. All the feeder boxes and section boxes are fitted up in the workshops, the box castings being obtained locally. Aluminum cross-overs have been used in several cases, and have been found to give great satisfaction, and are a great convenience, owing to their small weight. Owing to the hilly nature of the town, the demand for tramway current is exceedingly variable, the maximum current per car being 30 amps. with sixty cars running. In other towns, where the gradients are small, this does not exceed 15 amps. per car. There are grades of 1 in 9, and the sharpest curve is 30 ft.

The trolley wire is of 00 sectional area, and the ears are hammered over this, no solder being used. The poles are quite tasteful, as can be seen by reference to Figs. 11 and 12. The various insulators have been supplied by Estler Brothers.; Macartney, McElroy & Company, and the Electric Tramways Equipment Company. Section boxes have been fitted at half-mile intervals, and feeder boxes where needed. These sectional and feeder boxes have been fitted up by the tramways department, and contain the necessary switches to divide each section of the line, lightning arresters, etc. Guard wire has been erected to the requirements of the Postmaster-General, and is bonded to every fifth pole, itself being bonded by copper bonds to the rail. Every section box and feeder box

FIG. 11.—VIEW SHOWING OVERHEAD CONSTRUCTION

is also bonded to the rails. The guard wire in use is of No. 8 iron wire galvanized. The aluminum wire has been used as a trail, but did not give satisfaction.

The rails were laid under the supervision of James Lord, A.M.I.C.E., borough engineer, and are of the steel girder type in 30 ft., 45 ft. and 60 ft. lengths, the weight per lineal yard is 95 lbs. The rails are laid on a bed of concrete 6 ins. thick, and are connected by tie-rods 2 ins. x ½ in. every 10 ft. The angle-plates are six-holed and 60 lbs. in

weight per pair. Anchor patent sole plates are also used, riveted to the bottom of each rail and let into concrete. The bonds are Columbia bonds.

Spencer's patent slipper brake is used on the cars in addition to the ordinary hand brake.

There are seventy cars at present in use, the equipments being by the Westinghouse and British Thomson-Houston Company, and single-truck cars only are used. The car bodies were made by Milnes & Co., of Birkenhead and Hadley. The motors are the G. E.-800 of the British Thomson-Houston Company, and the No. 49 Westinghouse. The cars will hold about 45 passengers and weigh complete with truck about 8 tons.

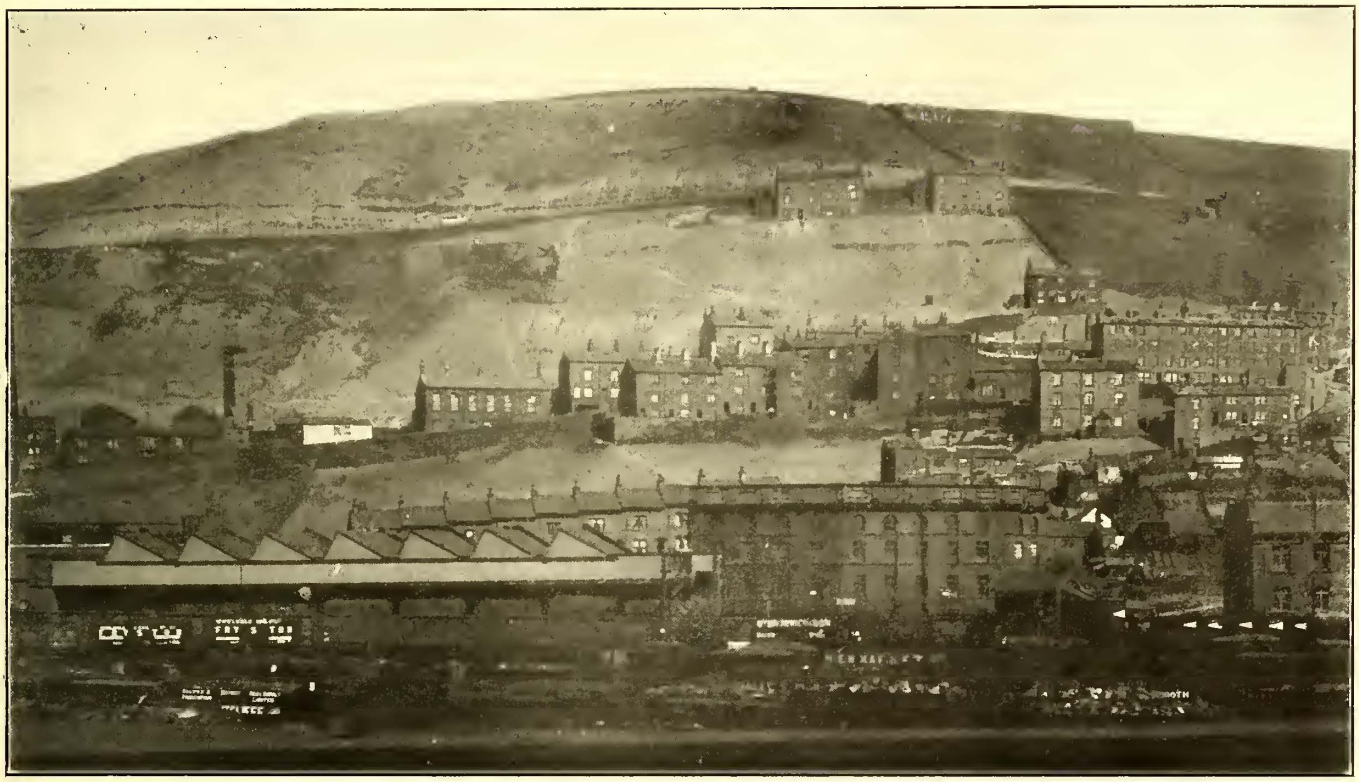


FIG. 10.—VIEW OUTSIDE HALIFAX, SHOWING HEAVY GRADES

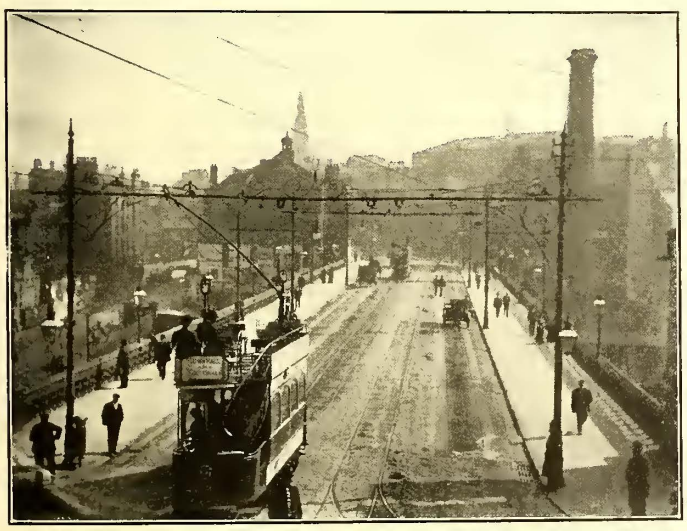


FIG. 12.—VIEW ON NORTH BRIDGE

For the foregoing particulars, this paper is much indebted to Mr. Rogerson, the electrical engineer of the corporation; Mr. Spencer, the tramways manager; Mr. Baldwin, chairman of the tramways committee, and the various contractors.

An Electric Railway to Connect Washington, Baltimore and Annapolis

The work of preparing the roadway of the Washington, Baltimore & Annapolis Electric Railway, which is to connect Washington, Baltimore and Annapolis, is progressing satisfactorily, and arrangements are being made for beginning track laying at once. The road will extend from the District line at Chesapeake Junction to the Baltimore city limits, connecting at Westport with the lines of the United Railway & Electric Company, of Baltimore. The distance between these points is about thirty-one miles, and the route to be followed is practically an air line. The line between Washington and Baltimore is graded for double track, but for the present a single track only will be laid. From Chesapeake Junction to Washington the tracks of the Washington Railway & Electric Company will be used to the terminus of the latter line at Fifteenth and H Streets. Here the Baltimore, Washington & Annapolis Electric Railway will erect a terminal station that will probably be used jointly by that company and the Chesapeake Beach Railway Company, which is to run its trains into Washington to this point.

The line to Annapolis will practically be a branch, for it will extend from Odenton, about eighteen miles from Washington, to Annapolis, a distance of fourteen miles. Together with the line to Annapolis, the road will be about forty-five miles long. The work of preparing for the line to Annapolis has not progressed as far as that for the through line between Washington and Baltimore, and it is probable that the Annapolis line will not be built until the Washington-Baltimore line is completed.

About two acres of land have been purchased at Hyattsville for a power house, and work on the plant will be begun at once. It is said that the power house and sub-stations which it is proposed to build will cost $350,000.

New Power Station and Car House at Manchester, England

About a year ago an outline was given in the Street Railway Journal of the plans of the Manchester City Corporation for the erection of an immense power station to supply power for the lighting and tramway systems of the city, both of which are owned by the municipality. Manchester has had, for some time, one of the most extensive electric power systems in the United Kingdom, but most of the distribution has been by direct current, and the lighting system has been on either the five or three-wire system. The demand for power, however, especially for tramway service, has for a long time exceeded the capacity of the two existing stations, although additional equipment has been installed in them, so that they now have an aggregate capacity of about 31,000 hp.

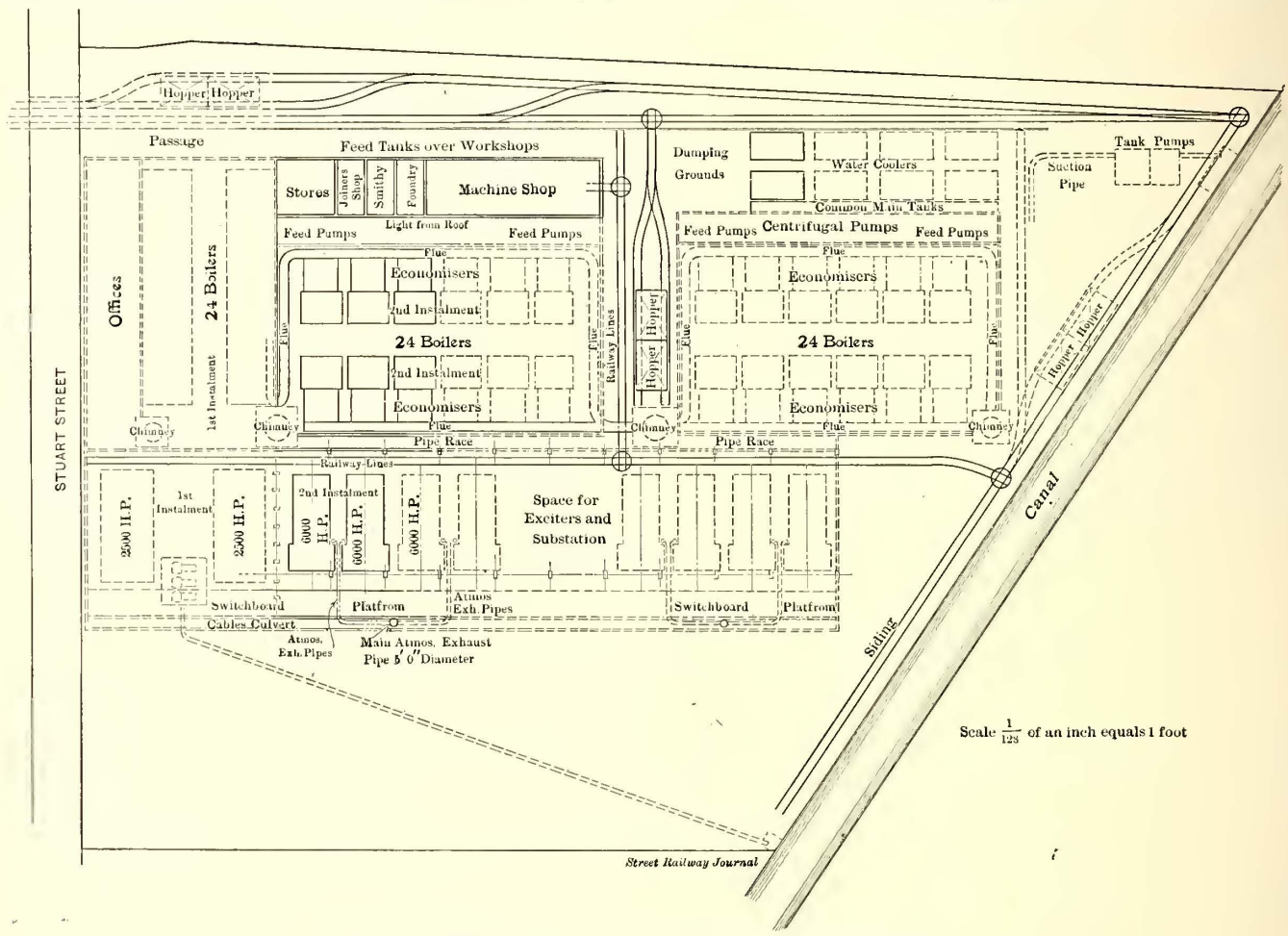


FIG. 1.—PLAN OF NEW POWER STATION AT MANCHESTER

The old stations are two in number, both situated on the Rochdale Canal and connected by an overhead walk. One of the stations, the Dickinson Street works, contains two 3000-hp Musgrave engines, two 1200-hp Ferranti engines, two Parsons 3500-hp turbines and seven 400-hp Goodfellow engines. The four latter are connected with their dynamos by belts or rope-drive. All the others are direct-connected to their respective machines. Part of the power distribution from this station is accomplished at 1500 volts by means of direct-current step-up transformers, by which the pressure is increased from 400 volts. Direct-current step-down transformers are used in the two sub-stations to which this current is supplied. There is also a temporary plant of three-phase inverted rotary converters for power distribution at the Dickinson Street station. The Bloom Street station contains four 3500-hp Musgrave compound engines direct connected to Westinghouse generators. The engine plant at this station is extremely compact, having a total of 14,000 hp contained in a room of 6600 sq. ft.

The new power plant which the corporation is building is known as the Stuart Street works. The work on this station was commenced in March, 1901, under the supervision of Prof. A. B. W. Kennedy, and the engines were put in service during the end of May of this year. Before the station was put in operation, however, the corporation realized that the future needs of the city for power would be greatly in excess of the ultimate power capacity of the plant, and steps were immediately taken to increase greatly the output of the plant. The plans for this addition were drawn up at the request of the Council, by E. F. Metzger, who had recently been appointed chief engineer of the city, so that the station now being completed at Stuart Street combines under one roof two complete stations of considerably different design. The work on the new part of this station is not sufficiently advanced to allow the publication of a complete illustrated article about it at the present time, but, in view of the importance of the work and the fact that the plans call for larger engines than are now being used for electric work in Europe, viz., of 6000 hp each, some particulars of this plant will be of interest.

The accompanying engraving shows a plan of the complete power station. The portion at the left of the plan indicates the first instalment designed by Prof. Kennedy, that of Mr. Metzger being at the right. In the Kennedy, or first, instalment the steam raising plant consists of twenty-four B. & W. water-tube boilers, built in pairs and arranged in two rows, one in each of the side bays of the boilers. These boilers generate steam at a pressure of 170 lbs. to the square inch, and each boiler is connected to each of two main steam pipes which run down the middle of the center bay and are connected in the engine house to a complete ring main with a branch to each en-

gine. The engine room contains two 2500-ihp vertical cross-compound engines built by Yates & Thom, running at 94 r. p. m., and each directly connected to a 1500-kw, three-phase alternator built by the Allgemeine Elektricitäts-Gesellschaft. These machines generate current at 6500 volts and 60 cycles per second. The high and low-pressure cylinders of the engines are 36 ins. and 71 ins. in diameter, respectively, by 42 ins. stroke, and they are steam jacketed. Each exciter set consists of a three-phase induction motor driven direct by current supplied by the main generators at 6500 volts, and coupled to low-tension

FIG. 2.—INTERIOR OF NEW QUEEN'S ROAD CAR HOUSE

shunt-wound generators. The auxiliary engine sets consist each of a 300-hp Willans compound engine, direct-coupled to a 200-kw direct-current generator built by the Allgemeine Company, and are used for supplying current for lighting and for the various motors about the power house, as well as an alternative source of exciting current for the main generators. Willans condensers are used in connection with water from the canal. There are also four Klein cooling towers.

The Stuart Street first extension, as it is officially called, or the portion on the right of the original station, as shown in the plan, is patterned more after American practice, in that the center bay of the boiler room is parallel to the engine-room wall, while the engines themselves are more in keeping with the projected size of the plant, being of 6000-hp each. The ultimate capacity of this portion of the system, as shown in the plan, is eight of these 6000-hp units, but two only are to be installed at first, together with six batteries of boilers, making an available capacity of 12,000 hp. Running over the whole length of the house will be a coal bunker of about 5000 tons' capacity. This will be equipped with electrically-driven Hunt coal conveyors. The boilers will be of the Babcock & Wilcox type and will be equipped with Babcock superheaters, which will give a superheat of not less than 120 degs. F. at 200 lbs. pressure. Each boiler will be capable of evaporating not less than 20,000 lbs. of water with 5700 sq. ft. of heating surface and will be the largest boilers that the Babcock & Wilcox Company has so far built. Green economizers will be used.

The engines will be of the vertical triple-expansion type arranged with four cylinders and four cranks, and will run at 75 r. p. m. with 190 lbs. pressure superheated steam at the stop valve. They will be supplied by the Wallsend Slipway & Engineering Company, Ltd., of Newcastle. Corliss valve gear will be used.

The leading dimensions of these engines are as follows:

H. P. cylinder, diameter	37 ins.
M. P. cylinder, diameter	59 ins.
L. P. cylinder, diameter	72 ins.
Stroke	60 ins.
Diameter of shafting at engine journals	21 ins.
Diameter of generator shaft through boss	31 ins.

The generators are being built by the Allgemeine Elektricitäts-Gesellschaft and will supply three-phase current at

6500 volts and 50 cycles. Two surface condensers, each of 11,000 sq. ft. of cooling surface and capable of dealing with 32,000 lbs. of steam, are being supplied by Mather & Platt. There will be two batteries of three cooling towers each, to deal with the hot circulating water. Each will be capable of cooling 90,000 lbs. of water and will guarantee to reduce the temperature from 125 degs. to 85 degs.

which consists of four 150-kw synchronous motor generators, and one 100-kw induction motor balancer. These units are all situated down one side of the new engine room and constitute the Stuart Street sub-station.

An additional gallery will be placed below the level of the engine-room floor, for the purpose of carrying all the necessary starting, regulating and feeder-charging rheo-

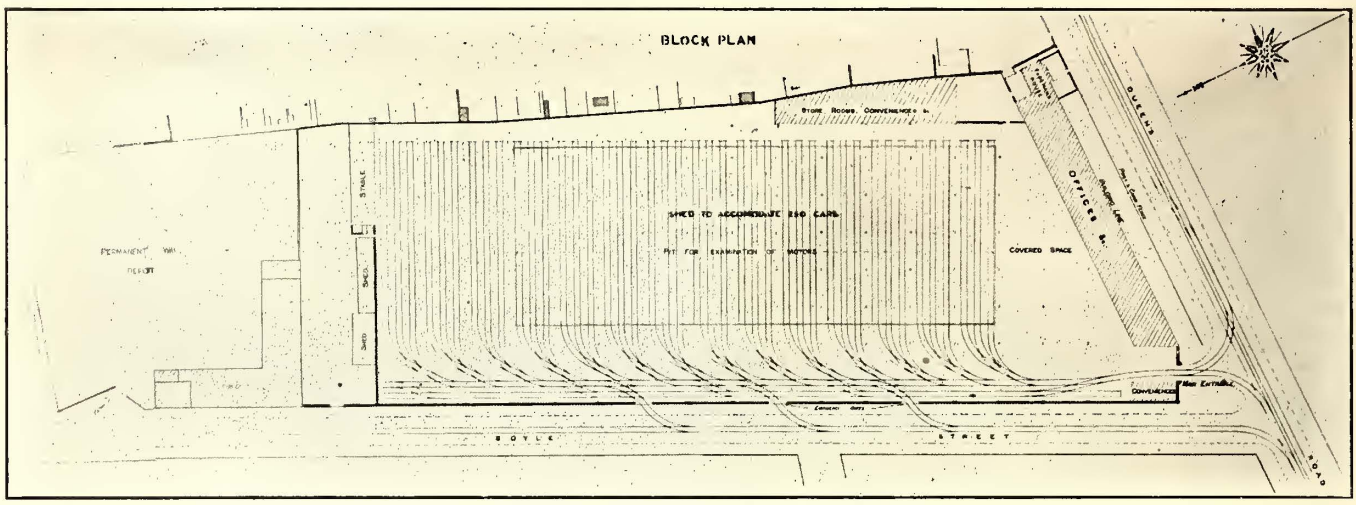
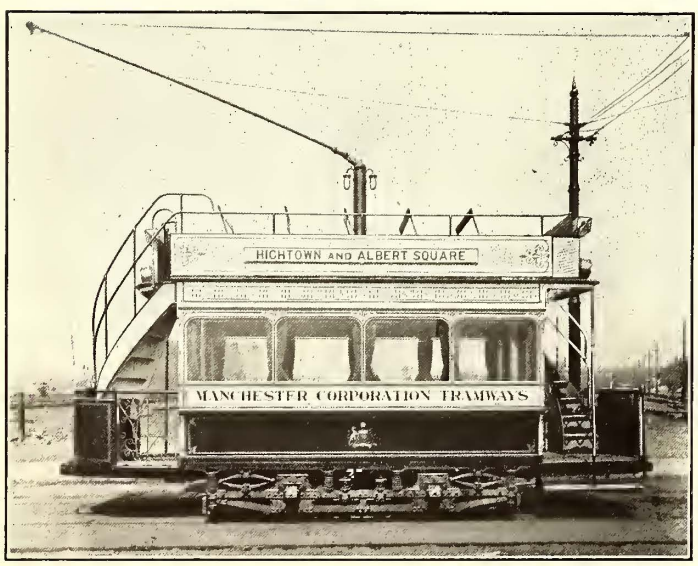


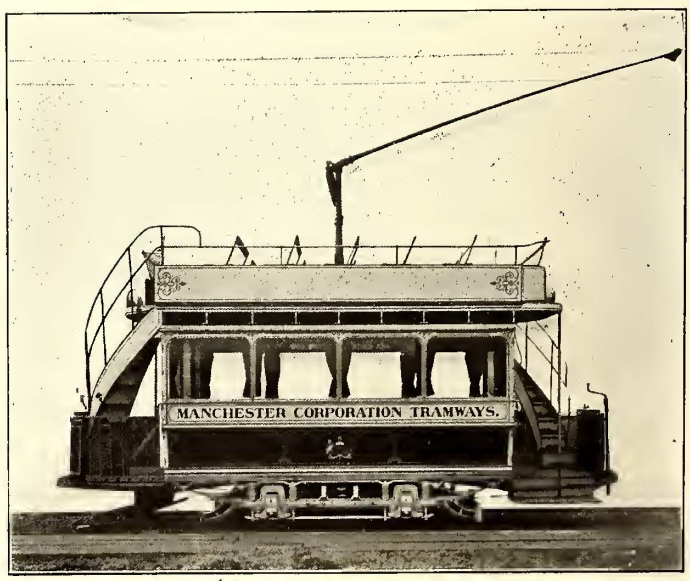
FIG. 3.—PLAN OF QUEEN'S ROAD CAR HOUSE

each. One battery of towers is being supplied by the Wheeler Condenser Company, and the other by Arthur Koppel.

The main switchboards, which are being manufactured by Messrs. Ferranti, are arranged on three galleries which extend down one side of the engine room. There is to be one main switchboard situated on the middle gallery, and

stats and resistances, which are to be worked by gearing and extended spindles carried up through the floor to suitable pillars and hand wheels, thus enabling each to be worked from its own switchboard level. Normally, the traction and lighting bus-bars will be kept separate, but arrangements are made for coupling them together if necessary, but they will also be connected, respectively, to





FIGS. 4 AND 5—STANDARD SINGLE TRUCK CARS, MANCHESTER CORPORATION

at the same level as the switchboards in the existing station, which controls the two main 3750-kw units, fourteen high-tension feeders, and the two 200-kw exciter sets. On the top platform are the main bus-bars for lighting and traction, and the change-over switches for enabling a machine to be run on either set of bars, while on the bottom platform the main fuses are placed in duplicate. Further along, on the middle or main platform, are the auxiliary lighting and power boards, each controlling twenty circuits, and fed from the existing continuous-current sets or from the sub-station at Stuart Street. Immediately beneath the auxiliary boards and on the lower platform are the switchboards for controlling the sub-station plant,

the traction and lighting bus-bars in the existing portion of the station.

Fifty-five ft. from the ground level there will be two 50-ton electric overhead travelers, made by Messrs. Higginbottom & Mannock, each having a span of 84 ft. Separate motors of the B. T. H. type are provided for hoisting, traversing, and cross-traversing, each worked by a special B. T. H. controller.

Two electrically-driven coal and ash elevators and conveyors are being provided by Babcock & Wilcox. Each conveyor will be capable of dealing with 40 tons of coal per hour. The conveyor is automatically fed from the hoppers under the railway sidings. It thence travels under

the boiler-house floor and, rising at the end boiler-house wall, automatically tips the coal into the large bunkers overhead. On its return trip it will pick up the ashes and deposit them in a separate bunker from which the railway cars on the high or low level can be filled.

The purpose of this article being simply to give a general outline of the proposed work at Manchester, no attempt will be made in this issue to describe the interesting sub-stations, the motor generators of which are being supplied by the Allgemeine Elektricitäts-Gesellschaft, and the switch gear by Ferranti; or the important distribution system which is being carried out by W. T. Glover & Company, the well-known cable manufacturers, and which will probably be the most complete of any in the United Kingdom. The work of construction is being carried rapidly forward, however, under the supervision of Mr. Metzger, and in a later article an opportunity will be offered for views of the work itself, with fuller particulars of the machinery being installed.

A description of the recent work in Manchester would

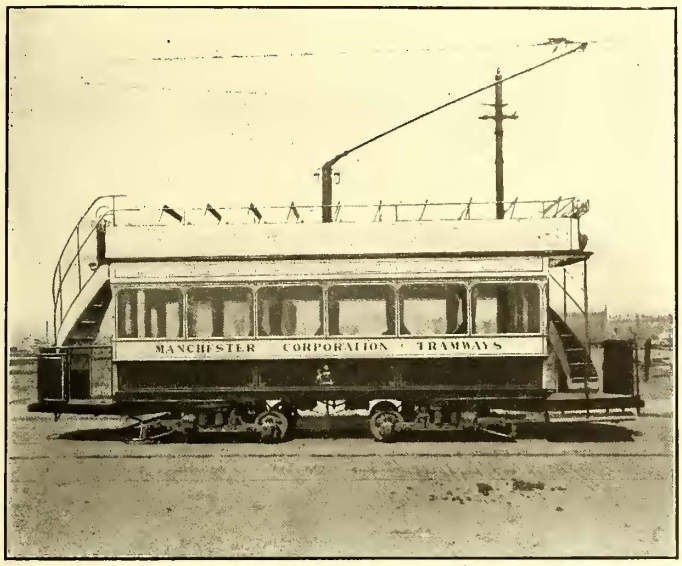


FIG. 6.—STANDARD DOUBLE TRUCK CAR

be incomplete in this paper without at least a reference to the tramway system, which is one of the largest, as well as one of the latest, in Great Britain. The tramways in Manchester are also owned and operated by the corporation, and the first section was put in operation in June, 1901. The system is not confined to the county lines, but extends beyond the city of Manchester in a number of directions, except in the direction of Salford which has its own roads The tramway system in Manchester was originally leased by the city to private operators for a term of years, but as the leases expired the lines have been taken back by the municipality and equipped with electricity. The system is now almost entirely under the control of the city and has been transformed to electric power. As it stands, it comprises about 150 miles of track

One of the principal features of the system is the Queen's Road car house, capable of accommodating 262 standard cars of the company, and said to be the largest car house in Europe. A plan of this building is presented in Fig. 3, and an interior view is given in Fig. 2. The car house consists of fourteen bays with three tracks in each bay. A pit having an area of 6500 sq. yds. is provided under eleven of the bays. The tracks over the pit are supported on old tramway rails which rest on steel pillars, providing free access over the whole area of the pit and allowing for the inspection of 200 cars at once. Running the entire length of the pit and at right angles to the tracks is a passageway deep enough so that the repairs foreman or chief inspector can walk the entire distance from one end of the pit to the other under the cars, and thus inspect the work in hand. In this trench are located the main hot-water pipes for heating the building. The pit and floor of the building are of concrete, while the walls themselves are of brick.

The cars usually enter and leave the building by the main entrance, which is 16 ft. wide at the front of the building, but three additional entrances are provided in the side of the building in cases of emergency, such as fire, a breakdown at the main entrance, etc.

The corporation is using both single and double-truck cars, and views of the standard cars are presented herewith. Single-truck cars are considered more desirable for most of the lines, but double-truck cars are used on the long-distance lines, especially during the morning and evening runs; the peak speed allowed it ten miles per hour. The cars were built by the G. F. Milnes Company and the Brush Company. The wages paid for a working week of sixty hours are as follows: First-class motormen, 31*s* 2*d*; second-class motormen, 28*s* 9*d*; first-class conductors, 27*s* 6*d*; second-class conductors, 25*s*; motor inspectors, 36*s* 3*d* to 38*s* 9*d*; washers and cleaners, 21*s* 3*d* to 25*s*; time-keepers, 27*s* 6*d* to 30*s*; ticket and night inspectors, 28*s* to 35*s*. The manager of the tramways is J. M. McElroy.

A Graphical Method of Making Time-Speed Curves

BY WALTER S. VALENTINE, M. E.

In the preliminary calculations for proposed electric railway systems, the time-speed curve is an important factor. By its use the engineer is enabled to compare the performance of various possible electric equipments for the service, and is the basis upon which a series of important determinations are made.

It is the object of this paper to describe a graphical method devised by the writer, which greatly facilitates the construction of these curves.

There are several factors which enter in to affect the velocity of the train, and which make the construction of the time-speed curve somewhat complicated. The factors which directly affect the nature of the curve are: Tractive effort of the motor; train resistance due to air resistance, friction, etc.; grade resistance, and finally resistance due to curves in the road.

The acceleration of the train is directly proportional to the algebraic sum of these forces, or:

$$A \propto T.E. - Tr. \pm Gr. - Cr. \qquad (1)$$

where A equals acceleration; $T.E.$ equals tractive effort due to motor; $Tr.$ equals the train resistance due to air resistance and friction; $Gr.$ equals grade resistance and may be either positive or negative; $Cr.$ equals resistance due to curves in the road. This last factor is expressed in pounds per ton per degree of curvature, and to simplify the above proportion, may be combined with $Gr.$ and expressed as equivalent grade.

The factors ($T.E. - Tr.$) will be referred to as net tractive effort.

The tractive effort ($T.E.$) varies in an inverse ratio with the speed, and its values with corresponding speeds for any particular motor equipment are obtainable from characteristic curves furnished by the manufacturer.

The train resistance ($Tr.$) in general varies with the train speed and may be found from some standard formula such as the Baldwin Locomotiove Works formula.

The weight of train being known, the successive accelerations of the train's velocity starting from rest may be com-

puted by use of the above proportion put in the form of an equation:

$$Acc. = \frac{1}{M}(T.E. - Tr.) \pm Gr. \qquad (2)$$

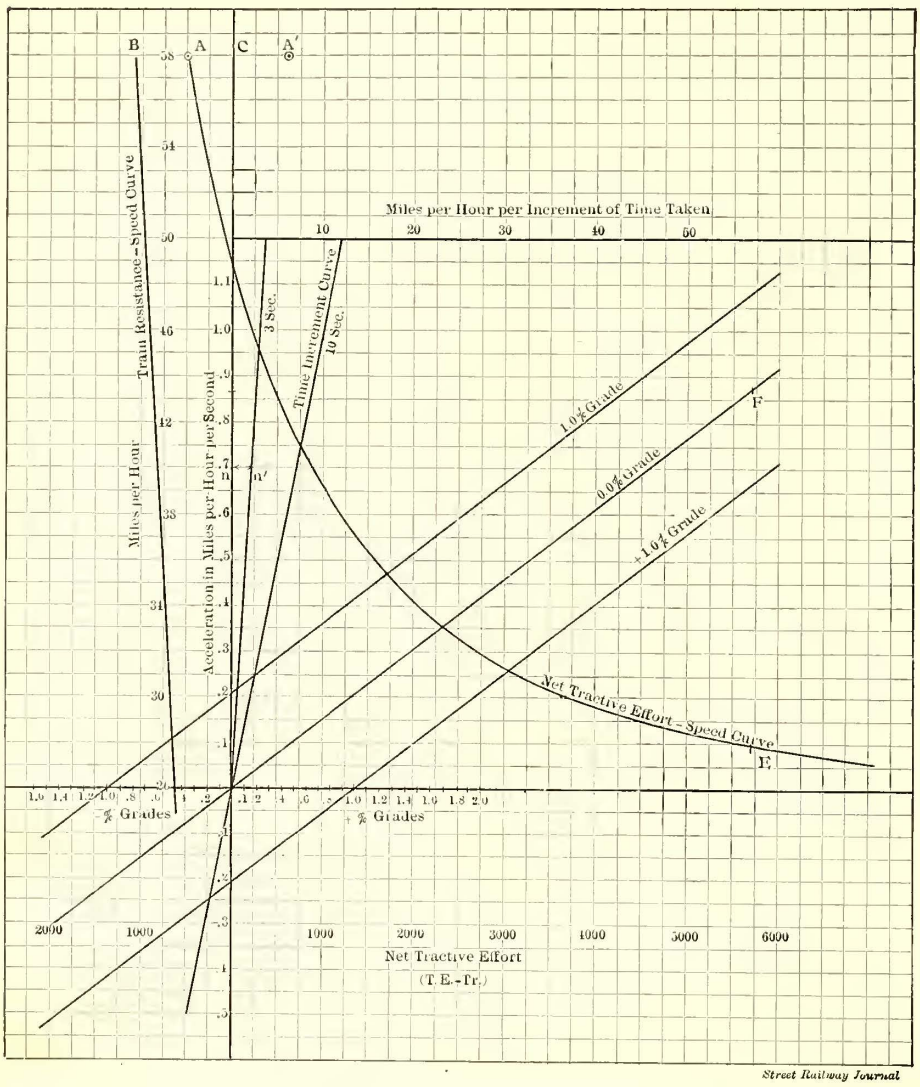


FIG. 1.—CHART FOR PLOTTING TIME-SPEED CURVES

where M represents the mass of train, including the equivalent mass of rotating parts.

The initial acceleration is considered as acting uniformly up to the point when the full line pressure is impressed on the motors. From this point on, the acceleration decreases because of the decrease in the $T.E.$ of motors. In order to obviate the necessity of computing the acceleration for each successive change in tractive effort, the writer has made use of a chart from which the increments of velocity may be transferred by means of dividers directly to the time-speed curve.

This chart, Fig. 1, is constructed as follows:

The net tractive effort is taken as abscissæ for both positive and negative values, and speed in miles per hour is taken for ordinates. The train resistance speed curve is drawn first and in case the B. L. W.'s formula is used, it is a straight line. Then having at hand a table of motor tractive efforts with corresponding speeds in miles per hour, the net tractive effort speed curve is plotted by making use of the train resistance curve; to illustrate, $A'C$ is value of motor tractive effort for the particular equipment for a speed of 58 m. p. h. Now, by aid of dividers, the point A' is moved to the left to the position A by an amount BC, the train resistance for that speed. In the same way from each value of motor tractive effort the corresponding value of train resistance is subtracted "graphically" and the net tractive effort speed curve is the result.

The inclined straight line curves, marked "% Grade," are plotted between net tractive effort and acceleration in m. p. h. p. s. for the several grades of the road. These net tractive effort acceleration curves are right line curves and have the same inclination for all grades. This will be readily seen to be the case if equation (2) is compared with the general equation of a right line curve,

$$y = mx \pm c$$

In case there should be a number of grades and consequently a number of grade lines or acceleration curves to be drawn, the writer has found that it greatly simplifies the chart to construct a scale of grade per cents along the horizontal axis, and then draw one grade line with vertical and horizontal axis upon a thin piece of celluloid, and place this over the chart in the proper position for the grades line required.

A second set of right line curves called "time increment curves" are drawn in chart, which serve to give the gain in velocity for any desired time increment to be used in the construction of the time-speed curve.

The use of the chart can best be explained by taking an example:

In Fig. 2 is shown a time-speed curve constructed for the equipment and conditions represented in the chart, using two grades—a zero and a + 1.0% grade. Assume that motors receive full line pressure at a speed of 28 m. p. h., then the initial acceleration will be uniform up to speed. Referring to the chart, the point E on the net tractive effort speed curve corresponds to this speed of 28

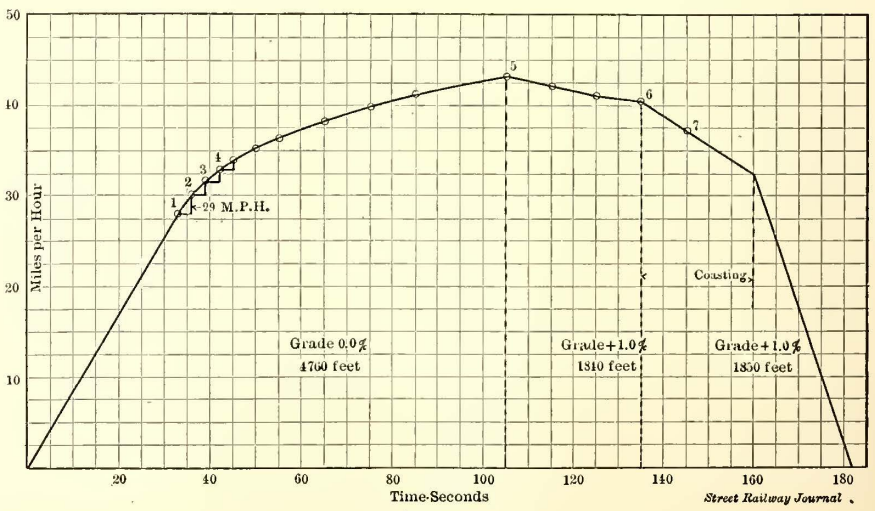


FIG. 2.—SAMPLE TIME-SPEED CURVE

m. p. h.; from E follow a vertical line intersecting with 0% grade line at F; from F follow a horizontal line intersecting the vertical axis, which point gives a value of .87 m. p. h. p. s. acceleration and is the initial acceleration of the train. A straight line is now drawn on time-speed curve from origin to point "1" at 28 m. p. h. with an inclination representing an acceleration of .87 m. p. h. p. s. Point "2" is now obtained by selecting a speed about midway between points "1" and "2," in this case 29 m. p. h., and in the same manner as before find the acceleration corresponding to a speed of 29 m. p. h. This acceleration may be considered as an average between the accelerations at "1" and "2," and in this part of the curve where the acceleration is high should be considered as acting for about 3 seconds. Now, instead of taking the acceleration from the vertical scale on the chart as m. p. h. p. s., the 3-second time increment line is made use of and with dividers set for the distance nn', the gain in velocity for 3 seconds may be transferred to the time-speed curve directly, locating the point "2." In this way the time-speed curve is built up until the area included between it and horizontal axis represents the length of grade. It will be noted that as the acceleration falls off larger time increments may be taken.

By referring to the + 1.0% grade line, instead of the 0.0% line, the curve may be continued for the 1.0% grade. In this case, however, the train having reached a speed which exceeds what would have been the ultimate speed had the first grade been + 1.0% instead of 0.0%, is retarded due to the fact that the train resistance plus grade resistance in this case exceeds the tractive effort due to motor. This fact is taken care of by the chart, for upon looking for the acceleration at 43 m. p. h. on + 1.0 % grade it will be found on the vertical scale below the horizontal axis, which means that the acceleration is negative; or, in other words, the train will be retarded.

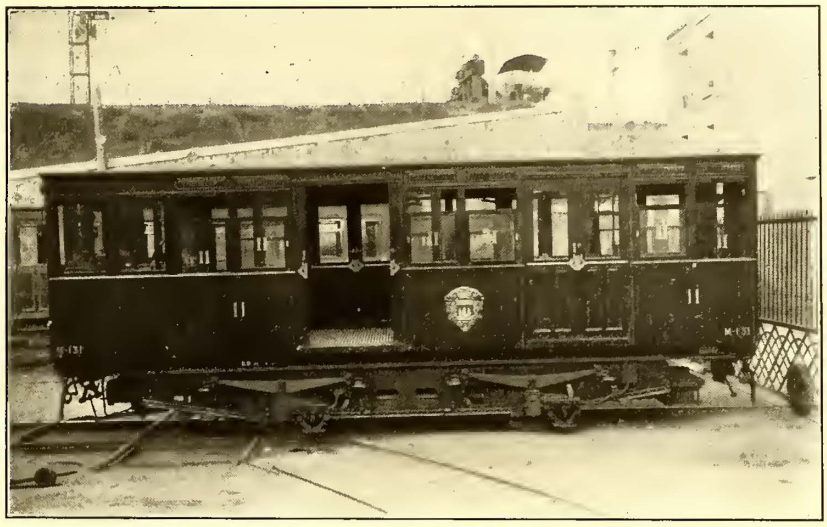
At the point "6" the power is assumed to be cut off and train allowed to coast. Retardation will, of course, take place, the rate of which may be ascertained from the chart by reference to the train resistance speed curve in the same manner that the accelerations were found from the net tractive speed curve at first.

In the chart are shown only two-time increment lines in order to make it as simple for presentation as possible. In practice, however, a number of these lines are used, they can generally be made for 3, 5, 10, 20 and even 40 second increments.

This method has been used in plotting a considerable number of time-speed curves and has been found to be a very efficient time saver.

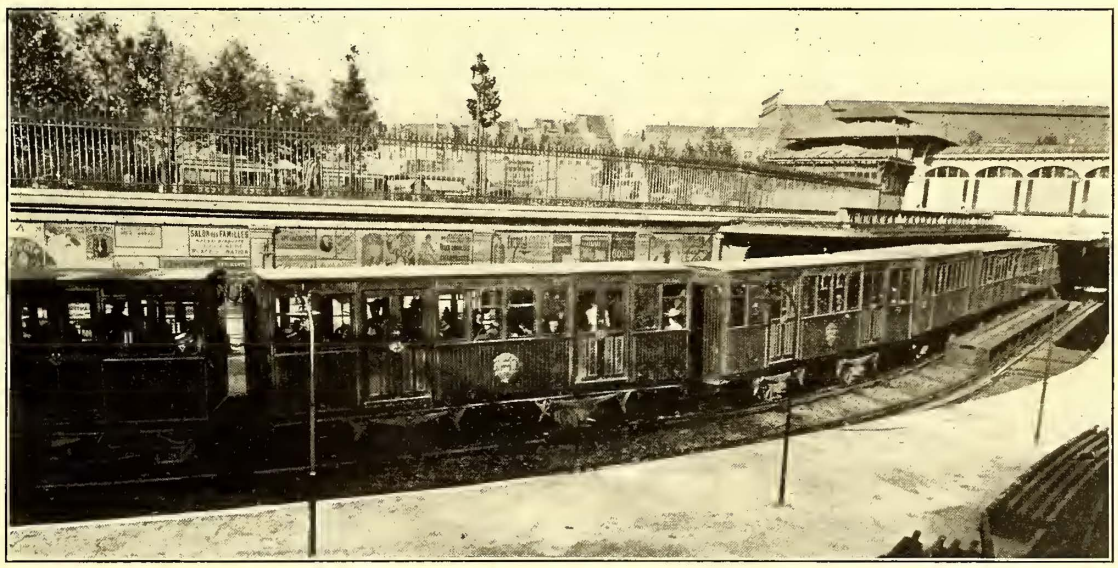
Recent Improvements on the Metropolitan Railway of Paris

The Metropolitan Railway of Paris, which, as will be remembered, is an underground electric road running approximately east and west through the center of the city, has proved to be one of the most successful traction enterprises inaugurated during recent years in France. The road was put into operation in July, 1900, and important extensions are now under construction which, when completed, will bring the road into connection with nearly every important traffic center in the city north of the Seine.



MOTOR CAR ON METROPOLITAN RAILWAY, PARIS

As will be remembered from the description of the road which appeared in the STREET RAILWAY JOURNAL for September, 1900, the original line extended from the Porte de Vincennes to the Porte Maillot and was a double track tunnel, the rails in which were located at an average depth below the surface of the street of only about 15 ft. to 20 ft.

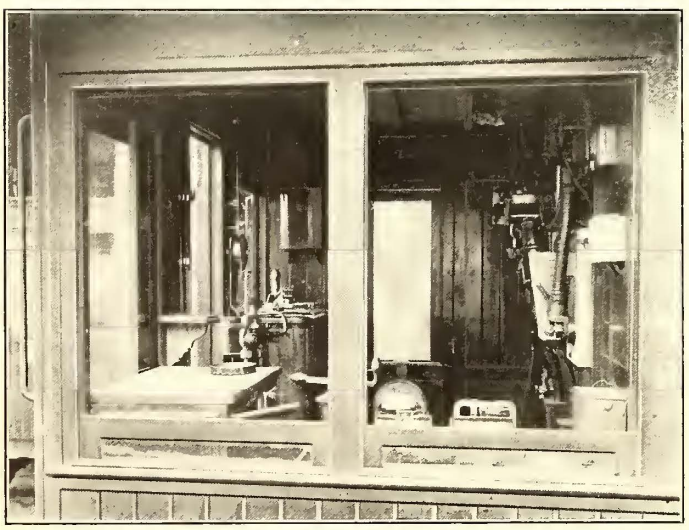


EIGHT CAR TRAIN, METROPOLITAN RAILWAY

The tunnel is 14 ft. 9 ins. high above the rails and between stations is about 23 ft. 4 in. wide. On curves the side walls are carried out to give an additional clearance of about 7 ins. The greater part of the rolling stock consists of 4-wheel cars, following in this respect the usual French steam railroad practice, and the cars themselves are similar in general design to the French railroad cars.

The original train service was conducted by trains of four cars each, of which the leading car only was a motor car, and was equipped with one controller and two motors. The popularity of the road as a means of transit through Paris made it soon evident, however, that an increase in carrying capacity was necessary. This could not be secured, however, by the addition of more trains, because, owing to the block signal system used, the frequency of the trains could not well be reduced below 2½ minutes service, which was in force. The company's engineers, therefore, decided to adopt during the rush hours an eight-car train corresponding to the greatest length allowed by the existing platforms. It was considered out of the question, owing to the limitations imposed by the size of the tunnel and the sharpness of the curves, to use single motor cars as locomotives for this service, and equip them with four motors to secure traction. Moreover, locomotives of this kind would have many drawbacks from the exploitation point of view.

FOUR-CAR MOTOR TRAIN, METROPOLITAN RAILWAY

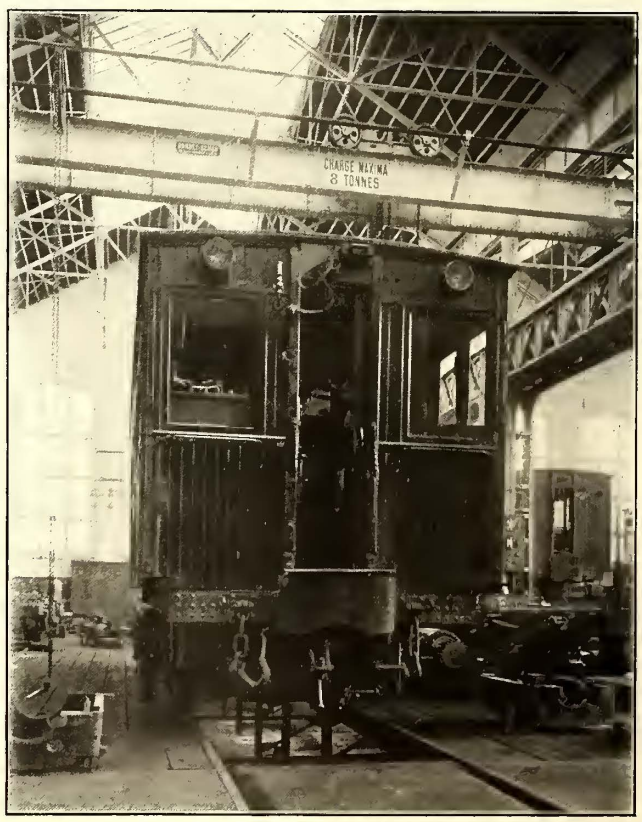


VIEW OF MOTORMAN'S CAB

The company, therefore, considered only the multiple unit system and the two-motor car train method, that is a train with one motor car at each end, operated by a single controller.

Based on the acceleration required (a maximum of about 2 feet per second), the latter plan was found to be cheaper and better suited to the particular conditions of the service. As this was one of the systems considered for the equipment of the Manhattan Elevated Company of New York, an extended description of the method adopted, which was proposed and installed by the French Thomson-Houston Company of Paris, and which in some respects differs from that employed in the New York equipments, may be of interest.

The problem presented to the French Thomson - Houston Company was as follows: A minimum frequency being imposed, say two and one-half minutes, which is to be kept during the whole day independently of any fluctuation of traffic, to adopt a system of traction allowing of a combination of an eight-car train with two-car trains coupled at will together, said four-car trains being completely independent when it is necessary to let them run alone at the hours of feeble traffic, and being coupled together and operated both from the front platform by a single motorman at rush hours.



END VIEW OF METROPOLITAN CAR, SHOWING END ENTRANCE

This, as will be seen from the diagrams herewith, has been accomplished by using a single large train cable for carrying the current necessary for two motors, and in addition, a very much smaller cable with twin conductors, that is, two wires, for an electromagnetic reverse switch. As above-stated, only one controller per motor car is used, making a total of four motors and two L-3 controllers per train, each motor car being provided with one L-3 con-

troller, one special "2 motors-4 motors" switch, one DB-16 magnetic reverse switch (which is the same as used in the General Electric train control system) and necessary number of rheostats for four motors, and finally two TH-4 motors of 125-hp each.

The combinations possible with this apparatus are shown in Figs. 1 to 8, in which Fig. 1 represents two cars with their equipment connected in series; Fig. 2, two cars with their equipments connected in parallel; Fig. 3, two cars in which the motors of the first car have been cut out of circuit; Fig. 4, two cars in which the motors of the second car have been cut out of circuit; Fig. 5, one car with motors in series; Fig. 6, one car with motors in parallel; Fig. 7, one car with the first motor cut out of circuit, and Fig. 8, one car with the second motor cut out. A schematic diagram of the connections by which these combinations are effected from one point is presented in Fig. 9.

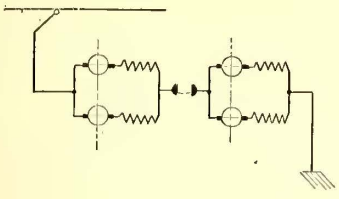


FIG. 1

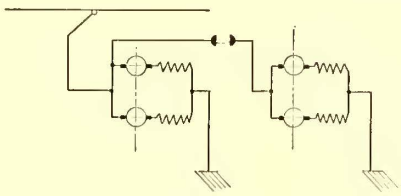


FIG. 2

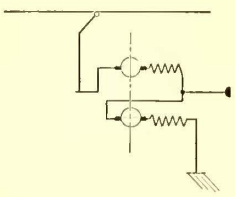


FIG. 5

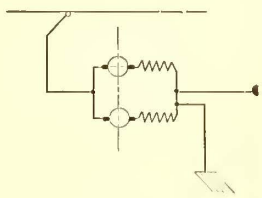


FIG. 6

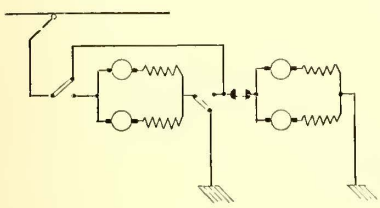


FIG. 3

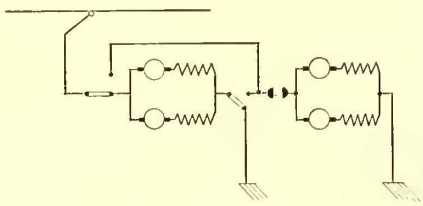


FIG. 4

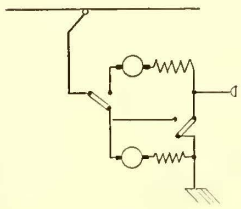


FIG. 7

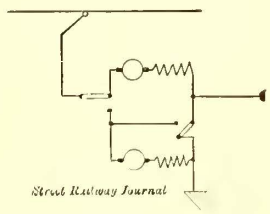


FIG. 8

In Fig. 9, T represents the third rail and F^1 and F^2, the current collectors; A, B and C are three conductors extending the entire length of the train, with couplings between the cars at a, a. D^1 and D^2, and P^1 and P^2 represent schematically the ordinary controller cylinders by which the resistances R^1 and R^2 can be connected in series with the

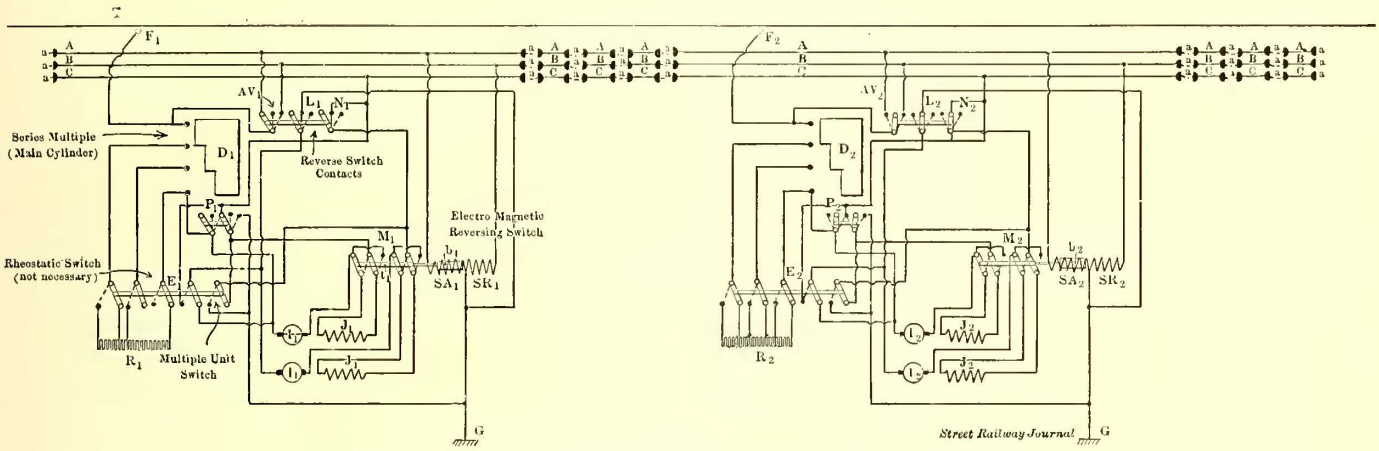


FIG. 9.—SCHEMATIC DIAGRAM OF METROPOLITAN CONNECTIONS

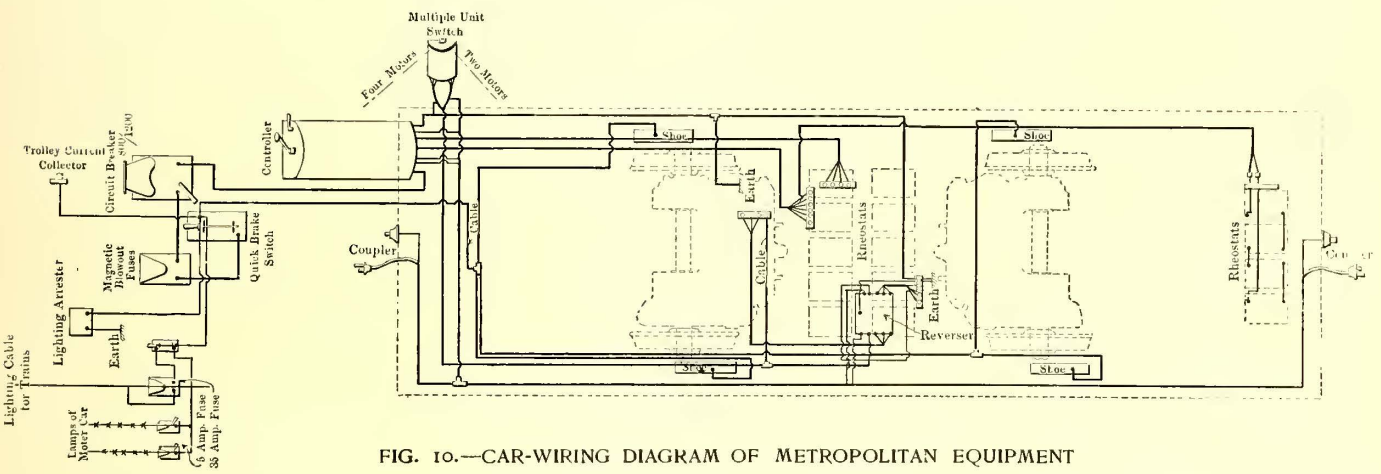


FIG. 10.—CAR-WIRING DIAGRAM OF METROPOLITAN EQUIPMENT

E^1 and E^2 represent the special switches, called "2 motors-4 motors" switches, by which the motor car connections are disposed for four-car trains or eight-car trains. At the same time, the steps of resistances are changed in order to suit exactly the two-motor or four-motor equip-

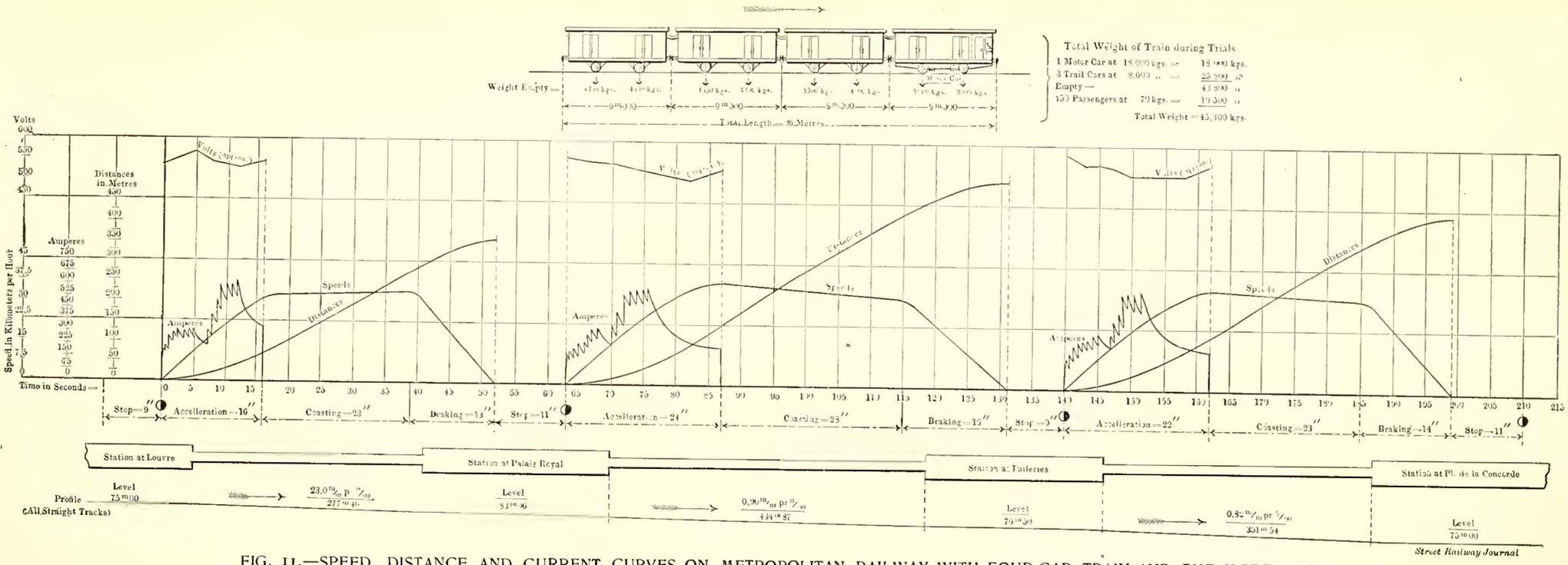


FIG. 11.—SPEED, DISTANCE AND CURRENT CURVES ON METROPOLITAN RAILWAY WITH FOUR-CAR TRAIN, AND ONE MOTOR CAR

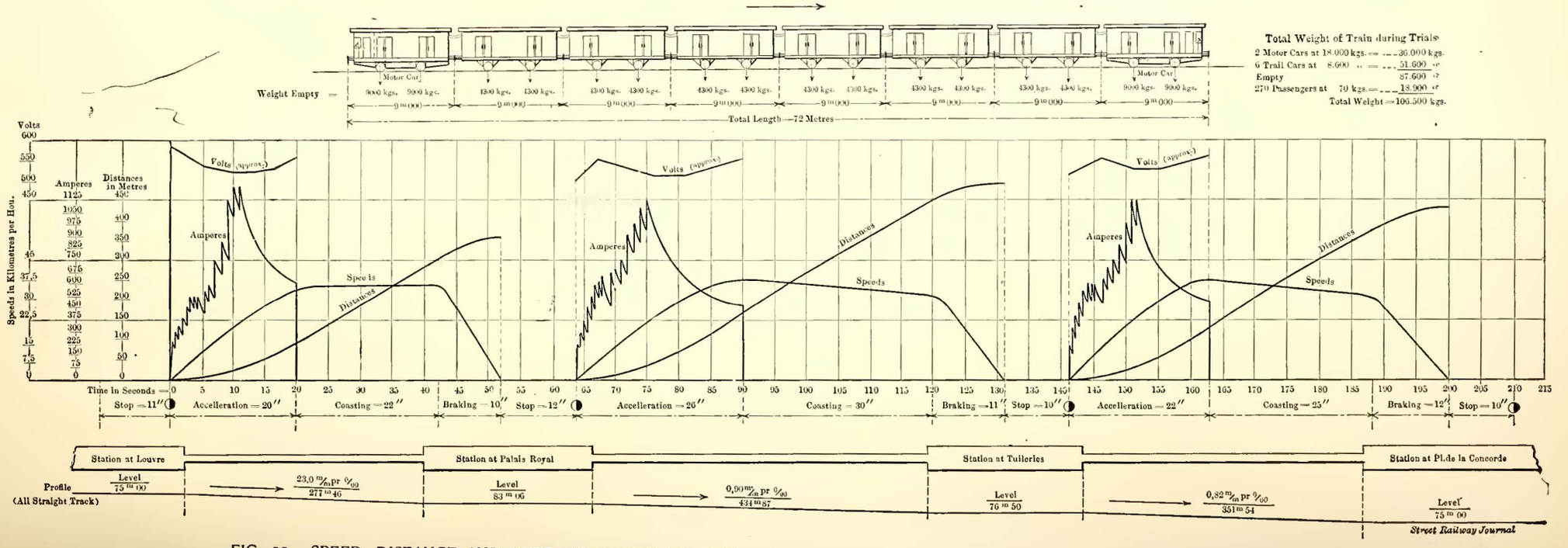
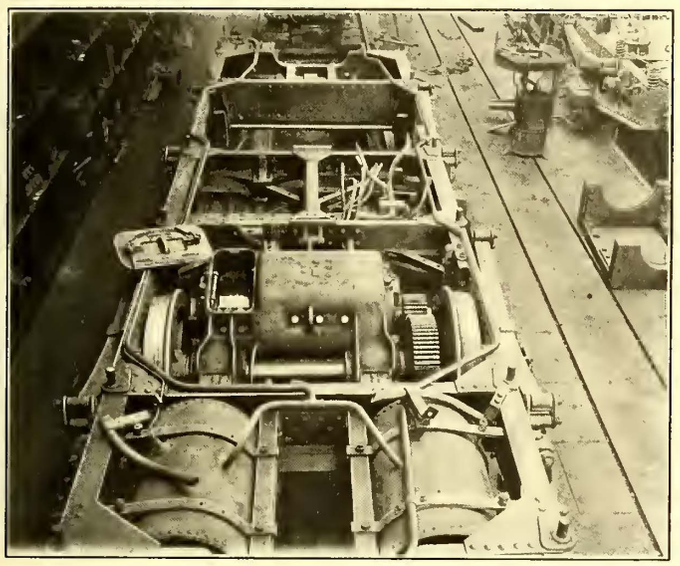


FIG. 12.—SPEED, DISTANCE AND CURRENT CURVES ON METROPOLITAN RAILWAY WITH EIGHT-CAR TRAIN AND TWO MOTOR CARS

ment conditions. It was found in practice, however, that this latter disposition was not necessary on the Metropolitan cars, and in the actual controllers this refinement was omitted.

I^1 and I^2 are the armatures, and J^1 and J^2 are the fields of the motors. M^1 and M^2 are the reversing switches for reversing the direction of rotation. SA^1, SR^1, SA^2 and SR^2

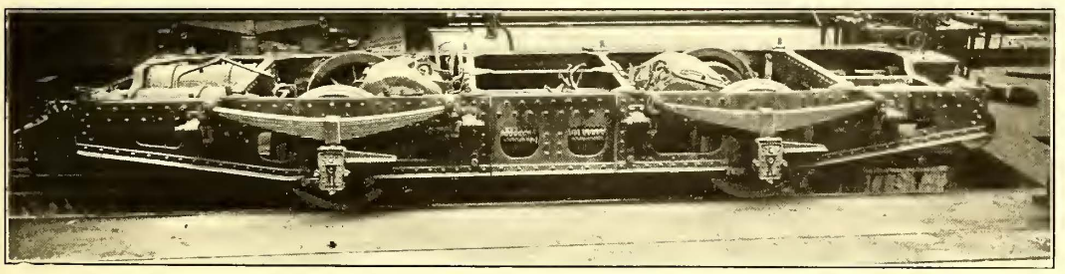


VIEW OF TRUCK

are solenoids which act on plungers b^1 and b^2, and which, by means of the levers t^1 and t^2 operate the switches M^1 and M^2 mentioned above.

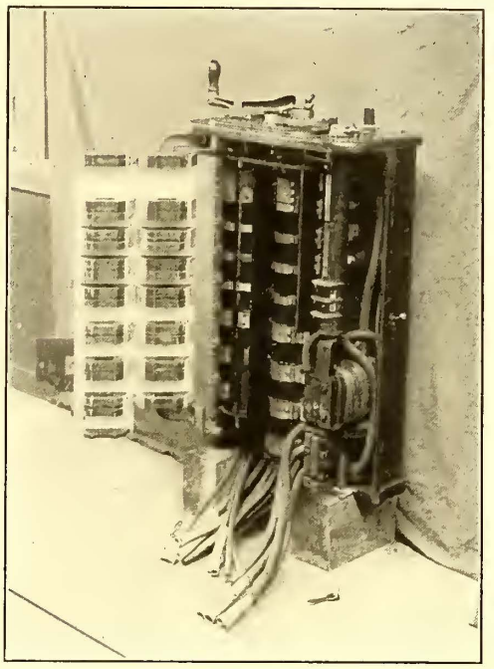
The three switches AV^1, AV^2, L^1, L^2, N^1 and N^2 are operated by the ordinary reversing handle, and serve to control the direction of running of the entire train. The same reversing handle serves to operate the E^1 and E^2 "2 motors-4 motors" switches.

The operation of the system is then as follows: To control the "double unit" train from one point, say from car 1,



LATEST TYPE OF MOTOR TRUCK, METROPOLITAN RAILWAY

the two switches E^1 and E^2 are put in the position "4 motors" shown in the diagram. The switch AV^2 being open, the current passes by the switch AV^1 either to wire A, or wire B. It then passes through the solenoids SA^1, SA^2 or SR^1, SR^2, according to the position of switch AV^1, throwing to the right or to the left the plungers b^1 and b^2, which, by the levers t^1 and t^2 throw the switches M^1 and M^2, and thus determine the direction of running of the train. The switches L^1 and N^1 being open do not allow any current to pass, while switches L^2 and N^2 being closed connect the motors I^2 and J^2 with the earth and the train cable C. The controller cylinder D^1 allows the current to pass through the resistance R^1, and then through the motors I^1 and J^1 and the controller switch P^1 connects the two groups of motors up in series or in parallel. To operate with a single unit, as, for instance, with unit No. 1, it is necessary only to change E^1 to the "2 motors" position. The terminals of the two motors I^1 and J^1 are then so connected that the movement of controller switch P^1 can put them either in series or in parallel. Fig. 10 is a car wiring diagram of the system.



CONTROLLER USED IN NEW METROPOLITAN EQUIPMENT

Figs. 11 and 12 show respectively the acceleration obtained by the Metropolitan Company with a four-car train, with one motor car, and an eight-car train with two motor cars equipped as above. They were obtained under ordinary service conditions and indicate very nearly as good acceleration with the eight-car train as with the four-car train. With expert control probably a slightly better showing could have been made.

The Metropolitan Company has now forty-one new two-axle motor cars with two TH-4 motors, which correspond very closely to the G.E-66, and which are equipped with the present double-unit system. In addition, the company has forty more cars under construction to be equipped with the TH-4 motors, and to be used on the new line through the Boulevards Extérieurs.

The number of motor cars equipped with the system described above allows of eight-car trains being run alternately with four-car trains during the rush hours in the morning and evening; at other times, four-car trains are sufficient to care for the traffic.

This new service was inaugurated in November, 1901, and the very important increase in receipts since that time show the success of the system.

A method employed on one of the San Francisco street railways for holding the motor pinion on the shaft is as follows. The ordinary lock-nut washer is not put on the shaft, but the nut is screwed up tight to the pinion. A blunt, round-nosed chisel is then employed to swell out a little the end of the pinion over the nut holding the latter in place. This method is found more desirable than the use of a lock-nut washer.

Failure of Municipal Ownership in England

BY HON. ROBERT P. PORTER

PART II., AND CONCLUSION

The general outline of the arrangement, mentioned last month, by which the British government in 1892 took over part of the telephone business of the country was that the trunk wires which connect large towns should be worked by the postmaster-general, and that business inside of towns, which in England is generally called "exchange business," should be left in the hands of private companies. This dual arrangement had its disadvantages, and, as those who understand the business will realize, its inconveniences; but the telephone company could do nothing but go ahead along the line mapped out by the government. Having no control over the entire system, and being more or less hampered by municipalities in the matter of laying wires, moreover being compelled to pay over a large royalty to the government, the inducement was not great to invest additional capital. The government and the company seemed to have got along fairly well, giving an indifferent service for a rather high price, until the municipal traders, looking around for new fields to conquer, took up the matter. The telegraph act of 1899 gives the municipalities the right to establish and work local systems within their own area in competition not with the government trunk lines, but with the telephone company. Now, as everybody knows, the telephone service is not one which lends itself to competition, because it is obviously very inconvenient for a telephone subscriber to find that people with whom he wishes to speak are not on his system, but on the system of some other company. What with the government absorbing the trunk lines and municipalities reaching out after the local business the company which originally undertook the exploitation of the telephone in England is becoming discouraged, and some of the officers openly say that rather than still further complicate and obstruct the business by municipal trading it would be wiser for the government to take it all over and run it, with the telegraph, as a State monopoly.

There are several reasons why this plan is just now not agreeable to the British Government. In the first place, public sentiment is murmuring against increasing State undertakings. Then the government has made a mess of the telegraph business, which does not even pay. Up to 1899 the British Government has lost the enormous sum of $35,000,000 in the management of the telegraph business. This has become alarming, because the loss is continually increasing, and last year it was $3,000,000. It is generally conceded that a private company, or two private companies, as we have in the United States, would do the business far better and make it profitable. Then again, in Victoria, where the railways have been worked for a considerable time by the State, the loss has been $35,000,000. In South Australia the loss has been $10,000,000. A commission appointed to investigate this shockingly bad management of undertakings on the part of the State reports "the service is disorganized and the political influence is noticeable throughout." It recommends the complete separation of the railways from the State and the placing of them under a board of five trustees, with a general manager. If this is done, the report states than an annual saving of $1,825,000 is indicated.

From India comes the same gloomy story in a report made by Mr. Bell, who is in the Department of India Railways. Mr. Bell expressed a strong opinion that the effect of the government having taken up the Indian railways had been to check the progress of Indian railways, and Sir Julian Danvers, who has so very much experience in the same direction, expressed the same opinion. Mr. Bell, in his report, said: "I have laid stress on what I should call the pernicious element in the present policy of the government, i. e., the retention of the idea that the State must continue to exercise direct action in both the construction and working of railways. I have implied that this cannot co-exist with really vigorous life in private enterprise, and that it is the latter to which we should look as the ultimate and sole agency for such operations." Lord Avebury, in his testimony before the select committee, brought out the fact of the great development of railways in the Argentine Republic by private enterprise, while there had been little of the same kind in India. Sir Julian Danvers said "that he had come to the conclusion that the agency of companies was upon the whole the most satisfactory mode of carrying out railway enterprise; that seemed to be now the opinion of the government; railways, being commercial concerns, were better in the hands of those who could manage them on commercial principles." The private investor in India, as he does elsewhere, takes the ground that if a railway was likely to pay it would be made by the government, and if it is left to a private individual to make it must be because it is not likely to pay. The result has been that there has been very little private enterprise in the matter of Indian railways. For these reasons, or because of the great loss in connection with the telegraph business, the British Government has hesitated to take over the entire telephone business of the country; but by taking the trunk lines and exacting too high a royalty and by letting the municipalities into the business it has spoiled it for private enterprise.

COST OF MUNICIPAL UNDERTAKINGS

The comparisons between public and private undertakings which are set afloat in the United States and appear in the newspapers advocating municipal ownership and operation of public utilities are valueless, because the real cost of municipal enterprise is never given. To make a fair comparison, these items should be charged as follows:

First—All the cost of all direct and indirect salaries and wages. (Indirect wages and salaries are not always charged in the case of municipal undertakings, such as, for example, a fair proportion of the salaries of the town clerk, borough surveyor, high-priced officials and others.)

Second—The full and fair cost of all materials consumed for the purpose of the undertakings. (Coal and many other materials are often charged in a haphazard way; it ought to be done accurately, from an accountant's point of view.)

Third—It should include the cost of insurance against loss by accidents of all kinds.

Fourth—The cost of adequate maintenance and up-keep.

Fifth—Provision should be made for depreciation, wear and tear and possible obloescence to meet the case of its becoming obsolete. (There is a great risk in municipal undertakings of something better presenting itself, and the undertaking, though it may be fully maintained and be in very good working condition, may be superseded by some new invention. This happened on a colossal scale recently in New York when the Metropolitan Street Railway Company scrap-heaped a $6,000,000 cable plant to put in an underground trolley system.)

Sixth—It should cover the value of municipal taxes relinquished by reason of municipal ownership. (This is never done by those who advocate municipal ownership. As yet it is impossible to make a fair comparison between municipal and company working if the municipality is taxed or rated lower than the company would be for the same undertaking.)

Seventh—State taxes paid or chargeable in respect of the undertaking should be included for the same reason as above.

Eighth—The interest on the entire investment.

Ninth—A sinking fund for redemption of capital within the period approved by the ratepayers and by the local government board or other government department.

These are the nine heads of cost which Emile Garcke, editor of the Manual of Electrical Undertakings and director of the British Electric Traction Company, thinks should be included in such comparisons. In nine cases out of ten they are not. If those debating the question would insist on this form being complied with and accept no comparisons between the working of municipal and private undertakings unless these rules have been followed out, the whole fabric of municipal ownership would fall to the ground of its own weight. The comparison would be overwhelmingly in favor of the private company enterprise.

LONDON CHAMBER OF COMMERCE

A good deal of effective work has been done against the extension of municipal socialism by the various chambers of commerce of Great Britain, and in this the London Chamber of Commerce has properly taken the lead. A municipal trading committee has been appointed by that influential commercial body and a number of meetings have been held. Last October the writer was invited to deliver an address in London under the auspices of the committee of the London Chamber of Commerce, and in the course of this address said:

"Within the last few years a change seems to have come over this municipal dream of yours. While we, as I have said, have been obliged to argue our case in the United States on a demurrer so far as England's experiences were concerned, there has arisen within the very shadow of Spring Gardens a perverse generation which has set about the demolition of the idols we have been told to bow down to and worship. The attack on the temple of municipal trading has been sharp and decisive, and the edifice is almost rent in twain. Having accomplished its partial destruction yourselves, aided as you have been by your own chambers of commerce, by the Society of Arts debate, by the Royal Statistical Society's investigations of the financial side of the question, by the Parliamentary committee, by numerous able pamphlets, and more recently by that powerful ally the London Times, you must not ask us foreigners to gaze upon what is left of the edifice and pronounce it complete and satisfactory. We are more likely to enter the sacred precincts through the aperture you have made in it and endeavor to solve the mystery of its departed power. We may even be encouraged to compare the cost of some of these boasted achievements with similar undertakings of our own. We might be tempted to ascertain if under a different method we have been able, by utilizing individual effort and private capital, to give the public as cheap and as efficient service. You, gentlemen, are too familiar with the shortcomings of municipal trading to need even a recapitulation to-night. You found it did not fit in with the extension of modern enterprise. You wanted to distribute your electrical power and sell it cheaply for all sorts of purposes and you were blocked by a combination of town clerks. There was a demand for cheap producers, gas for use in the gas engine, the latest and cheapest invention for motor power, and you were held up by municipalities whose business interest prompted them to oppose cheap power. So it was with light—electric and gas—and with the extension of tramways and light railways. Then it was that you discovered that these towns and cities, with their retinue of officials, had been merely nibbling at the electrical industry. Private enterprise was being dampened and dwarfed by hold-ups in the shape of provisional orders. Meantime England was behind even Italy in an industry in which she should, by rights of priority of practical application, have led Europe and been side by side with the United States. When these facts were fully established your British ire was thoroughly aroused. Whatever may be the final outcome, and whether you ever come to any understanding with these authorities as to boundary lines or not, you have weakened their power. If they still, as is probable, cling tenaciously to that which they have, they will have to fight harder for that which they may in future wish to appropriate. The municipal trader may preach 'no finality to municipal trading,' but Parliament, the limitation of the debt-creating power, the patience of the ratepayer and the necessity of encouraging British industry, will prevent its being carried out. Still more disastrous will be the trap which Mr. Garcke has set for the municipalists and into which Mr. Donald, editor of the Municipal Journal, recently precipitated himself.

"As I have said, until the severe attacks on municipal trading referred to above we had been given to understand in America that in England wonderful success had attended the efforts of municipalities to monopolize individual endeavor or enterprise. The appeal, however, was chiefly made on the exceedingly fallacious ground that the 'profits' thus extracted from the pockets of the capable and enterprising, the energetic and far-sighted, the ingenious and the inventive were enabling the rest of the community to live free of taxation. Herein lay its chief attraction. Mr. Donald disposes of this point himself, and thus denudes the whole theory of 'no finality to municipal enterprise' of its principal charm to American municipalities by the following declaration: 'It would be preferable in all cases that municipalities ceased to make profits from their undertakings, whether water, gas, electricity or tramways.' Here we have an advocate of municipal trading in England abandoning the very essence of the argument of his co-laborers across the Atlantic. The bait of lower taxation is the luscious morsel which the Bryanite orator and American college professor have been dangling before our taxpayers. Without it the subject will not prove permanently attractive and hardly command respectful attention."

Strong speeches were made at that meeting by well-known and influential Englishmen and by Charles T. Yerkes, of the United States, who has undertaken extensive enterprises in connection with London rapid transit. Sydney Morse, the chairman of the committee, among other things said that "when a few years ago it was found that the municipalities and local authorities throughout the kingdom were anxious to enter into the arena of trade in competition with their ratepayers—with money raised on the security of the rates these traders paid—it was felt that a time had arrived when a special committee of the chamber should be appointed to endeavor to deal with the question. The committee had been doing what it could in a small and unpretentious way; it even ventured to risk a general battle with the representatives of the municipal traders by getting the government to appoint a joint committee of both houses, and although that joint committee made no report and came to no definite decision it collected a great deal of valuable evidence, which has now been published. He had the authority of their guest for saying that that report had been of great value to our friends in America. The question was really of immense importance. Few of them realized fully the extent to which municipal trading, if it was allowed to have its full sway, would interfere not only with traders, but with the comfort of everyone in the country, if it did not in the end interfere with the government of the country in a disastrous manner."

Sir Charles Rivers Wilson said: "The Chamber of Commerce had done gallant service and put themselves in the

forefront of the battle, but it was not to be expected they would conquer in the fight unless they received more support from the government, the public generally and Parliament; and it is in that direction that all the efforts of those interested in this question should be applied. He urged them to try and form popular opinion on this subject, and it could be done by disseminating information and arguments such as they had listened to that night. He hoped that the interesting and important document contributed by Mr. Porter would be printed and circulated and given the widest publicity."

Dixon H. Davies, commenting on the speeches of the evening, said "he was struck by the figures that were mentioned of the vast stock which the railway companies of this country had charge of. Even in these bad times, under the commercial management of the railway directors, that great property produced a profit of £40,000,000 sterling per annum. Compare that with the figure which was mentioned in the Times that morning regarding only a portion of the railways of France (instituted under government auspices and dependent for their returns on the aid of the State), on account of which a deficit of 40,000,000 francs would be charged in the budget of France next year. Let them compare the two—in this country £40,000,000 sterling profit, in France 48,000,000 francs deficit. That was only one indication of the failure of enterprise when it was subjected to governmental interference. Railway men knew of many expansions of their systems which would be desirable from every point of view and which were forbidden by the municipalities. He could mention towns where great railway companies had for years been projecting important extensions and which they had been prevented from carrying out because those towns have started municipal tramways and because they believed the railways would take away the trade from those tramways."

INDUSTRIAL FREEDOM LEAGUE

The outcome of this agitation, which has been carried on in various ways in England for nearly five years, as I have said, has been the formation of the Industrial Freedom League, an association formed to free private enterprise from undue interference and from rate-aided competition. Membership of the Industrial Freedom League is open to all persons or companies who are in sympathy with its objects, and the membership charge is nominal. The need of such an organization is abundantly proved by the facts and data I have above submitted. The constitution sets forth that "the rapid encroachment of local governing bodies upon the legitimate functions of manufacturers, merchants and tradesmen is injurious to the commercial interests of the nation and of the municipality and the piling up of an enormous debt, now amounting to several millions, has the effect of increasing the burden of local taxation and diverting the stream of investment capital from its most useful channels." Again it says: "The disastrous tendency of the new municipalism is not a capitalist's question nor a trader's question merely. It is pre-eminently a poor man's question. The expenditure of a municipality inevitably increases in proportion as its trading increases. Toward this it has to levy rates which fall entirely upon the rental value of the property in the town. In the more ambitious boroughs the rates are already approaching 10s. in the pound, which means that for every pound per year you pay as rent you have half that amount to pay as local taxes. The result is, of course, that houses become dear and scarce. When the eyes of the people are open to the true bearing of these abuses, as it will be the business of the league to open them, an economic reform which promises to the poor man the boon of a cheap house is sure to command general popularity."

The work the league maps out for itself is as follows: "It is the aim of the Industrial Freedom League to provide the machinery for systematic and sustained opposition to a policy which threatens the extinction of private trade. A fuller statement of the damaging effects already produced by municipal trading and of the direction in which the league may most usefully exert its influence will be found in a pamphlet entitled 'The Industrial Freedom League; Its Purposes and Programme," which may be had from the secretary."

In short, the league's plan of campaign may be briefly summarized as follows:

1. To prepare and publish statistics bearing upon municipal trading and its injurious effects.
2. To arrange lectures, addresses and debates throughout the country.
3. To keep the press well informed of the trend of municipal socialism.
4. To extend assistance to local traders unfairly hampered by restrictive by-laws.
5. To distribute literature and otherwise take part in municipal elections.
6. To assist ratepayers' associations in opposing want and extravagance on the part of the councils.
7. To watch cases giving rise to suspicion of municipal corruption.
8. To urge action on the part of ministers and private members of Parliament.
9. Generally to arouse public opinion and secure the revival of that spirit of industrial toleration to which the past commercial success of the nation was so largely due.

CONCLUSIONS

The fundamental idea of this league is the preservation of that "freedom for the play of all the talents, all the energies, all the force of human initiative for the subjugation of the powers of nature and their direction in the service of mankind" which has enabled both England and the United States to lead the world in all great modern enterprises.

To check this individual effort means the destruction of industrial progress and the reversion to commercial impotence. In one of his exceedingly able addresses Lord Avesbury (Sir John Lubbock) recently said: "The country is now at the parting of the ways in the matter of great commercial undertakings being carried on by municipalities or by individual enterprise. Government and municipal competition are fatal to private enterprise." To combat this fatal competition the Industrial Freedom League has been formed.

The attendance and character of the speeches at the first meeting of the league were well calculated to arouse public opinion. There were present some of the strongest and most influential men in England. Nearly all the great railway enterprises of the kingdom were represented; the building trades, great electrical interests and various associations of manufacturers and a fairly representative number of economists and scientific men. It might be added here that not only has the London Society of Arts taken up the subject actively, but likewise the Royal Statistical Society. Sir Henry Fowler, the retiring president, two years ago contributed the most valuable statistical paper on the subject, and this year the present president, Lord Avebury, made it the chief topic of his annual address. Alexander Henderson, M. P., presided at the inaugural meeting of the Industrial Freedom League, and his address was a valuable contribution to the literature opposed to the growing evils of municipal trading. He called attention to the stupendous increase of local indebtedness in the United Kingdom,

which he said had doubled in twenty years and now exceeded $1,500,000,000. A large part of this debt had been created for industrial enterprises to be managed by town clerks. As Sir Henry Fowler had previously shown that the dividends earned on the debt thus created was about one-half of 1 per cent per annum it is easy to imagine that much of this will become a heavy burden for the ratepayer to bear. The proportion of this huge total which has been invested in trading concerns would have been supplied by private enterprise but for the fear that councils would render capital so expended unproductive. There was no disposition to complain of much of the good work done by the British municipalities within their proper sphere—sanitation, water, markets, streets and other strictly municipal undertakings were all right in the hands of these public bodies. On the other hand, tramways, gas, electric light and power and many other trading enterprises in which corporations are or contemplate being engaged should not be handled by them. "Workmen's dwellings," said Mr. Henderson, "about which there is so much talk at the present time, would to a large extent have been provided by private enterprise but for the fear that councils would render capital so expended unproductive." I happen to know from another well-informed source that since the London County Council has entered the "workmen's dwelling" field private capital has retired. Public-spirited men were venturing considerable capital in these enterprises, giving excellent results but getting very small returns on their investments. They have now left the field entirely. The local debts of some of the English towns compared with the relative taxable value is enormous. Compared with the United States, I find in the aggregate the municipal debt is fully double. This ought not to be, for our population is more than double that of England and our ability to pay greater. The actual increase in municipal debt in the United States between 1880 and 1890 was only $60,000,000, which was very small when we remember that in that period the value of taxable property doubled. In the United Kingdom the total increase in the ratable value of the country in twenty-five years has been less than 30 per cent, while its local debt has trebled. Our returns for the last ten years are not yet published, but I think it may be safely asserted that the inverse of this proposition is true, namely, that our local indebtedness has increased, say in thirty years, 30 per cent and the value of taxable property has trebled. The reason for this happier condition of affairs is largely due to the State constitutional limitations placed upon municipal indebtedness and to the fact that up to the present our municipalities have kept out of industrial enterprises. Think what it would be to-day if we owned, as England does, say half our municipal tramways and half our gas plants. Here we have $3,000,000,000 in all, half of which would be $1,500,000,000, plus say $800,000,000 existing debt, and the total burden comes to $2,300,000,000. If we take them all over as some advocate we have a total debt of $3,800,000,000, and if electric lighting, power plants and other businesses in which British towns dabble be included we could easily make it $5,000,000,000.

But right here the wisdom of the State constitutions come in and prohibit this reckless expenditure and debt of the taxable value of property. Two per cent in Indiana, 5 per cent in Illinois and many other States, 7 per cent in Pennsylvania and 10 per cent in New York are the legal limits of municipal indebtedness. The effort to repeal these constitutional provisions, even when advocated by reputable men like Bird S. Coler (see Municipal Affairs, September, 1901), should be strongly combatted. It is but the entering wedge of municipal trading, for the programme of its advocates cannot be carried out so long as these wise limitations on the debt-creating power of municipalities continue in force. A careful study, covering several years, of the gradual movement against municipal trading in England leads me to make the following observations: The men acting in opposition to the socialistic experiments are not merely those whose industries have been taken up by the municipal corporations and who feel themselves aggrieved in consequence. The opposition is rather from the conservative financial people who look with alarm upon the growth of local indebtedness and the increase of local taxation. The railway interests are keenly alive to this movement by reason of the heavy and increasing burden of local rates upon the revenue of railway companies. Lord Claude Hamilton, chairman of the Great Eastern Company, who was an interesting speaker at both the important meetings referred to above, said in one town his company paid $150,000 taxes, and that had it not been for the formation of a ratepayers' association to combat the industrial tendency of the council the burden of taxation would have become unbearable. There are also indications in the British world of finance that municipal corporation credit has suffered a check. For example, the corporation of Leeds recently issued $10,000,000 of 3 per cent stock at the price of 94 cents on the dollar. The prospectus of this stock was advertised March 5 of this year. It resulted in a subscription by the public of about $1,100,000, leaving about 90 per cent upon the hands of the syndicate. It may be news to some in the United States to learn that London County Council 2½ per cents sell at 85 cents on the dollar. The prices of most of these securities indicate, at least to my mind, that the limit of local indebtedness has been reached in England, if it has not crossed the danger line. In our own country, where debt is incurred for purely administrative purposes —sanitation, police, municipal buildings, streets, parks and waterworks—something like finality is obtainable. Added to this we have our constitutional limitations, and, as a rule, a twenty-year retirement clause instead of sixty years, as in England. The advocates of municipal trading practically say there is no finality to their enterprises, hence there seems to be no limit to the capital account in respect of undertakings of a reproductive character, such as gas, electricity, water and tramways. This feature is menacing to the future of municipal finance in England. Hitherto local bodies have been able to get their money very easily, but it is by no means certain that this will continue, because of the impossibility of predicting a limit to their expenditure. A successful undertaking of a remunerative character is inevitably one that requires more and more capital, and the financier who studies municipal finance is faced with this alternative—either the corporation works are a failure and the money invested therein is wholly or partially lost, or, if successful, large additional sums will be required to carry them on. In either case there is room for grave concern. Trading concerns, as every business man knows, are often obliged to spend money owing to the universal demands of the public and not necessarily in extension of their undertakings. Mr. Henderson, in his address, takes the London & North-Western Railway as an example. Its length in 1891 was 2,021 miles and its capital expended $507,025,000; in 1901 its length was 2,094 miles and its capital expended $654,215,000, an insignificant increase in length of line equal to only 73 miles (3.6 per cent) against an increase in capital expenditure of $146,690,000, or 29 per cent. The same rule must apply to corporation trading undertakings. If they are successful there may be no desire to extend them, but public requirements and progress will demand the expenditure of capital for improvements.

This brings us to the very essence of the financial danger. The figures of the gas undertakings and electric light plants

and the tramways of certain cities will be cited as proving that some corporations have traded wisely. The answer to all this is contained in the above illustration of the London & North-Western Railway, or, if you please, in the Metropolitan Street Railway, of New York, when that company threw out its valuable cable plant and put in electric traction. Gas has been a profitable commodity in the past, and may be in the future, if its manufacture is kept up to the standard of the United Gas Improvement Company, of Philadelphia, for example. No example of a municipal corporation managing gas undertakings as that company manages its business can be given. For absolutely the inverse of the proposition read the history of the Philadelphia municipal gas works. Examine municipal corporation accounts in gas as the Street Railway Journal has done in tramways and you will find that the sum set apart for depreciation is altogether insufficient to meet losses that must inevitably be realized in connection with all these classes of risks.

In conclusion let me call attention to two or three points made by Lord Avebury in his address which seem well worth considering. Lord Avebury cited the traveler in China who came across a building in a remote up-country town on which was inscribed "All kinds of business in this building carried on with invariable success." That appears to be a good motto for some of the British town halls. The effect of municipalities carrying on so many industries in England is lowering the standard of the aldermen and councilors—something greatly to be regretted. I happen to know that Lord Avebury was obliged to give up his work on the London County Council because it required all his time to master the details of the various business proposals constantly before that board. Experienced and capable business men are gradually giving way to the professional politicians who are willing to give their entire time for the influence it gives them.

The labor question is also giving the municipal traders a good deal of trouble. The British workman, it has been found, is not half so energetic when he is working for the municipal corporations as when employed by individual firms. In consequence, everything costs more. The workman argues that he helps to elect the municipal body and to some extent they are his servants, and he "goes to his work," said one of the speakers, "with the idea that he is the proprietor of the whole show, and it is generally known in the trade that a man once employed on the County Council is likely to be unsatisfactory to others." Added to this, municipal trading in England has undoubtedly proved a great check to private enterprise. It will be a matter of interest to note what effect this awakening to the failure of municipal ownership of public utilities in England will have upon the spirits of those of our own countrymen who are so vigorously trying to entail upon our municipalities burdens similar to those from which a considerable body of thinking men in England are anxious to be relieved.

The current issue of Harper's Weekly contains, as a frontispiece, a full-page portrait of Herbert H. Vreeland, president of the Interurban Street Railway Company, of New York. The portrait appears as one in a series entitled "Americans of To-morrow," and is the fifth of the portraits in this series published by Harper's Weekly. In speaking of Mr. Vreeland, the paper recites many of the successes which he has already secured, and refers to him as being as big and broad mentally as he is physically. It gives his age as forty-five, and predicts that unless he is deluded by admiring friends into the notion that he has reached the top, he will be a very important and useful factor in American development during the next twenty years.

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Coupons

BY E. S. PATTER

The best method of handling coupons is a subject of more or less interest to accountants in connection with corporations having a large funded debt and correspondingly large numbers of coupons to be accounted for. We herewith outline a simple plan that may be of interest. As an illustration, we will assume that the bonded indebtedness of the corporation is $5,000,000; $3,000,000 first mortgage bonds due Jan. 1, 1912, at 5 per cent and $2,000,000 second mortgage bonds due same date at 6 per cent interest, payable semi-annually January 1 and July 1, at a trust company in New York. It being necessary for each month's statement to carry its proportion of all fixed charges, including interest on funded debt, the following journal entry is made each month and posted to the corresponding ledger account:

Interest on funded debt apportioned		$22,500
Dr. to		
Interest accrued for July on		
$3,000,000 first mortgage bonds due 1912 at 5 per cent	$12,500	
$2,000,000 second mortgage bonds due 1912 at 6 per cent	10,000	

As the operating accounts, together with all fixed charges apportioned for the month, are written off at the close of each month and charged against earnings, the interest on funded debt apportioned is also written off, but the interest accrued remains as a liability on the books of the company until balanced by the semi-annual payment of interest January 1. The journal entry is as follows:

Interest accrued for 6 months, due Jan. 1, 1903, on		
$3,000,000 first mortgage bonds at 5 per cent		$75,000
$2,000,000 second mortgage bonds at 6 per cent		60,000
Treasurer		$135,000

An entry is then made and posted to coupon accounts as follows:

Trust Company, coupon account		$135,000
Dr. to		
Coupons, first mortgage bonds due July 1, 1902		$75,000
Coupons, second mortgage bonds due July 1, 1902		60,000

Upon the return of paid coupons from the trust company, and after being checked against the statement to verify the number returned, they are then arranged numerically and the reverse of the former entry is made and posted for all coupons returned. It seldom occurs that all the coupons of any one payment of interest are returned at one time. This necessarily leaves a debit balance against the trust company's coupon account and a credit balance to various coupon accounts.

In making up the balance sheet, the accounts "Trust Company's Coupon Account" and the total of the various "Coupon Accounts" balance (debits and credits) and therefore do not necessarily have to appear on the balance sheet.

The coupons arranged numerically are pasted in a specially ruled and printed book, the folio of which corresponds with number of bond, the right-hand page being spaced and numbered to correspond with the number of each coupon to maturity of the bond. The left-hand page is reserved for the pasting in of the paid bond, thus making the record complete. By this plan it is a simple matter to ascertain quickly from the balance of the trust company's coupon account the value of the coupons unredeemed, and also determine from the individual coupon accounts the value, series and number of coupons outstanding. You can also determine the number of the bond to which outstanding coupons l elong.

The Distribution of Accounts

BY H. D. EMERSON

The elements which enter into and which are combined to make up a report on which to base the value of securities are very numerous. Primarily the property itself is the consideration, and a careful investigation of its location and physical condition with relation to both operating and traffic possibilities is considered. The earning power of the property is based upon the report of operations; that is, the income account, which, to use a race-horse term, might be called "the past performance." It is generally assumed that the figures as given are correct; that is, that the totals are accurate, and that on the operating side the distribution of accounts of the various classes had been properly made. If there is any question as to the distribution it is of course necessary that the statement in hand be revised and be readjusted along the lines which experience has proved is proper. This brings up the question of proper bookkeeping and goes back further than simply a question of proper audit. There can be no question at all but that every corporation owes to itself, and the management of every corporation should, for individual record, as well as for individual protection, keep the books and accounts of the corporation in the most perfect and at the same time simplest manner. Bookkeeping and the forms thereof are often considered a mystery and handled as though accounting was a separate and distinct profession like the law, to be used only at certain intervals, or when the occasion demands, whereas it is, perhaps, the most vital part of every business enterprise, and no one who is not competent to keep and understand the books of his business is competent to be placed in charge of that business. Bookkeeping is simply a record of the business done by the corporation, and as the goal of any business enterprise is profit, so the cash handled and the cash accumulated is the measure of success of the business. Therefore, it may be said that the essence of bookkeeping is, and should be, a record of the cash handled.

With this proposition as a basis it is very easy to understand the system and forms which show accurately when and how the cash is received, and when and how it was paid out. Stockholders desire to know how much cash has been saved as the result of the operations of the corporation, as this cash is the measure of their profit. But in addition they desire to know for what cash was received, and for what it was paid out, in order that they may judge of the competency of the management. The officers composing the management of the corporation desire to know from time to time the elements which go to make up their receipts and expenses. In order that this statement may be comparative, all receipts and expenses are classified and the totals of these classes can be compared from month to month, and from year to year. The assigning of the various individual items to the various classes constitutes the distribution of accounts. This distribution calls for more judgment, and the exercise of sterling integrity than any other part of accounting. As a result of many years of experience in the handling and accounting of the funds of corporations, a system has been developed which is accurate, and because accurate, satisfactory to security holders. This system, sometimes called the voucher system, which is a system of single entry bookkeeping with various items thrown into classes, and classes totalized into a small number of general accounts, is the basis of the systems used by the steam railroads of the United States, as approved by the Interstate Commerce Commission, and it is the basis of the system advocated by the Street Railway Accountants' Association. Where these systems are in use we do not have to question the income account, as we know the system of distribution. The individual who fools himself is the simplest fool, and that management which attempts to fool others by a manipulation of accounts in the end destroys itself and the credit and integrity of the corporation.

Securities are based upon the earning power of the property against which they are issued, and the value of any security depends upon the amount and probability of continuous income for that security. The marketing of a new security depends upon the ability of those in charge of the corporation to demonstrate to prospective investors that the corporation can earn or has earned a certain amount, and will continue to do so. An instance which recently came under the writer's observation, might be cited as showing the importance of this fact.

A trolley road had been built extending from a large city to a very small country town. The reported earnings, both gross and net, were much larger than would normally be expected from the population tributary to the line. The gentlemen who owned the property; that is, who had furnished the money for construction, were of the highest integrity in banking and business circles, so that when they submitted figures to the bank on which to predicate a sale of the bonds, the question of dishonesty in bookkeeping was not considered. The amount of the bonds and their price, based upon earnings as reported was very satisfactory, and on the face of the papers it was assumed that a trade would be made. But the bank has a rule that before purchasing any securities, or before offering them for sale to the public, the property must be investigated by its own representative. The figures as presented showed that the net earnings amounted to 60 per cent of the gross receipts, and interest charges on the bonds came to less than half the net earnings. The impressions of the physical conditions of the property from riding over it were excellent. The track and overhead work were in excellent condition, and being lately constructed was modern and up to date. The equipment was new and all that could be desired, and the power station was well constructed and ample for the requirements of the property. Everything seemed all right. On returning to headquarters and asking for the books, it was found that no books had been kept, except a cash account showing daily receipts and expenditures. The receipts appeared all right, so it became necessary to investigate the expenditures. It took some time to audit this part of the accounts, and the audit was particularly disagreeable, because the assistance which was furnished was unintelligent, and in addition was grudgingly given. After an audit had been made it was found that the expenses as reported covered only the labor and fuel cost of operating the cars and the power station. When to this were added extremely low amounts covering cost of maintenance of track, equipment and power station, the net earnings were materially reduced. When from this taxes and interest were deducted, net earnings approached the vanishing point. When in addition a sum was figured which when set aside and capitalized at the same rate of interest as paid by the bonds would retire the bonds within the limits of the franchise under which the property was built a deficit was shown. The final result was that the bonds were not sold, and I believe the owners, the gentlemen who first furnished the money, still have them. If, in this case, the financial backers of the enterprise had been as careful in having the accounts of their electric road properly kept, as they are the accounts of their banks, they would have been in better position to have placed securities and would not have destroyed their individual reputation as good business men with a large New York bank.

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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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It is very curious that a tunnel third-rail contact carrying a heavy current requires to be used under heavy electric load, in order to operate sparklessly. Such is the undoubted fact. A third-rail unused for forty-eight hours sparks and sputters for the first few trips, and then settles down to satisfactory operation. This would naturally be accounted for by the presumption that rust and foreign material had accumulated and was thus removed, and even if the rail appeared bright, at the beginning of the experiment, one would be still inclined to adhere to this idea. A third-rail engineer, however, contributes this piece of information, which certainly gives rise to some further speculation: A tunnel is equipped with two tracks and two third-rails. Regular service demands that the locomotives pull heavy trains over one track and return light over the other. Both third rails obviously get equal mechanical cleaning. In fact, they look clean and exactly alike, yet when, through some exigency of traffic, the locomotive is required to pull a load over the tracks on which it commonly operates light, the attempt is accompanied by most formidable sparks and arcs which do not cease till repeated heavy trips have been made. It is not a matter of shoes, because the locomotive in question has ample opportunity, in its regular work, to use all of its shoes under heavy load. This would seem to indicate some curious virtue imparted to the third-rail by the heavy current-carrying shoe and not by an idle shoe. Simple inspection does not suffice to explain the phenomenon, and complex investigation is yet to be heard from.

The Aurora, Elgin & Chicago Railway opened for traffic Aug. 25, an event which is believed by many to mark the beginning of a new epoch in electric railway history, because of the high-schedule speeds that will be made, which are far in excess of anything of the kind heretofore attempted by either electric or steam roads, number of stops being considered. Owing to the newness of the roadbed and the necessity of letting it settle thoroughly before attempting high speeds, the officers have wisely decided to work up to fast schedules gradually, and the 34.5 miles between Fifty-Second Avenue in Chicago and Aurora, including all stops, and the entrance of Aurora, is made in the modest (?) time of $1\frac{1}{4}$ hours, or 27.6 miles per hour. To be sure, this is faster than any other steam or electric road schedule in existence to-day, all things considered, but the management has purchased the equipment and built the road for much faster time than this. From the preliminary runs, before the opening of the road, the reports of those connected with the company are all enthusiastic as to the ability of the road to make the fastest schedules contemplated. Later it is hoped and expected that experiments will be conducted on the line to determine what factors enter into electric railroading at speeds of 80 miles per hour and over. Tests of these kinds and on a roadbed so good as that possessed by the Aurora, Elgin & Chicago, would go far toward settling many of the knotty points in the present problem of high-speed railroading. However, the real point of interest in the new road is the fact of its being the first of a class of roads different from previous attempts to give suburban rapid transit service in the neighborhood of a great city, a type which it is to be hoped will multiply in the next five years, until the suburbs are set free from the necessity of patronizing infrequent steam trains, and another important victory for electric traction shall have been secured.

In the early days of electric railroading the motor was undeniably rather a frail machine, and was liable to develop weakness in its winding or commutator or some mechanical trouble that put the car out of service until the trouble was repaired. Modern methods of insulation and construction have pretty nearly overcome all of these early defects, and, with the exception of the commutator, there is nothing, so far as the motor itself is concerned, to prevent an increase of the normal working voltage on trolley lines considerably above the 500-volt limit, where it has so continuously stuck. The fact, however, that while

commutator troubles have not entirely disappeared, they are at least now under reasonable control, marks the present as a date when it is interesting to speculate whether higher pressures at the car motors, or certainly on the line, are not going to find favor.

The trolley wheel and controller contacts have done nobly. Indeed, it is marvelous how much current they seem to be able to collect and transmit without material injury, but in these days of heavy interurban railroading, and even trunk-line traction, these overworked and faithful auxiliaries are going to join hands with the copper market, and call a halt to the cry for more current. The natural solution is current at more pressure, but how? Are we to use motors in series and 1000 volts on the trolley wire? The difficulties in the way are certainly serious enough to make one hesitate about saying "yes" without thinking seriously what this plan involves. To be sure, this arrangement enables the present dynamo-electric equipment, both on the car and at the power house, to be used; in fact, they must be used until some ingenious designer produces 1000-volt commutators of large current capacity. But how about the controller and the car wiring? The present controller, with a 1000-volt service, would need reinforced insulation and a stiffer blow-out. A new design would be very much better, perhaps absolutely necessary. Then the fuse, the wooden fuse box and lightning arrester, the soft rubber motor bushings, the motor windings, the mud and water, all combine to make one incline to draw aside and let the other fellow try first. Not only this, but four motors would always be necessary for double equipment, for to run home with one motor on 1000 volts when disaster overtakes the other seems impractical, to say the least. The outlook is not encouraging, and yet those who would preserve the direct-current system, and we venture to believe there are many such, must consider this problem of higher-pressure equipments, for our alternating-current friends have solved this part of the problem better than the direct-current engineer can ever hope to do. There are some expedients, however, which will be very helpful to anyone who is bold enough to tackle the problem. One of these is to put both armatures to line and insulate them for it, reserving the adjacent ground circuit position for the fields which will then be very unlikely to ground against the motor casing. The rheostat and controller could also come on the ground side, and an automatic hood switch worked by the controller could cut the armatures clear when a stop was made. These little devices would render the controller, the fields, rheostat and 90 per cent of the car wiring less than 500 volts above the ground at all times, and therefore practically as secure as at present. Multiplying two series of motors might call for some more automatic work to confine the high voltage wiring to a system of small extent. Finally, the transfer of the car wiring above the floor would probably be advisable. In fact, we believe that the technical staff of any of the large companies could get together and accomplish the results, not only practically, but commercially. It comprises a general reinforcement of the entire car equipment, evading the high pressure where possible and insulating against it when not The reward is a 75 per cent saving in the copper line, and that saving in these days of interurban and trunk-line work means much; in fact, so much that the problem is worthy of serious consideration.

A Study of Train Resistances

Owing to the practice of the British Institution of Civil Engineers, the official report of a paper presented before that important body, with the accompanying discussion, is not issued for a number of months after the meeting. It is through this custom that the complete treatise of J. A. F. Aspinall, on the subject of train resistance, and the accompanying discussion, which was presented before that association, some time ago, have just become available. Dealing, as the paper does, with English track and rolling stock, it inevitably leads to results not rigidly comparable with those obtained under American conditions, but it is singularly rich in experimental results obtained at high speeds—from 60 miles to 80 miles per hour —and it is, therefore, peculiarly valuable in dealing with modern conditions. Particular attention was paid to the subject of air resistances, and in the discussion which followed, a large amount of valuable information was added to the original paper. For many years the train-resistance formulæ of Searles and of Wellington were held to represent the sum of human knowledge of the subject, and subsequent experiments were adjudged good or bad according as they did or did not agree with one or the other of these authorities. They could not well agree with both! Occasionally, Clark's formulæ were also cited, but, as they apply to the track and rolling stock of more than half a century ago, even the most conservative and hide-bound of engineers would hardly look upon them as final. As we have, heretofore, flatly stated, Searles and Wellington to-day have long stood discredited upon the facts, at least above the most moderate way train speeds, and we must look for guidance to later experiments, dealing with modern equipments and high speeds. From this point of view the results obtained by the Baldwin Locomotive Company, Barnes, and Sinclair, are of primary value as based upon recent American conditions, and now comes Aspinall substantially confirming these, and, what is of still greater importance, indicating something of the causes which produce variations in the resistances found by various experimenters.

The vital point in the matter of train resistance is not whether the formula that is written around the experimental results contains the first, second, or some fractional power of the speed, but whether the total resistance of a train at, say, 80 miles per hour, is twenty-odd or forty-odd pounds per ton. We need not squabble over variations of 10 or 20 per cent, when the question really at stake is the possibility or impossibility of operating at very high speeds with practicable amounts of power at the driving wheels . On this point, the experiments of Aspinall should be regarded as decisive, irrespective of what others have done. His final results indicate a resistance of from 28 lbs. to 22 lbs. per ton for 80 miles per hour, as the train was lengthened from 6 to 21 cars. These were, of course, English cars, shorter and lighter than our own, but mounted on bogie trucks in the manner customary here. His formula for the general train, its length being taken into consideration, was

$$R = 2.5 + \frac{I^{\frac{5}{3}}}{50.8 + .0278\ L}$$

This is a little out of the ordinary in containing a fractional power of V, and the constant term is notably small. The effect of air pressure was investigated with most unusual care, by means of recording ammeters and pressure gages, and the value finally reached was $r = 0.003\ V^2$, which was considered rather too large by several of the distinguished engineers who participated in the discussion. It is, however, in wonderfully close agreement with the results reached in the Zossen tests and contributed to the discussion by Mr. Siemens, who was present. Aspinall's formula gives results materially larger than those of Barnes, Vaulain and Sinclair, but, on the other hand, very much smaller than those of the older and some more recent investigators. It is notable, in this connection, that every one of the tests at speeds of 70 miles per hour and upward has given relatively small values of the train resistance, while the large ones have uniformly been derived by a process of extrapolation from experiments never carried up to the speeds now under discussion. Every time a careful series of runs has been made at 70 miles to 80 miles per hour, it has shown less tractive resistances than had been foretold for it, and, even in these experiments of Aspinall's, it is curious to note that while the formula seems correctly to represent the curve of averages as a whole, ten out of the fourteen runs made above 70 miles per hour give results materially less than the formula. In fact, above 75 miles per hour two runs agree with the formula, and the only other two fall to 20 lbs. per ton, in spite of a rising gradient.

We do not believe that any regular curve can satisfy the experiments in a matter involving so many variables as train resistance. It would be far sounder policy to use one formula up to, say, 50 miles per hour and another at the higher speeds. In Aspinall's experiments the failure of a formula representing single curvature is very noticeable, and there are strong indications of a lessened slope at the higher speeds. This, of course, does not show anything of the shape of the curve beyond the limits of the experiments, but it lends weight to a contention which we have more than once expressed, that tractive resistance is not a smoothly increasing quantity, but is subject, like the resistance of ships, to maxima and minima following no law yet discovered. But to follow up Aspinall's paper —it is remarkable that even at 80 miles per hour he finds that half the total resistance is due to miscellaneous causes other than air pressure and axle friction. The composition of this miscellaneous resistance is very uncertain, but it is assuredly a matter of the greatest importance. During the discussion, two factors of this resistance were disclosed with great clearness. First came the familiar matter of rail flexure, by which the wheels are, as it were, on a perpetual rising gradient. This gradient was estimated roughly by Mr. Mallock as between 1 in 250 and 1 in 400. In this country, Dr. Dudley has found a considerable decrease in tractive effort due to the use of stiffer rails, and there seems little doubt that the flexure effect is considerable. Sir Frederick Bramwell added the important observation that this effect would be considerably modified by the resilience of the rail and the speed of the train, so that at high speed the effect would be lessened.

An even more suggestive point was raised by Prof. Carus-Wilson, in the imperfect guiding of the bogie trucks producing large flange friction and a constant effort to pull the trucks back into line. He added that the weight of the bogie was not an unimportant factor in this resistance, and suggested that perhaps the large tractive resistance obtained from some electrically-driven trains might well be due to the large added weight carried on the trucks. In such case, and, in fact, in all tractive experiments, there would be a factor of resistance depending not on the weight of the cars, as a whole, but upon the weight of the trucks alone and upon their wheel-base. We may add that the speed would also enter this particular question probably in a rather complicated manner. Flange friction due to cross wind must also be taken into account among the miscellaneous resistances, and this may help to account for some of the discrepancies always found in experiments on traction. Whatever may be the various factors that go to make up these miscellaneous resistances, their aggregate amount is great enough to cut no small figure in the total, and to give an important opportunity for making improvements. As to other resistances, Aspinall made a thorough study of the direction of the air currents about the train, and reached the interesting result that the air envelope carried by the train was very thin, and that of the surrounding air currents, even that on the leeward side of the train, showed a strong swirl inward, while the reduction of pressure at the rear of the train is rather less than is generally supposed. Altogether this research of Mr. Aspinall's is a most valuable addition to our knowledge of a very complicated and troublesome subject. The work of the past few years has done much to throw light upon it, but there is still great uncertainty about some of the details. We may now feel tolerably sure that the total of train resistance at 80 miles per hour or so is for trains of moderate length, materially less than 30 lbs. per ton, with our heavy vestibuled cars probably not over two-thirds of that amount. The value of air resistance seems, likewise, to be pretty thoroughly settled as not exceeding $0.003\ V^2$, and probably nearer $0.0026\ V^2$, the theoretical value. The axle friction, according to Mr. Aspinall's results, is nearly uniform, but has a weak minimum at about 40 miles per hour, and then slowly rises. The miscellaneous elements of resistance seem to rise slowly with the speed, and are probably capable of considerable reduction by proper attention to the track and the trucks. All the recent experiments show the desirability of giving the train a smooth surface, and pointing at least the front in a roughly parabolic form, whatever the driving power adopted. We shall be greatly interested in the results obtained from the special locomotive and train now under construction in Germany, as showing the capabilities of steam when skilfully applied, as against the electric cars tested at Zossen. But whatever the issue of this particular competitive struggle, the fact remains that, taking into account the work of the last few years, of which this research of Mr. Aspinall's is an admirable example, it has been, in our opinion, effectively demonstrated that very high railway speeds are entirely practicable, so far as the engineering side of the problem is concerned. High speed, like high voltage, is little to be feared on the score of practicability. The difficulties are far more commercial than technical, and when the public really wants to ride at a hundred miles an hour there is little doubt that it can readily be accommodated, and that at short notice.

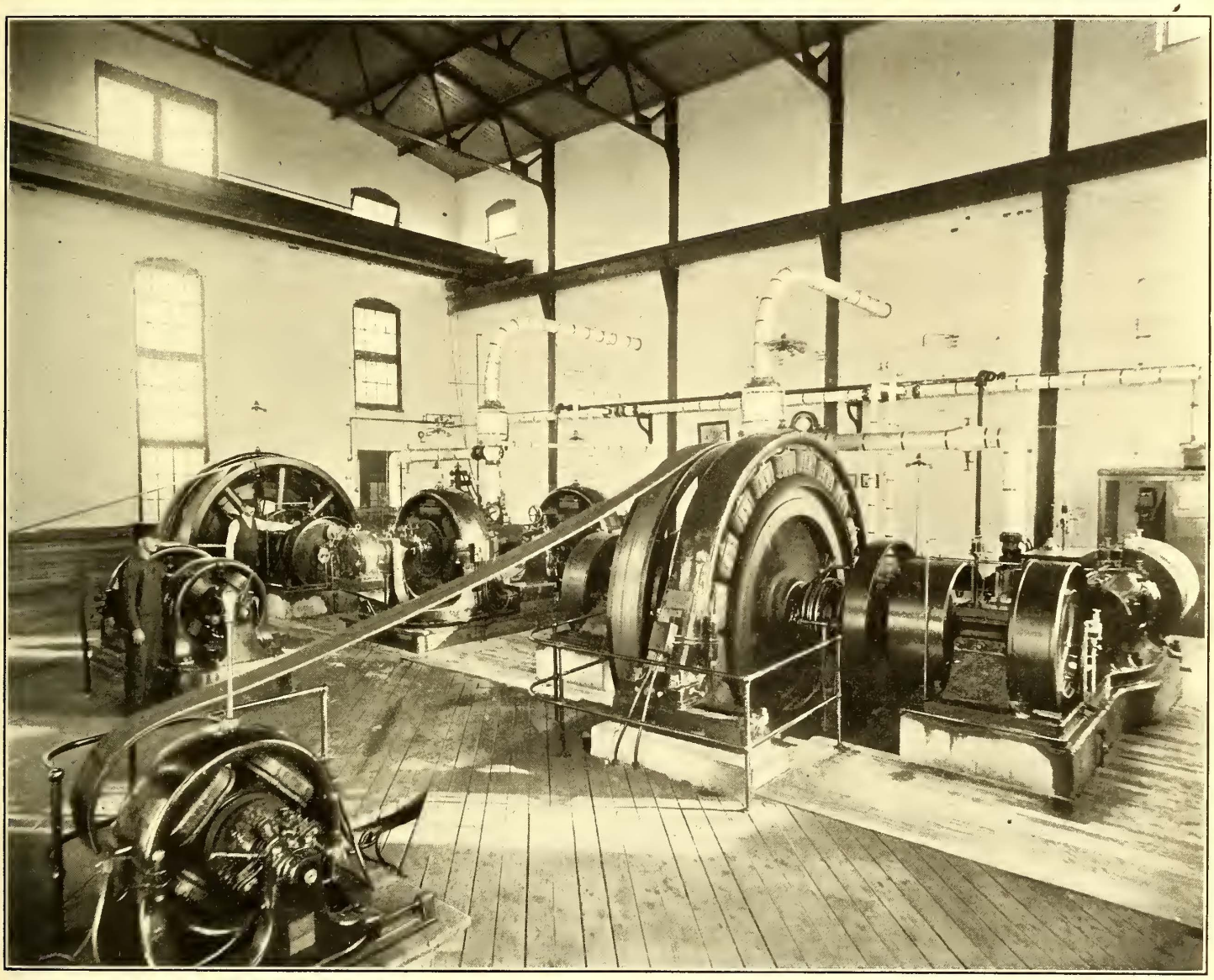
An Important Interurban Road in Southern Ohio

The Dayton & Northern Traction Company's interurban road connects Dayton and Greenville, Ohio, and is 39.5 miles long. At the present time, cars do not operate into the business center of Dayton, as the bridge across the Miami River is not sufficiently strong for interurban cars, but a new and stronger one is about to be constructed, and the interurban cars will then pass through the business portion to a central point, where connection will be made with all the electric interurban lines radiating from Dayton.

The towns and villages, exclusive of the terminal points, through which the road passes, are Salem, Brookville, Dodson, Bachman, Wengerlawn, West Baltimore, Gordon, Ithaca, Arcanum and Jaysville. None of these towns is large, but a satisfactory return is secured from the passenger service, and an exceptional and unexpectedly large package freight business has been developed. They are mainly agricultural centers, and the country tributary to them is rich and highly cultivated.

The route selected, exclusive of the towns, is principally over private right of way and adjacent to the highway. In towns the greater portion is through the streets, but here, too, some portions are on private right of way. Owing to the contingencies of the case, resulting from the necessity of obtaining rights of way and the requirements of business, the road contains quite a number of curves; and, in the twelve miles nearest Dayton there are also several grades. The balance of the road, however, is comparatively level.

The rail is 70-lb., 30-ft. T-rail, except in Greenville, where 70-lb. girder rail is used. The ties are oak, 6 in. x 6 in. x 8 ft., and gravel ballast is used, 1500 yards to the mile. The grading and brickwork was started by a Dayton contractor, and was completed by the Chase Construction Company, of Detroit, which was also the contractor for the line work. The bridges are small and few in number. All are iron girders, and some of the culverts are quite large brick or stone arches.



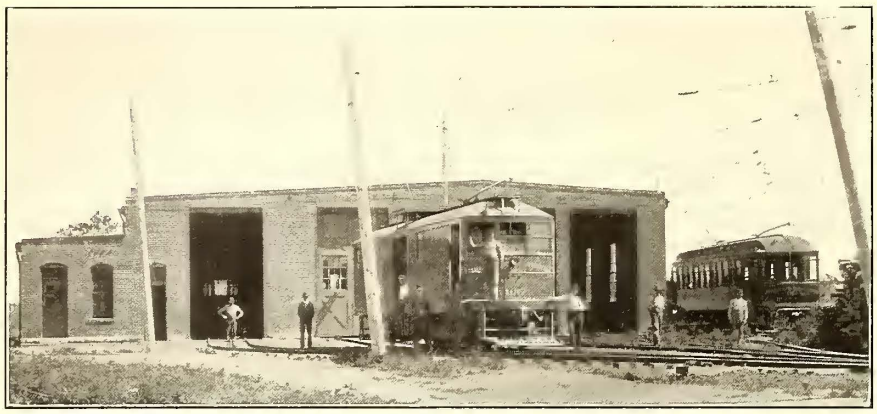
ENGINE ROOM IN POWER PLANT AT BROOKVILLE, SHOWING BELTED EXCITER AND DIFFERENTIAL BOOSTER FOR STORAGE BATTERY

ROLLING STOCK

There are at present in operation six passenger and two combination passenger and express cars, built by the Barney & Smith Car Company, each seating forty-six passengers, and being 44½ ft. long over the vestibules. These cars are mounted on two four-wheel pivoted trucks having a wheel base of 6 ft. Each car is provided with four 50-hp Lorain Steel Company motors. The cars are heated by electricity, and are equipped with air brakes of the Christensen Engineering Company's storage air type. The seats are of the Barney & Smith standard make, reversible and covered with Pantasote. Wagenhall's arc headlights are used, and Providence fenders. As cars can

not, as yet, be turned at the Dayton end, it was necessary to make them double-ended. Later, one controller and trolley pole will be taken off.

In addition there are one motor freight car, 42 ft. over all, having the same motor equipment as the passenger cars, and a few flat cars. The freight car has a top platform for line repair work and a standard steam railway coupler for hauling steam-road cars. These features are shown clearly in the cut of the car house, before which a passenger and freight car are standing.



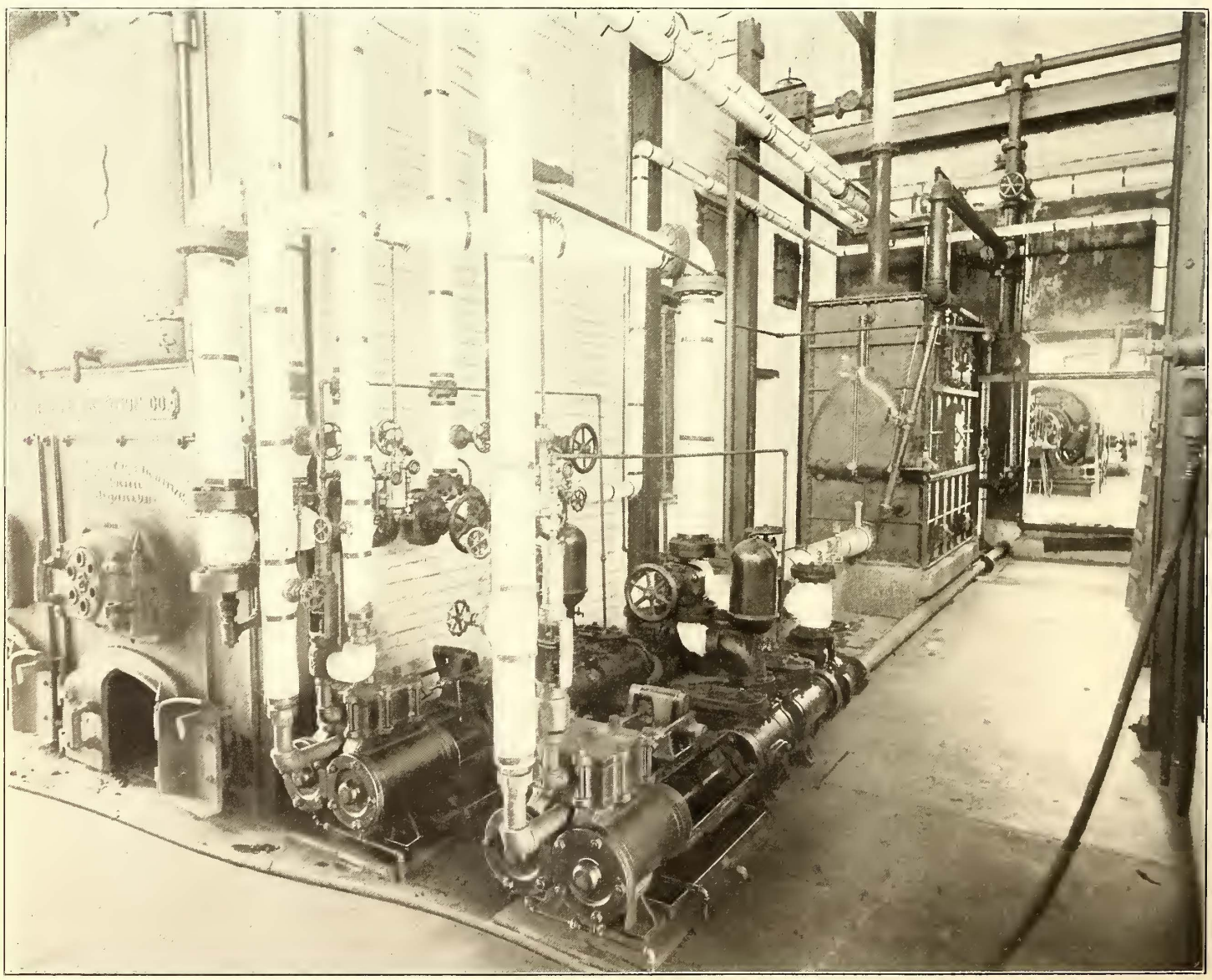
CAR SHEDS, SHOWING FREIGHT CAR WITH TOP PLATFORM FOR LINE REPAIR WORK

The passenger car schedule necessitates, on some portions of the road, a speed of from forty-five to fifty miles an hour.

POWER PLANT

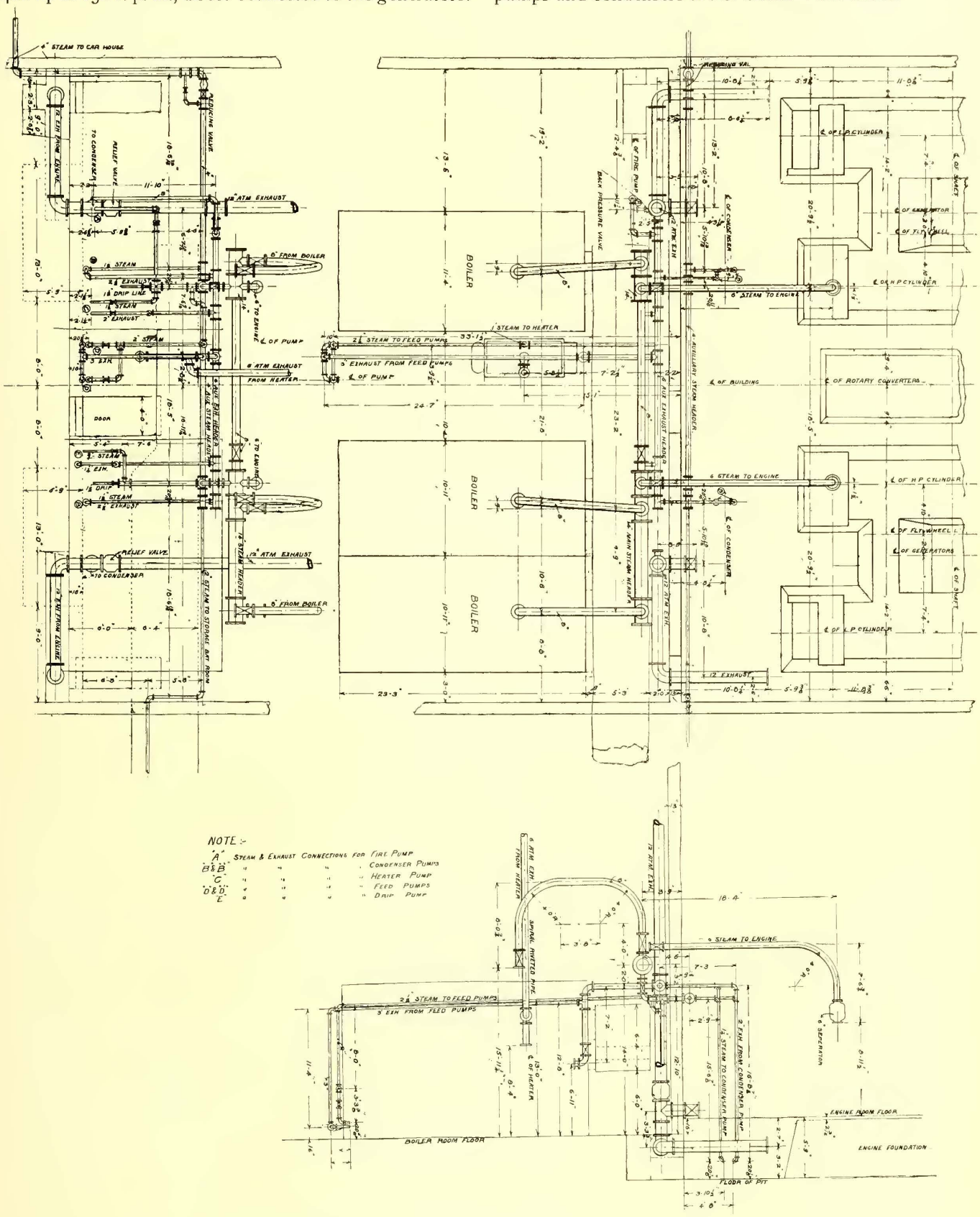
The power house is located in Brookville, approximately 13½ miles from the Dayton end of the road; and a sub-station is located at Arcanum, approximately 12 miles from the Greenville end of the road, three-phase transmission being used from the power house to the sub-station. The distances of the power house and sub-station respectively from the ends of the road are somewhat greater than would have been the case if it were not for local conditions, the power house location being fixed by the water supply, while the sub-station location was determined largely by the fact that at Arcanum it would be necessary, in any case, to have a freight and passenger station, and if the sub-station were not located at the same point, the additional salaries would more than offset the interest on the additional feeder required. This, therefore, is one of the numerous cases where the consideration of all the conditions materially affected a design based on purely engineering factors.

Steam is generated by three Cahall horizontal water-



BOILER ROOM, SHOWING FEED PUMPS AND HEATER

tube boilers, of 260 hp each, with Tupper grates. There are two 14¼ ins. x 28½ ins. x 30 ins. cross-compound condensing Buckeye engines, with reheating receivers, rated at 400 hp at 150 r. p. m., direct-connected to the generators. Sorge chemical purifying system, and with quartz filters, one 8 x 3½ x 8 compound Ingersoll-Sergeant air compressor, with duplex air cylinders, 8 ins. x 8 ins. The pumps and condensers are of Smith-Vaile make.



PLAN, SIDE AND END ELEVATIONS OF STEAM AND EXHAUST PIPING

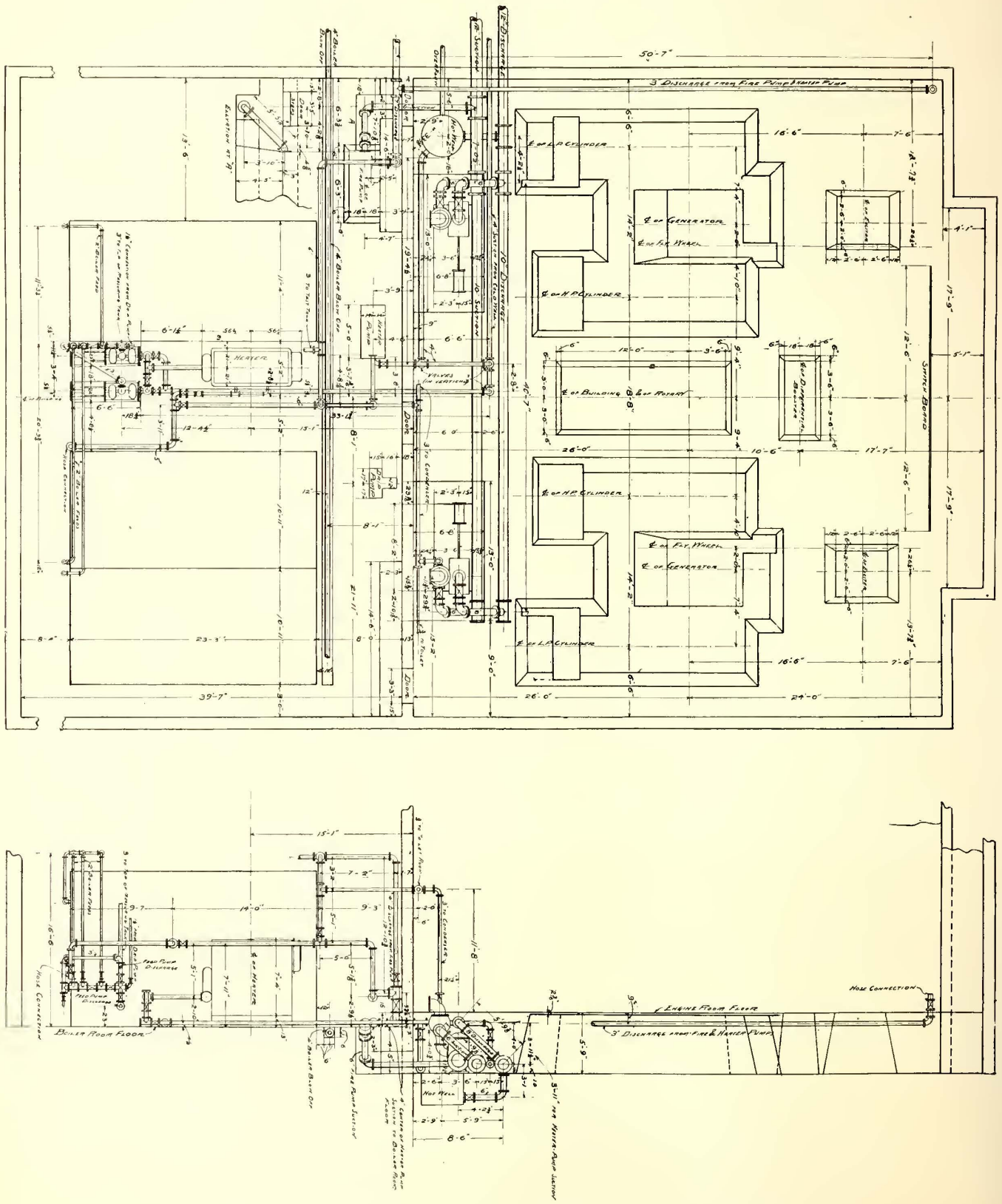
The auxiliary apparatus consists of two 9½ ins. x 16 ins. x 18 ins. jet condensers, one 6 ins. x 6 ins. x 10 ins. duplex heater pump, two 7 ins. x 4½ ins. x 10 ins. plunger type feed pumps, one automatic pump and receiver to drain live steam mains, one 16 ins. x 9 ins. x 12 ins. duplex fire pump, one 1200 hp Cochran feed-water heater, fitted with the

The piping and all auxiliary machinery, except the air compressor, was contracted for and installed by Ware & Moodie, of Dayton, Ohio. All live steam lines and high-pressure feed lines are of extra heavy pipe and fittings, and all of the large high-pressure gate valves are of the by-pass type.

Cross connections and valves are so placed that more than one piece of machinery would have to be disabled before the economical operation of the plant would be affected, and it would require a very serious mishap to cripple the plant to such an extent as to prevent the operation of cars.

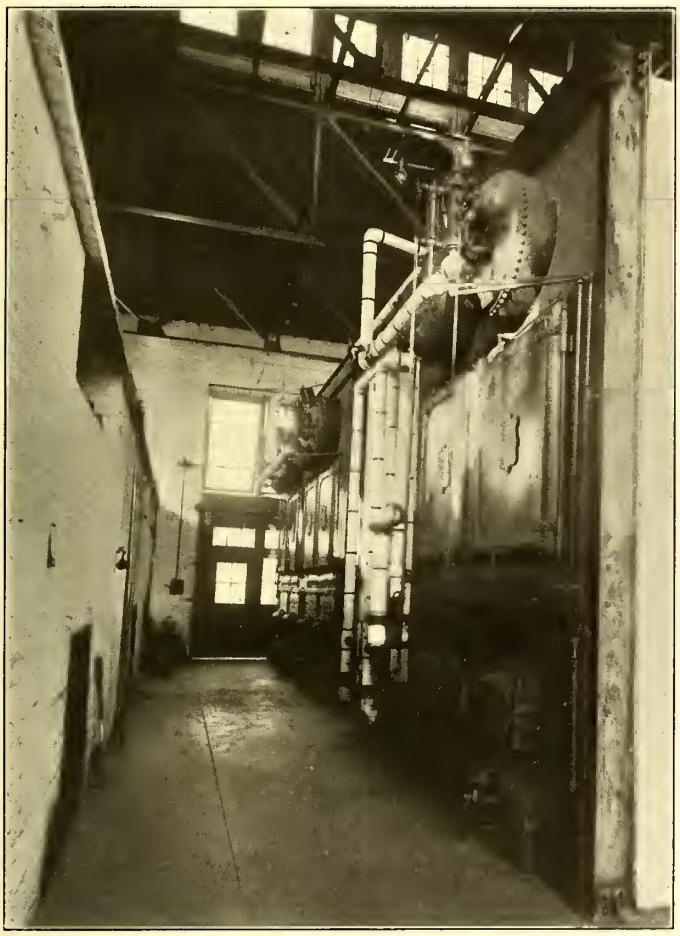
Water is obtained mainly from wells, and, to a slight degree, from a stream. The latter is dammed and forms a reservoir, and there is also a deep well. Over a portion of the reservoir are placed cooling trays. The water from the condensers passes first to the cooling trays, next to the reservoir, and thence to the deep well, which is also a cold well, and enough is allowed to pass from the reservoir to the cold well to make up the deficiency of supply on the part of the well. When the plant is not in operation the water in the well is not far below the surface of the ground, and the amount which the well supplies varies with the seasons.

With the exception of the differential boosters for the batteries, the Westinghouse Electric & Manufacturing Company installed the complete electrical equipment in the power house and sub-station, consisting of two 250-kw three-phase alternators, revolving field type, direct-connected to the engines, and making 150 r. p. m. There



PLAN AND SIDE ELEVATIONS OF FEED WATER PIPING AND FOUNDATIONS

are two 22½-kw exciters belted to the engines, each having sufficient capacity for exciting both alternators, two 100-kw rotary converters, the direct-current voltage being 650, and each is equipped with an induction starting



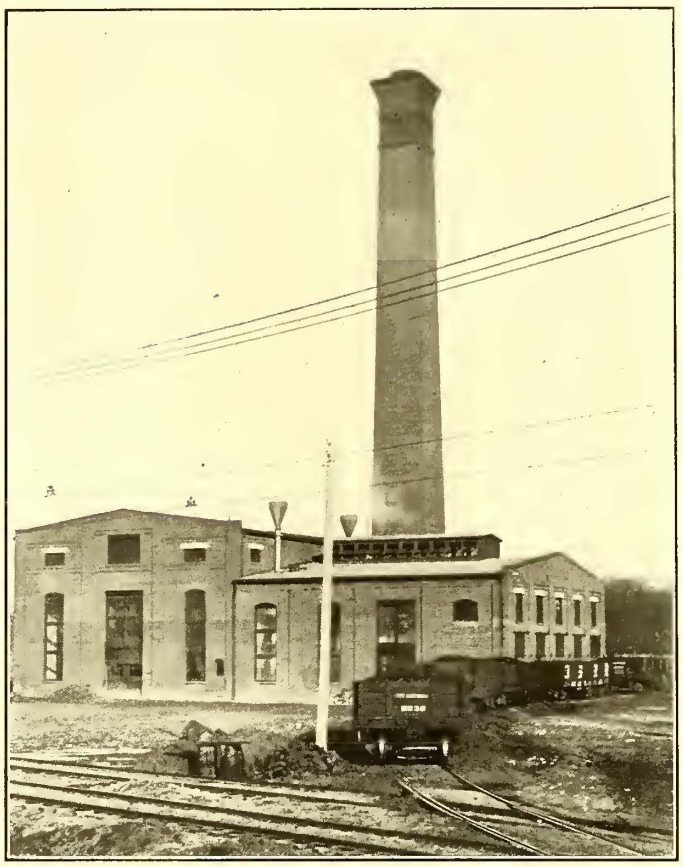
BOILER ROOM WITH COAL BINS ENCLOSED

motor. There are also four 75-kw, step-up transformers, 10,000 to 11,000 volts, one of these being held as reserve.

Both the first sub-station, in the power house at Brookville, and the second one, on the line at Arcanum, are equipped with Chloride accumulators. The object of these

STORAGE BATTERY PLANT IN SUB-STATION

batteries is to take the fluctuations caused by the varying load of the cars, allowing a steady load to be supplied by the rotaries, and consequently by the generators. The equipment in each case consists of 312 cells, type G-11, of the standard Chloride accumulator, installed in lead-lined tanks of type G-13. Each battery is rated to discharge at 400 amps., in regulating the rapid fluctuations, and has a capacity of 800 ampere-hours when discharged at the normal rate. Each is controlled by a differentially-wound booster, designed to charge and discharge the battery automatically, as the demand increases or diminishes. By a special interlocking device, the motor circuit-breaker



POWER HOUSE AT BROOKVILLE

can not open without tripping the battery circuit-breaker, thus insuring the safety of the booster. By means of a special double-pole, double-throw rocker switch, the battery may be thrown directly across the line without the booster; or the booster may be connected up as a single-charging booster; or, again, the entire outfit may be thrown across the line for automatic regulation.

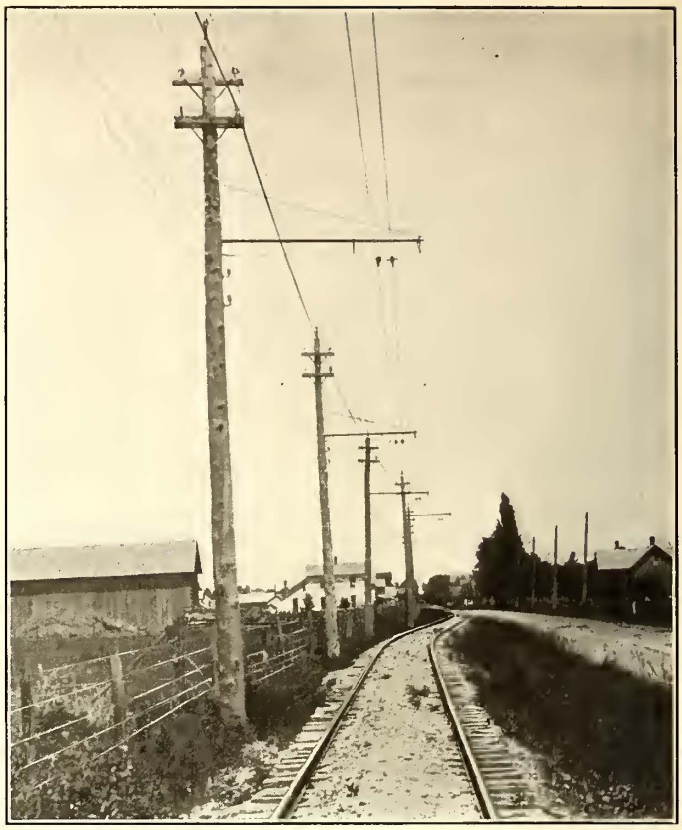
The power-house switchboard contains twelve panels. There are two alternating-current generator panels, two alternating-current and two direct-current rotary panels, a total output panel, one lighting panel, two feeder panels, and two storage-battery panels.

The machinery mentioned is placed in a power house 107 ft. long x 66 ft. wide, containing two rooms, a boiler room, 51 ft. x 60 ft., and an engine room, 50 ft. x 60 ft., each covered by a steel-trussed roof. There is a clear space of 29 ft. 3 ins. above the floor in the engine room. A 30-ton two-trolley traveling crane built by Chisholm & Moore, 48½ ft. long, is provided, and can be operated over the full width of the engine room. On one side of the engine room is built a static transformer room, 18 ft. x

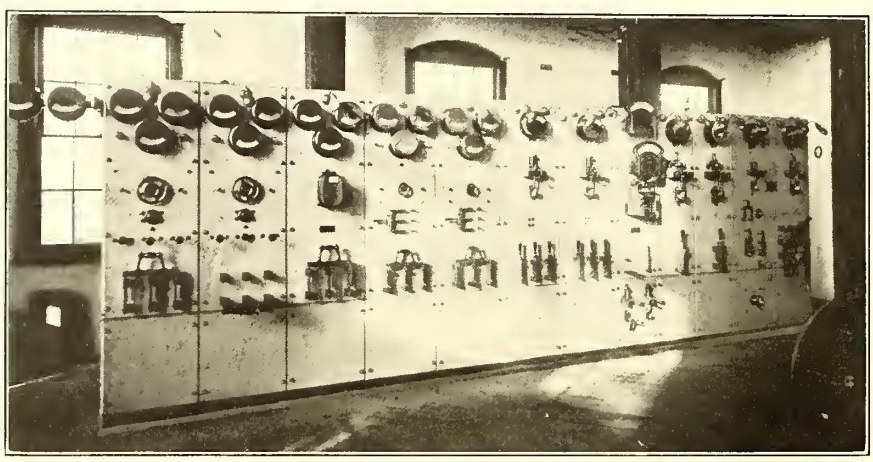
18 ft., and on the same side stands the brick stack, 150 ft. high. The outside of the stack is square in section, tapering from 14 ft. at the base to 9 ft. at the top, and it provides a circular smoke passage 6 ft. in diameter. The

SUB-STATION, FREIGHT HOUSE AND AGENT'S RESIDENCE

power house is connected by a covered passage-way to a specially constructed storage-battery building, which contains a single well-ventilated and lighted room, 77 ft. x 29 ft. x 10 ft. high.



TYPICAL OVERHEAD CONSTRUCTION



12-PANEL SWITCHBOARD IN POWER PLANT

SUB-STATIONS AND CAR HOUSES

The Arcanum sub-station equipment of rotary converters, static transformers and storage battery is a duplicate of that in the power house. One attendant looks after all the apparatus in this sub-station and attends to the ticket office and freight. The building at Arcanum is a handsome structure, the front being two stories high by 56 ft. wide, and containing a ticket office and waiting-room, and the living apartments of the station attendant and his family. The rear portion contains a static transformer room, a room for the two converters and switchboard, and a large storage-battery room, 44 ft. x 26 ft.

The car house, located near the power house, is 162 ft. x 76 ft., and is divided longitudinally into two sections by a brick wall. One section, 52 ft. wide, contains four tracks, and has a storage capacity for twelve cars. Each track is provided with an inspection pit. The other portion of the building, 20 ft. wide, contains a machine shop, repair pit and office room.

TRANSMISSION SYSTEM

As already mentioned, there are two sub-stations, one in the power house and one at Arcanum, 15 miles distant. Each contains two converters and a storage battery, delivering direct current at 650 volts. Three-phase current at 10,000 volts is transmitted to Arcanum over three bare aluminum wires of No. 00 B. & S. gage.

A bare aluminum feeder cable of 477,000 circ. mils extends the whole length of the line within 1 mile of each terminus. In addition, there is one 6-mile and one 12-mile cable, of the same size, extending from the power house toward Dayton,

ROTARY AND SWITCHBOARD IN SUB-STATION

and one 6-mile cable from the Arcanum sub-station toward Greenville, making, in all, 61.5 miles of aluminum cable. Two figure 8, No. 00 trolley wires are used, thus avoiding all switches and crossovers, and providing a duplicate line, so that one can be used in case the other breaks. These wires are suspended from the Richmond type of bracket, except in towns where cross suspension is provided. Thirty-five ft. poles spaced 100 ft. carry the transmission system, and also two telephone wires supported one above the other on brackets. Each car is provided with a complete telephone set, so that communication with the power house or train despatcher is possible at any time from any point on the line.

FREIGHT AND EXPRESS

One freight car is constantly in use. It makes two round trips daily, but this is not now sufficient for the business. The minimum charge is 7 cents per cwt. For the convenience of patrons the company's agents are authorized to use the private telephone line in ordering goods of any kind from merchants in Dayton, thereby saving long-distance tolls, and insuring quick delivery.

DAYTON AND NORTHERN

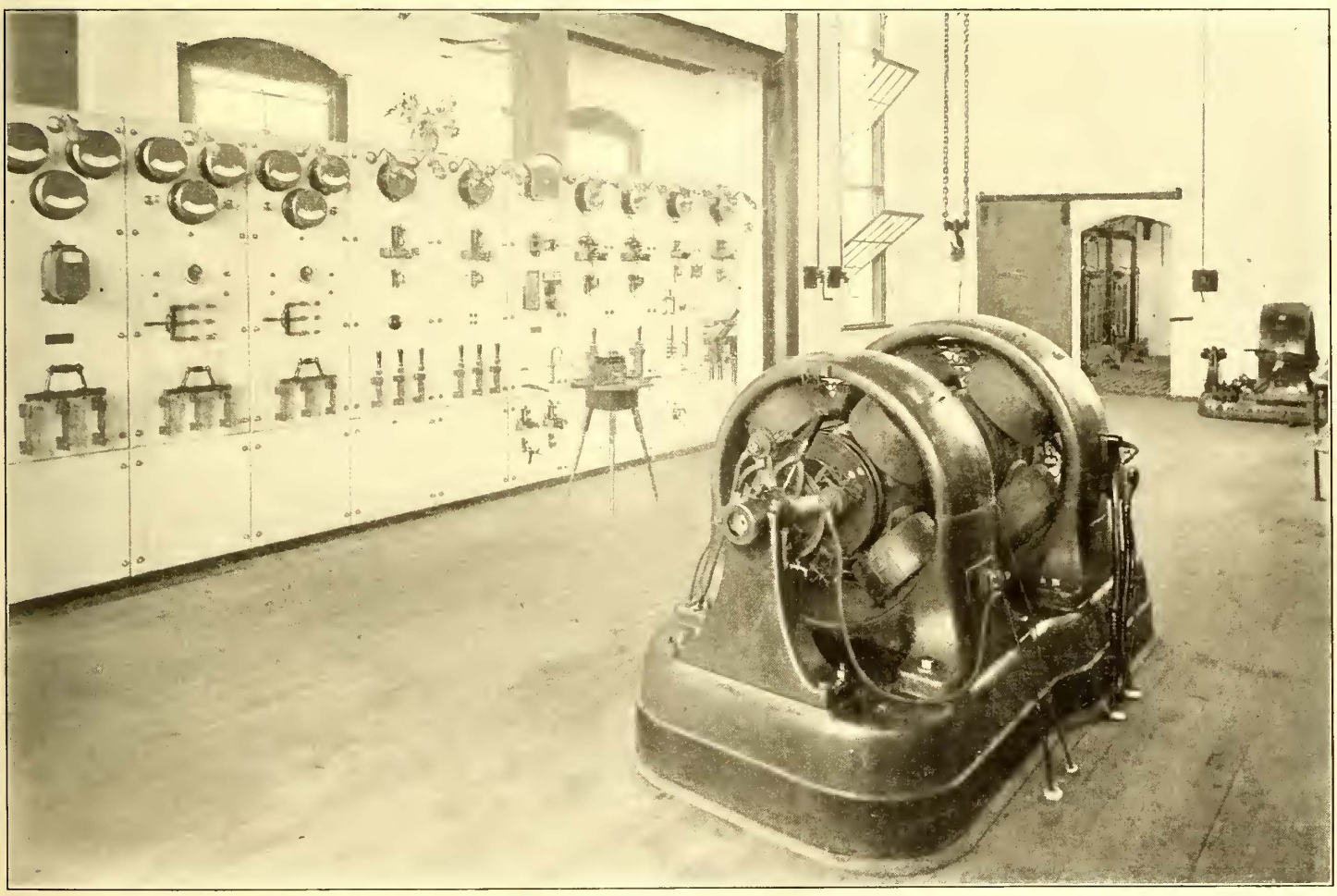
IN EFFECT APRIL 1, 1902

Cars leave Dayton Main Street River Bridge every hour from 6:00 a. m. till 11:00 p. m., making following points:

Miles	Stations	Single Fare	Round Trip
3	Fairview	$0.05	$0.10
8	Haines Station	.10	.20
10	Taylorsburgh	.10	.20
13	Salem	.15	.25
16	Brookville	.20	.35
18	Dodson	.25	.45
19	Bachman	.30	.50
20	Wengerlawn	.30	.50
22	W. Baltimore	.35	.60
25	Gordon	40	.65
27	Ithaca	.40	.70
31	Arcanum	.45	.75
35	Abbottsville	.50	.85
36	Jaysville	.55	.90
43	Greenville	.60	1.00

Freight car leaves at 7:30 a. m. and 1:30 p. m. All kinds of freight and express carried.

10:00 p. m. last car for Greenville.



INTERIOR OF SUB-STATION, SWITCHBOARD, BOOSTER AND FIREPROOF ROOM FOR STATIC TRANSFORMERS

At Dayton, Brookville, Arcanum and Greenville, freight and passenger stations are provided, and at the other towns trucks are furnished for taking the freight to and from the road.

PASSENGER SERVICE

Cars are operated on hourly and at times during the summer on half-hourly schedule, and the run of approximately two miles in Dayton and 39.5 miles on the tracks of the Interurban Company, is made in 1 hr. 55 min. The schedule given. Owing to the curves and grades on some portions, it is necessary to make high speed wherever possible, in order to secure a fair average.

11:00 p. m. to Brookville only.

Connection made at Greenville with Panhandle and Cincinnati Northern.

Connection at Arcanum with Big 4.

9:00 p. m. last car from Greenville for Dayton.

10 and 11 p. m. from Greenville to Brookville only.

The entire length of road practically parallels the Dayton & Union steam road, on which is operated six trains each way every day, making a regular charge at the same rates as the Dayton & Northern, with special rates for special occasions. Nevertheless, the result has been most satisfactory to the electric road which, it is claimed, obtains 90 per cent of the business.

RECORDS OF TESTS OF PASSENGER CAR

A very complete test of the equipment has been made by E. P. Roberts & Co., of Cleveland, and the results have been tabulated, and are here presented in convenient form.

The records obtained were voltage and current at car, recording wattmeter readings between specified points on the road, and speed. Without a careful comparison of these with the map and profile, and stops, the individual figures have no value; therefore, only a few general results are given.

Oct. 6, 1901. Car number, 125.

Total weight, approximately, 25 tons.

Weather, clear and dry.

TABLE I

Summary of Results

Location	Dist. Miles	Time Min.	Schedule Speed Mile per Hour	Watt Hrs.	Kw Hrs. per Car Mile
Power house to Salem	3.79	11	20.7	8,400	2.21
Salem to Haines (R. R. crossing)	5.02	14	21.5	8,700	1.71
Haines (R. R. crossing) to Dayton circuit	4.95	16	18.5	11,400	2.30
St. Railway into Dayton depot	----	7	----	1,500	----
Dayton depot to D. & N. T. Co.'s power	----	6	----	5,100	----
D. & N. T. Co.'s Circuit to Haines (R. R. cross'g)	4.95	19	15.6	13,200	2.67
Haines (R. R. crossing) to Salem	5.02	16	13.8	13,800	2.75
Salem to Power House (Brookville)	3.79	11	20.7	9,600	2.53
P. H. (Brookville) to Wengerlawn	3.45	8	25.9	7,800	2.26
Wengerlawn to W. Baltimore	2.44	5	29 3	4,200	1.72
W. Baltimore to Gordon	2.35	7	20.1	4,200	1.79
Gordon to Sub-station (Arcanum)	6 20	17	21.8	12,000	1.94
Sub-station (Arcanum) to Fair Ground	9.87	27	21.9	22,800	2.28
Fair Ground to Greenville end	1.46	11	8.0	5,400	3.70
Greenville end to Sub-station (Arcanum)	11.33	29	23 4	24,600	2.17
Sub-station (Arcanum) to Gordon	6.20	19	19.6	10,500	1.70
Gordon to W. Baltimore	2.35	7	20.1	3,000	1.28
W. Baltimore to Wengerlawn	2.44	5	29.3	4,500	1.24
Wengerlawn to P. H. Brookville	3.45	2	25.9	6,900	2.00
Dayton to Greenville	39.53	121	19.6	93,000	2.35
Greeenville to Dayton	39.53	109	21.8	78,000	1.97
Total run (on D. & N. T. Co.'s circuit)	79.06	230	20.6	171,000	2.16
Total in Dayton	----	13	----	----	----
Total lay overs	----	247	----	----	----
Total time out	----	490	----	----	----

The heaviest grades and sharpest curves are between Dayton and Brookville. Greenville is higher in elevation (260 ft.) than Dayton. The instruments used were a recording wattmeter, made by the General Electric Company especially for E. P. Roberts & Co., and a Weston voltmeter and a Weston ammeter.

Current used for heating and lighting is not included in the car tests (Table II.) where measurements were made at the car.

Same car—Dec. 12 and 13, 1901.

Dec. 12—Average temperature was above freezing and track dry, but snow on ground.

Dec. 13—Temperature high, requiring no heat on cars during the day. Track dry, but ground soft from thaw of snow. Strong wind from southwest.

Total run of six round trips equals 474.36 miles.

TABLE II

Passenger Car Tests. Heating and Lighting Not Included.

Location	Miles	Time Min	Kw Hrs.	Schedule Speed Mi. per Hour	Kw Hrs. per Car Mile
Car House to Dayton, 1st trip	13.76	30	27.6	27.5	2.00
" " 2d "	13.76	35	26.4	23.6	1.92
" " 3d "	13.76	38	26 4	21.2	1.92
" " 4th "	13.76	43	25.2	19.2	1 83
" " 5th "	13.76	40	28.8	20.6	2.09
" " 6th "	13 76	33	24.0	25.0	1.74
" " Average	13.76	37	26.4	22.3	1.92
Dayton to Car House, 1st trip	13.76	37	31.2	22.3	2.27
" " 2d "	13.76	42	37.2	19.6	2.70
" " 3d "	13.76	42	33.0	19.6	2.40
" " 4th "	13.76	43	27.6	19 2	2 00
" " 5th "	13.76	37	28.8	22.3	2.10
" " 6th "	13.76	38	29.4	21.7	2.14
" " Average	13.76	40	31.3	20.7	2 27
Car House to Greenville, 1st trip	25.77	75	52.8	20.6	2.05
" " 2d "	25.77	85	43.2	23.8	1.68
" " 3d "	25.77	80	47.4	19.3	1.84
" " 4th "	25.77	85	50.4	18.2	1.96
" " 5th "	25.77	66	43.2	23.4	1.70
" " 6th "	25.77	65	51.0	23.8	1.98
" " Average	25.77	75	48.1	21.3	1.87
Greenville to Car House, 1st trip	25.77	70	50.4	22.0	1.96
" " 2d "	25.77	74	59.8	20.9	2 22
" " 3d "	25.77	81	43.8	19.1	1.70
" " 4th "	25 77	70	44.4	22.0	1.72
" " 5th "	25 77	75	54.0	20.6	2.10
" " 6th "	25.77	72	49.8	21.5	1.94
" " Average	25.77	74	50.2	21.0	1.95
Average Car House to Dayton and return	27.52	77	57 7	21 6	2.10
Aver. Car House to Greenville and return	51.54	146	98.2	21.1	1.91
Average Dayton to Greenville	39.53	113	79.4	21.0	2.01
Average Greenville to Dayton	39.53	110	76.6	21.6	1.94
Average round trip	79.06	224	156.0	21.3	1.96
Total test runs	474.36	1,337	936.0	21.3	1.98
Total run (in Dayton)	----	----	36.0	----	----

TESTS OF FREIGHT CAR

Weight of car and equipment, 23.5 tons.

Gearing, same as passenger car, approximately 45 miles per hour on level, 500 volts.

Running speed slower than passenger car, because of long stops.

Dec. 14, Saturday—Snow storm, but snow not above rail.

Dec. 16, Monday—Very cold and snow not to top of rail.

Dec. 17, Tuesday—Very cold and snow not to top of rail.

Dec. 18, Wednesday—Very cold and snow not to top of rail.

TABLE III

Summary of Results on Test of Freight Car No. 105

No. of Run	Location	Miles	Kw Hours	Kw Hrs. per Car Mile
1	Car House to Dayton, 1st trip	13.76	26 4	1,92
7	" " 2d "	"	25.6	1.88
11	" " 3d "	"	20.4	1.48
15	" " 4th "	"	22.8	1.66
20	" " 5th "	"	22.2	1.62
A	" " Average trip	"	24.1	1.75
3	Dayton to Car House, 1st trip	13.76	31.6	2.31
8	" " 2d "	"	32.4	2.36
12	" " 3d "	"	28.3	2.07
16	" " 4th "	"	30.0	2.18
B	" " Average trip	"	30.6	2.23
9	Car House to Greenville, 1st trip	25.77	57.0	2.21
13	" " 2d "	"	43.6	1.77
17	" " 3d "	"	51.2	1.98
C	" " Average trip	"	51.3	1.99
10	Greenville to Car House, 1st trip	25.77	48.8	1.89
14	" " 2d "	"	50.4	1.95
18	" " 3d "	"	48.8	1.89
23	" " 4th "	"	40.8	1.58
D	" " Average trip	"	46.6	1.81
	Average Car House to Dayton and return	27.52	54.9	2.00
	" " " Greenville "	51.54	97.9	1.90
	" Dayton to Greenville	39.53	85.7	2.07
	" Greenville to Dayton	39.53	70.7	1.79
	" Round trip	79.06	156.4	1.98
	Total test runs	382.10	774.8	2.03

The following records were kindly furnished by J. E. Feight, superintendent of the road:

TABLE IV

Power Output in Regular Service in Kw Hours

1902	Average per Hour							
	A. C.	D. C.			A. C.	D. C.		
		P. H.	S. S.	Total		P. H.	S. S.	Total
July 28	5,000	1,880	2,460	4,340	238	89.5	117 1	206.6
July 29	5,400	1,940	1,700	3,640	257	92.4	81.0	173.4
July 30	5,100	1.940	1,970	3,910	243	92.4	94.0	186.4
July 31	4,900	2,040	1,960	4,000	233	97.1	93.4	190.5
August 1	5,300	1,910	2,090	4,000	253	91.0	99.5	190.5
August 2	5,800	1,990	1,720	3,710	276	94.8	82.0	176.8
Average	5,250	1,950	1,983	3,933	250	92.0	94.4	187.3

This amount is somewhat less than the average of the results of the tests of E. P. Roberts & Co., and it is possible that the car-mileage, as given, is slightly high. On the other hand, the track was much better than at the time of E. P. Roberts & Co.'s tests, and also when their

tests were made the trucks and motors were new, and the friction may have been greater. The ratio of alternating current to direct current is practically as obtained by E. P. Roberts & Co., and as hereafter referred to.

POWER HOUSE AND SUB-STATION TESTS

Oct. 5, 1901, a complete efficiency test was made by E. P. Roberts & Company.

The steam plant tests gave no results of special interest. The engine operated at 10 per cent overload, the vacuum was low, as the cooling trays had not been installed, and the result obtained, corrected for moisture and low vacuum, was 16.3 lbs. of dry steam per indicated horse-power. The receiver reheater of the engine tested was not in satisfactory operation at the time of test. The friction of engine and generator, direct-connected, and of the exciter belted to the engine fly-wheel, was 9 per cent of the rated indicated horse-power.

In December, 1901, the following test was made for coal per kilowatt—alternating current—the kilowatts being as stated in Table VI.

The fuel was very wet and was high in volatile matter, and low in heat units, and the fireman did not handle it properly. This test showed that materially better results than were reported at the time of the efficiency test were readily obtainable by coking firing with the same coal, or by using better coal.

Reducing the results obtained to an equivalent of coal having 14,000 B. T. U., and boiler and furnace efficiency of 65 per cent, gives for coal (no reduction for ashes, etc.) 3.70 lbs. per kilowatt. Time of test, noon, Thursday, Dec. 12, 1901, to 1:00 a. m., Sunday, Dec. 15. The output in alternating current and direct current during the same period was as follows:

TABLE V.

AVERAGE OUTPUT OF MACHINES

TIME	POWER HOUSE						SUB-STATION		
	A. C. Output of Generator			D. C. Output of Station			D. C. Output of Station		
	Kw Hours	Hours	Ave. Kw	Kw Hours	Hours	Ave. Kw	Kw Hours	Hours	Ave. Kw
Thursday, Dec. 12—									
12.00 m. to 7.00 p. m.	2,100	7.0	300	848	7.0	121	521	7.0	74
7.00 p. m. to 12.00 p. m.	1,200	5.0	240	530	5.0	106	315	5.0	63
12.00 p. m. to 1.05 a. m.	100	1.0	100	45	1.0	45	0	--	0
12.00 m. to 1.05 a. m.	3,400	13.1	261	1,425	13.1	108	{836 {836	13.1 *12.0	64 70
Friday, Dec. 13—									
1.05 a.m. to 4.30 a.m.	0	3.4	0	0	3.4	0	0	3.4	0
4.30 a.m. to 7.15 a m.	400	2.8	143	143	2.8	51	{377 {377	2.8 *1.5	135 252
7.15 a.m. to 12.00 m.	1,600	4.7	340	668	4.7	142	429	4.7	91
12.00 m. to 6.17 p.m.	1,580	6.3	251	682	6.3	108	----	----	---
12.00 m. to 7.30 p.m.	----	----	---	----	---	---	947	7.5	126
6.17 p m. to 12 45 a.m.	1,840	6.5	353	595	6.5	92	----	----	---
7.30 p.m. to 12.00 p.m.	----	----	---	----	----	---	260	4.5	58
1.05 a.m. to 12.45 a.m.	5,420	23.3	232	2,088	23.3	90	2,013	24.0	84
Saturday, Dec. 14—									
12.45 a.m. to 5.45 a.m.	570	5.0	114	99	5.0	20	0	5.8	0
5.45 a.m. to 7.15 a.m.	510	1.5	340	132	1.5	88	----	----	---
5.45 a.m. to 12.00 m.	1,510	6.2	260	839	6.2	135	272	6.2	44
7.15 a.m. to 12.00 m.	1,100	4.8	229	707	4.8	147	----	----	---
12.00 m. to 12.40 a.m.	3,950	12.7	311	1,677	12.7	132	----	----	---
12.00 m. to 12.00 p.m.	----	----	---	----	----	---	1,441	12.0	120
12.45 a.m. to 12.00 a.m.	6,130	23.9	256	2,615	25.9	109	1,713	{23.9 {*18.2	72 94
Total, Thursday 12 to 12.40 a m. Sunday	14,930	60.7 57.3	247 251	6,126	60.7 *57.3	101 107	4,662	60.7 *49 2	75 93

* Times of actual run of generator or rotaries.

It should not be overlooked that this plant has storage batteries, and that the direct-current output is that given to the line; therefore, the comparison of alternating current and direct current for short periods should not be made, as the batteries are sometimes charging for an hour or more in excess of their output, and at other times far less. This even affects the totals for the day, but the average for the three days probably closely approximates the actual average

TABLE VI.

Efficiency from alternating-current generator ouptput to total direct-current output of both stations, including loss of storage batteries, rotaries, statics and transmission line.

	A. C. Kw Hours of Generator	Total D. C Kw Hours of Rotaries	Efficiency
Thursday, Dec. 12— 12.00 n. to 1.05 a. m.	3,400	2,259	66.4%
Friday, Dec. 13— 1.05 a. m. to 12.45 a. m	5,420	4.101	75.7%
Saturday, Dec. 14— 12.45 a. m. to 12.40 a. m	6,130	4,328	70 5%
Total— Thursday 12.00 noon to 12.40 a m. Sunday.	14,950	10,688	71.5%

for longer periods, although the first day's record was probably lower than the average. This is also indicated by the results previously noted, 74.9 for six days' run.

Considering the average efficiency as 74.9 per cent from alternating current to direct-current output of sub-station, the following *assumed* efficiencies would give this result. Possibly none of the assumptions is exactly correct.

The sub-station supplies practically one-half the direct current output, therefore, only one-half the alternating-current energy is transmitted over the high voltage line and through the statics, and at the load as recorded. For the greater portion of the time only one rotary in the sub-station was in operation at approximately its rated load, and the statics at one-half load. At times, however, both rotaries in the power house and in the sub-station were operated. Under these conditions consider the average efficiencies estimated by the engineers as follows:

Storage Battery.—Approximately 20 per cent of the energy was assumed to pass through the battery, and the efficiency was taken at 80 per cent. This gives for efficiency of battery relative to total output, 96 per cent.

Generators.—For short period, two at underload; for other short periods, one at underload; for other short periods, one at overload. Consider average efficiency as 91 per cent.

Rotaries.—Practically same condition as to operation at load and over and under loads, but somewhat longer times; two in either power house or sub-station, and one in the other location, and therefore a longer period of light load. Consider as average efficiency under these conditions 91 per cent.

Transformers.—Transmit one-half of the alternating-current energy, and if their efficiency is taken at 94 per cent, their effect on the total efficiency will be 97 per cent.

Line.—The efficiency of the line is 92 per cent when the load is equal to the rating of both rotaries, but 96 per cent at half load. If it is taken at 95 per cent, the effect on the total efficiency would be 97.5 per cent.

The above assumption then gives:

Battery, 96 per cent.
Generators, 91 per cent.
Rotaries, 91 per cent.
Statics, 97 per cent.
Line, 97 per cent.
Total efficiency, 74.7 per cent; call 75 per cent.

From an inspection of the measurements of voltage and current at the car it is probable that the average energy losses (not voltage losses) do not exceed 25 per cent; voltage losses, 20 per cent. On this basis the percentage of energy delivered to the car equals 75 per cent of 75 per cent, or 56 per cent.

STORAGE BATTERY

Both the first sub-station in the power house at Brookville, and the second one on the line at Arcanum, are

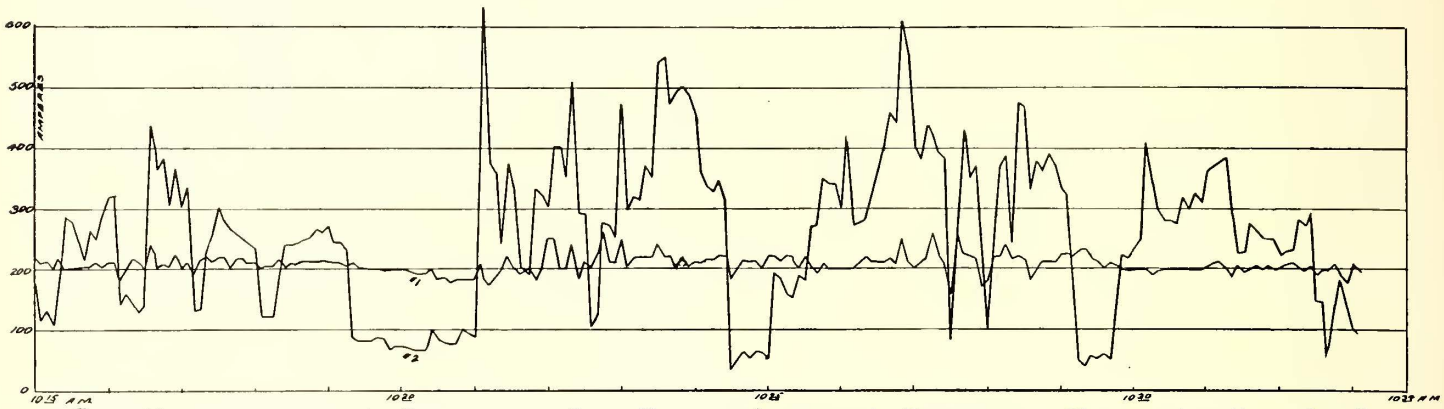
equipped with Chloride accumulators. This equipment has already been described in this article.

A curve taken March 30, 1902, at the Brookville power house, shows that the rotary load did not vary more than some 50 amps to 70 amps, whereas the total station output varied from about 40 amps up to almost 650 amps. The result of removing these fluctuations from the rotaries and generators is a great increase in the economy of operation at the station. Besides improving the economy, however, the battery serves to increase the capacity of the station, in that the average load may be increased to the full rating of the generators and rotaries, leaving the fluctuating load to be carried entirely by the accumulators.

Considerable use was made of these batteries in completing the road. At that time it was deemed inadvisable to operate the plant continuously, and for many days the work car was operated entirely from the two storage batteries.

The effect of the batteries in increasing the capacity of the station is shown by the following:

The operation of one engine, generator and one rotary in the power house and one in the sub-station, is sufficient for the operation of four passenger cars and one freight car. One generator is, as stated, 250 kw; each rotary is



Curve No. 1, rotary output in direct current. Curve No. 2, station output in direct current. Five-second readings taken Sunday a. m., March 30, 1902.

DIAGRAM SHOWING OUTPUT OF ROTARY AND BROOKFIELD SUB-STATION AND BALANCING EFFECT OF BATTERY

100 kws, and the batteries are 400 amps on hourly rating. Therefore, the momentary load permissible without exceeding the rating of the rotaries is: Two rotaries, rating at 154 amps, 308; two batteries at 400 amps, 800; total, 1108. This is available at 650 volts, and equals 720 kws. To obtain the same momentary overload without batteries would require a rotary capacity, taken at 50 per cent momentary overload, equal to 480 kws rated, and generator capacity, at 75 per cent efficiency, between alternating current and direct current, and at 50 per cent over rating at the time of such momentary overload, equal to 640 kws.

Of course, if necessary, the generator and rotaries operating with storage batteries can also be run above rating momentarily, but the percentage increase is comparatively small, because of the preponderance of the battery.

When two generators are in use the difference in momentary capacity is less. For example, with two 250-kw generators, four 100-kw rotaries, at 154 amps, equals 616 amps, and two batteries 800 amps, making a total of 1416 amps, which, at 650 volts, equals 920 kws.

The two rotaries, previously estimated, if 480 kws would give at 50 per cent overload 720 kws, and four, to continue the comparison, 1440 kws, and therefore a greater momentary overload, but doubling the cars not only doubles the average, and this the doubling of generator and rotaries (with batteries) provides for, and doubling the cars does not double the momentary maximum, and therefore the two-generator plant, without batteries, has a greater momentary maximum than is sufficient for doubling the service. This is not intended as an argument in favor of batteries for all plans and under all conditions, but merely a statement, by the engineers, as to their function in this case and their effect on capacity.

Engineering.—The civil engineering was in charge of C. Larue, assisted by E. Carbaugh. The superintendent of the Dayton & Muncie, J. E. Feight, is a trained civil engineer, and co-operated with the civil engineers mentioned. The architects were Peters, Burns & Pretzinger, of Dayton, Albert Pretzinger having the matter especially in charge. The mechanical and electrical engineers were E. P. Roberts & Co., of Cleveland, Ohio.

New Conduit Work of the Brussels Tramway Company

The city of Brussels, the capital of Belgium, which, with its many suburbs, has a population of over half a million people, has always been most prominent as a tramway center, and from this city many of the tramways throughout Europe and even Asia and Africa are controlled. At the present time there are some ten or fifteen large tramway investment companies owning tramways throughout Europe, whose headquarters are in Brussels and whose stock is actively quoted on the Brussels stock exchange. The city, in fact, occupies a commanding position in the tramway world second to no other city in Europe. In this respect it has no correspondance with any American city except possibly Philadelphia, the capitalists of which for a long time, and even at the present time, have given special attention to tramway investments all over America and control many of the larger systems. The number of tramway syndicates in Brussels, however, is much larger than in Philadelphia, and their operations are not confined to one country, but they are ready to take up enterprises of this character in practically every country on the globe.

This is one reason why the tramway system of the city of Brussels itself is of peculiar interest. Another is that the city, which is an exceedingly attractive one and contains many fine and large buildings, is located on the side of a hill on which the grades of the streets vary between five and fifteen per cent. The wholesale business district is located at the foot of the hill,but the principal retail business shops and office buildings are on the sides of the hill, while the finest residential portion and the King's palace, and a number of the principal hotels are at the top of the hill. This makes tramway riding almost essential to a large number

of residents and has been the means of developing a large traffic.

Early in the development of electric traction the company installed the trolley system on some of its suburban lines, and in 1897 had 27 or 28 km of double track equipped with electricity. The greater part of this was trolley but on some of the lines within the center of the city, where the trolley was not permitted, a conduit was employed. The trolley lines were installed by the French Thomson-Houston Company while the conduit lines were installed by the Union Elektricitäts-Gesellschaft, both representatives in Europe of the General Electric Company, of New York.

The power for operating the lines is supplied from a direct-current station containing two 400-kw machines, two 250-kw machines and five 100-kw machines, the latter having been installed at the time of the establishment of the first electric lines in 1894. In spite of the fact that the station is small and the transmission circuit has to be divided into two parts for use, respectively, on the conduit

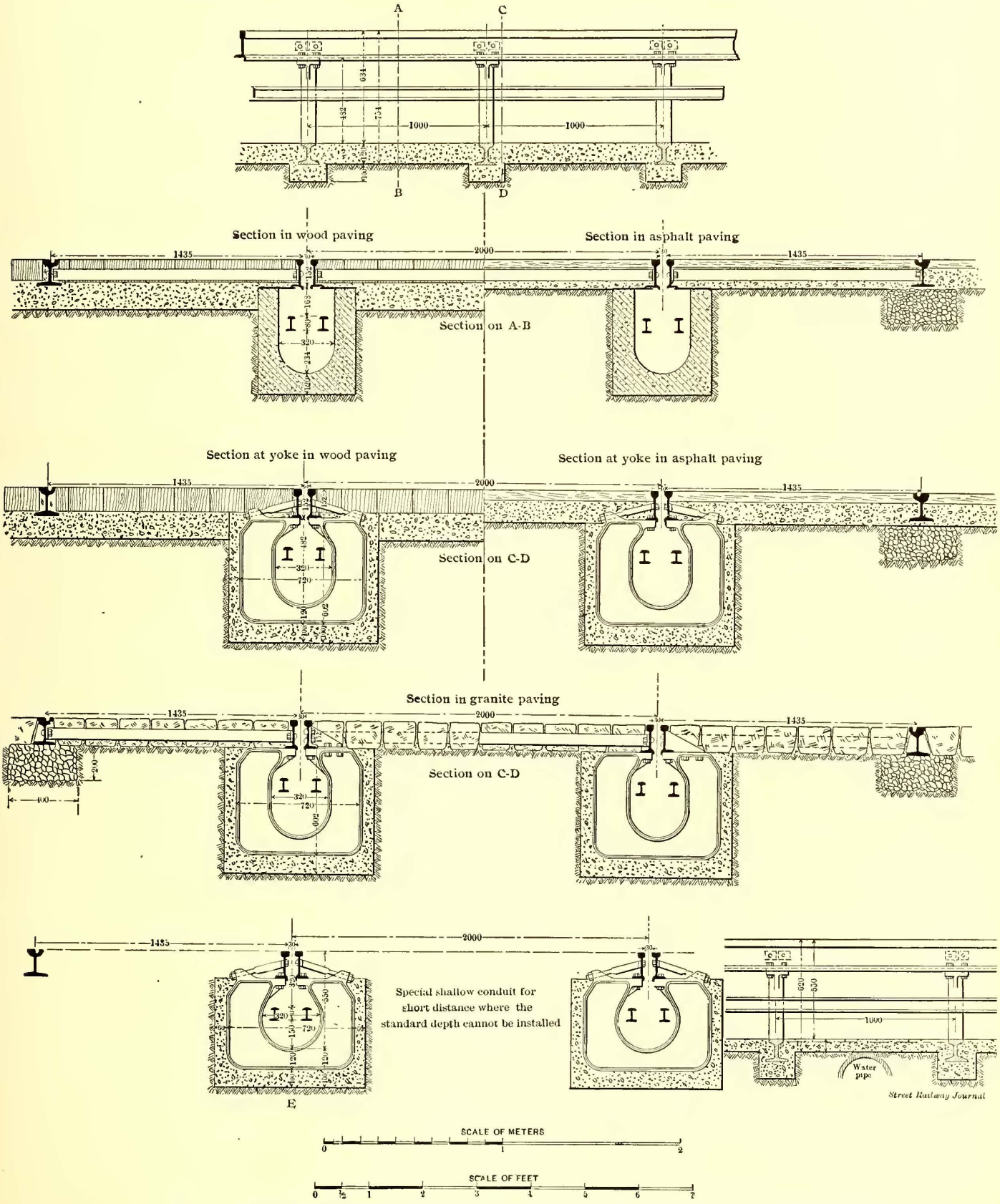


FIG. 1.—SECTIONS SHOWING STANDARD CONDUIT CONSTRUCTION USED IN BRUSSELS

and the trolley lines, the economy of the current generation has been very satisfactory and the consumption of coal per kilowatt-hour has varied between 1.7 kg and 1.85 kg (3.74 lbs. and 4.07 lbs.) The consumption of energy per car-kilometer is about 575 watt-hours on the conduit lines and 850 watt-hours on the trolley lines. The greater power required on the trolley lines is due to the steeper grades which are encountered.

As a result of the successful operation of this electric system, the company decided recently to change over some of the few remaining horse-car lines to electric power, and as it was not possible to secure the right to install a trolley on this section, the conduit was adopted. The work is now being carried forward under the direction of Mr. d'Hoop, chief engineer, and Messrs. Pedriali, Lechat and Dugniolle, engineers, and is now approaching completion.

The conduit is laid under one of the rails instead of between the rails, as in America. This system was adopted because the authorities were not willing that the center conduit should be used, on the ground that it introduced too much iron in the streets. The side conduit, as is well known, is employed quite extensively in a number of cities, including Vienna and Budapest. While cheaper to construct, in that it does not require so much excavation, the system has certain disadvantages, the principal ones being that the switches are quite complicated, and the slot opening must be considerable, especially at the switches. The width of the slot opening in Brussels at the switches is 45 mm ($1\frac{3}{4}$ ins.). At first these openings caused a number of accidents, as the wheels of light vehicles and of bicycles were caught in them and sometimes slipped through them. These troubles have about disappeared, however, as the public generally has learned to avoid driving over these places. Considerable trouble is also found in the accidental movement of the switch tongues by vehicles passing over them, but a switchman is now employed to keep them in position as well as to prevent carriages from passing over them. The company reports that the additional supervision required for the conduit system over the trolley system consists of a force of eleven men for each 2 km of single track. This is made up as follows: The chief inspector; 6 cleaners, including 1 car driver; 2 ordinary day inspectors and 2 night inspectors.

The original conduit was 62 cm (24.4 ins.) from the top of the pavement; the slot was 30 mm in width, and the slot rails were of the Harrmann type, each weighing 6 kg per meter (12 lbs. per yard). The latest conduit is slightly deeper, *i. e.*, 634 mm (25 ins.). The yokes, which are 1 meter apart, weigh 90 kg (198 lbs.) each. The conductor rails are of iron, originally weighed 9.3 kg per meter (18.6 lbs. per yard), and were 10 meters in length. The new conductor rails are 10 kg. (20 lbs. per yard) in weight and 15 meters in length. They are supported by insulators every 5 meters.

The insulators are not made up of porcelain as in this country, but are of hard rubber, moulded around an iron stud. So far this insulation has proved very satisfactory, being much less breakable than porcelain and seeming to retain its insulating properties. The use of these insulators has made it much easier to align the conductors, as the insulators are not rigid.

The contact device, or plow, differs radically from those used in America in four respects. In the first place the plow is arranged to be lifted from the conduit by means of a small winch on the car. This is necessary because the through cars will be run partly on the trolley system and partly on the conduit system, and a serious delay in the change would vitally affect the desirability of the service. The second point of difference is that the contact shoes instead of being pressed out horizontally, as in the New York and Washington plows, are mounted on a short lever and swing out vertically in the arc of a circle. In this respect the shoes are similar to those of the plows used in Vienna and Budapest, except that the latter are hinged from above and swing around an arc of about 45 degs., while the Brussels shoes swing around an arc of about 135 degs. The third point of difference lies in the fact that the positive and negative contacts are supported on separate shanks instead of being opposite each other, as in the American installations and in the Siemens & Halske roads in Budapest and Vienna mentioned above. This was done to avoid any dangerous short circuits between the leads, and in practice has seemed to work very satisfactorily. The fourth difference is that the rubbing surface of the contact is on top of the contact rail instead of on the side, as in all the other conduit systems. This makes

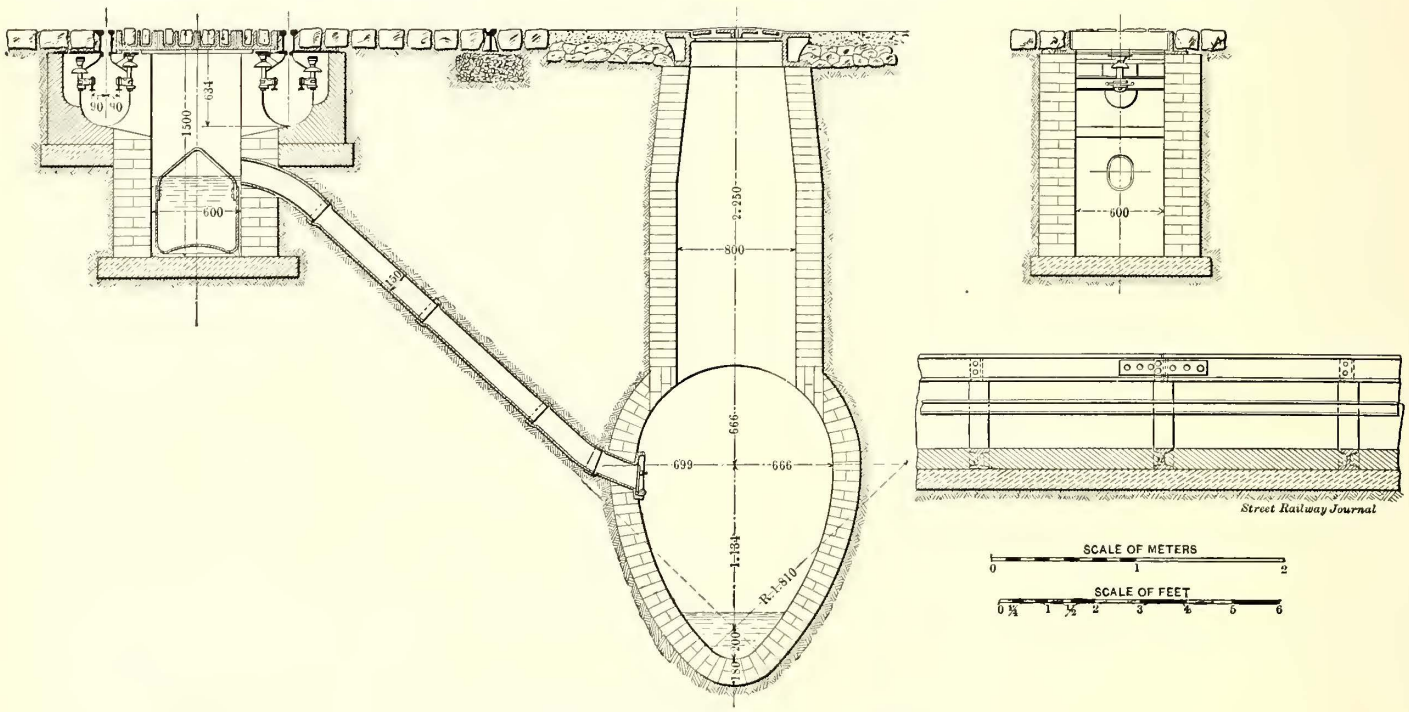


FIG. 2.—SECTION OF CONDUIT AT A MANHOLE

it necessary to have the joints of the contact rails well aligned, as any deviation would be apt to tear off the shoe. No serious difficulty, however, has been experienced in this way. The expansion and contraction is taken up in the crossing where the conductor rails are bolted to the insulators through oval bolt holes.

At these crossings, the conductors are necessarily interrupted and the car passes over the break by momentum. To allow the shoe to rise again to the level of the conductor, the free ends of the conductor bars are furnished with inclined planes in the form of horns, as illustrated in Fig. 4. These pieces originally gave considerable trouble; they were first made of soft wood, but under the repeated shocks of the trolley shoe the wood wore rapidly away and the shoes caught in the hollow thus formed. The experiment was then made of covering the surface of these inclined planes with porcelain, but this broke after a short time owing to the pounding of the shoes. Various types of hard woods, such as box, were then tried, but did not give entirely satisfactory results until experiments were made with elm, in which the grain of the wood was an angle with the direction of the movement of the shoes. The latter, then, in passing over the wood rubbed against the fibre in a different way. In spite of this precaution, the cars have to pass over the switches at a moderate speed.

The plow itself, as illustrated in Fig. 3, consists of two pieces of sheet steel separated by a filling piece of bronze in which the insulated conductor is held. The lower part of the contact shoe, which is of ordinary cast iron, is hinged at its upper end and is held by a spring in the position shown as *O A* in Fig. 6. No part of the plow has a greater width than 36 mm, so that the plow can be lowered or raised from the conduit at any point in the track. When the plow is lowered, the shoe lever first swings around to

The plows are also fitted with chafe plates of hard steel to take up the wear against the slot rails. The time required to make the change from a trolley to a conduit line or vice versa does not require more than 15 to 20 seconds. A special switch, which is attached to the controller, changes the connections from the trolley pole to the conduit.

The company has tried flexible current leads between the shank of the plow and the main car cable, but found that these are subject to considerable deterioration. The device was finally adopted which is illustrated in the side elevation of the plow, and which consists of a sort of lazy tongs made of strips of copper. The same engraving shows the method of raising and lowering the plows mechanically by means of a steel cable wound around a winch.

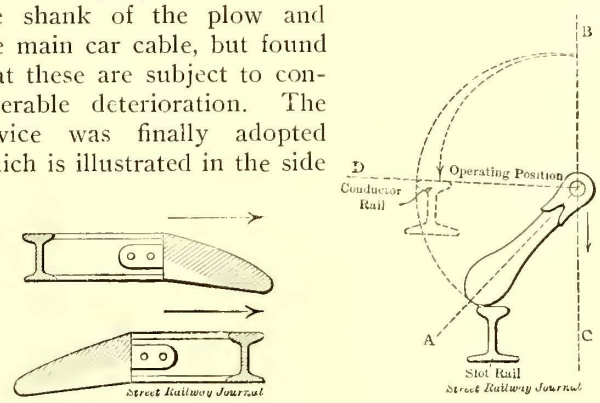


FIG. 4.—HORNS AT END OF CONTACT BARS

FIG. 6.—DIAGRAM SHOWING MOVEMENT OF CONTACT SHOE

The insulation of the conductors in the conduit is in general satisfactory and varies from 4000 to 400,000 ohms per km, depending upon the humidity. The principal cause of the breaking down of insulation is the mud and street refuse, which are washed into the conduit and upon the insulators in the case of a heavy rain. The company has found it advisable to wash off the insulators from time to time as the insulation of the positive conductor tends to increase, and that of the negative conductor to grow less, due to electrolytic action. For the same reason the sections are changed over from one side to the other at the switchboard of the power station.

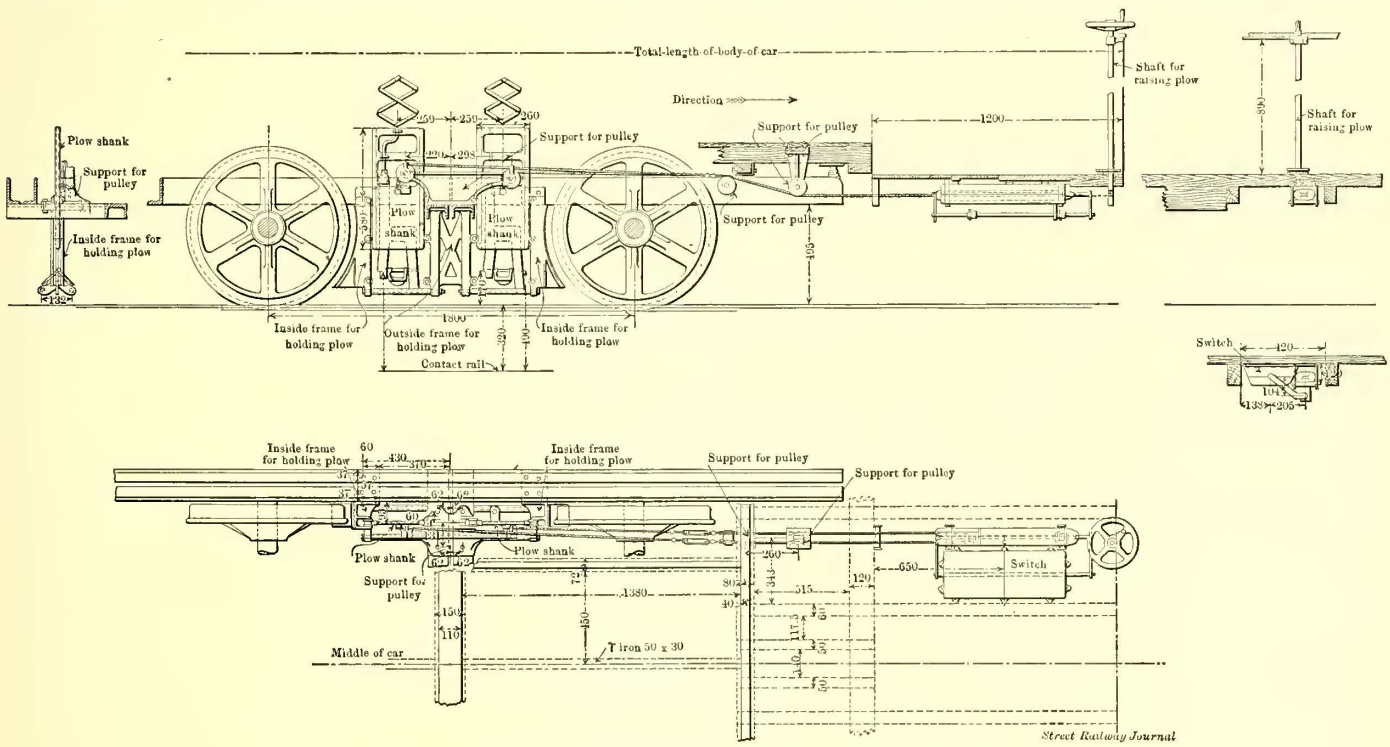


FIG. 5.—SIDE ELEVATION, CROSS SECTION AND PLAN OF PLOW

the position *O B* and then to *O D*. When it is removed from the conduit, it takes the position *O C*. When it is taking current from the conductor-bar it is in the position *O D*. After a number of experiments, the form of a spatule which could be replaced and used on both sides was adopted. The shoes last from three to four weeks and cost about 18 centimes, so that the cost of replacement is insignificant.

The switchboard is equipped with the usual earth indicator, consisting of two banks of lamps connected to the two conductors of the underground system and joined at the center to earth. This shows in a visual way the approximate insulation between the conductors and the earth. Short circuits, however, are not unknown, and as it is difficult to locate them in the ordinary way, owing to the fact

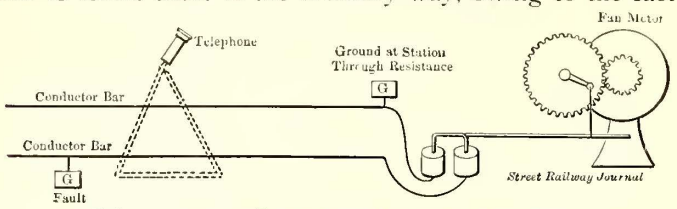


FIG. 7.—METHOD OF TESTING FOR GROUNDS

that the conductors themselves are enclosed within the conduit, a special device for this purpose, devised by Prof. Eric Gérard, is employed. This method, which must be employed when there is no load on the section, consists in first connecting to earth at the power station, through a resistance, the end of the conductor bar on which the short circuit does not exist. A make and break contact device, similar to that shown in Fig. 7, is then connected to both conductors. This current, of course, starting, say, from the power station, follows the short circuited conductor up to the point where the short circuit exists, then passes into the earth and returns through the earth connection of the good conductor to the power station. An inspector is then sent along the route with a triangular induction coil about 60 cm (2 ft.) in height and including a telephone receiver in its circuit. This can be slipped through the slot between the conductor rails. The make and break circuit will then produce a noise in the telephone when the coil is inserted in the slot between the power station and the fault, but is not affected if the coil is placed in the slot beyond the short circuit. The coil and telephone weigh only about 1 km (2¼ lbs.), and yet a fault can be determined within a meter. All the conduit installations have been carried out by the French Thomson-Houston Company and by the Union Elektricitäts-Gesellschaft.

Reference has already been made to the present direct-current station of the Brussels Tramways Company. The demand for power and the extension of its lines has led the company to draw up plans for a new large station, which is now under construction, and which will have a capacity of 10,500 kw. The station, the plans of which are presented herewith, will contain seven units of 1500 kw. The engines will be cross-compound and built by Van der Kerckhove, of Ghent. The alternators will be supplied by the Union Elektricitäts-Gesellschaft and will generate current at 6600 volts and 25 cycles per second. The boilers will be supplied by the Babcock & Wilcox Company, and superheaters will be used for supplying steam to the engines at a temperature of 330 degs. C. The tramway company has guarantees of an ihp-hour on 4.75 kg (10.45 lbs.) of steam.

There will be three sub-stations; one containing five

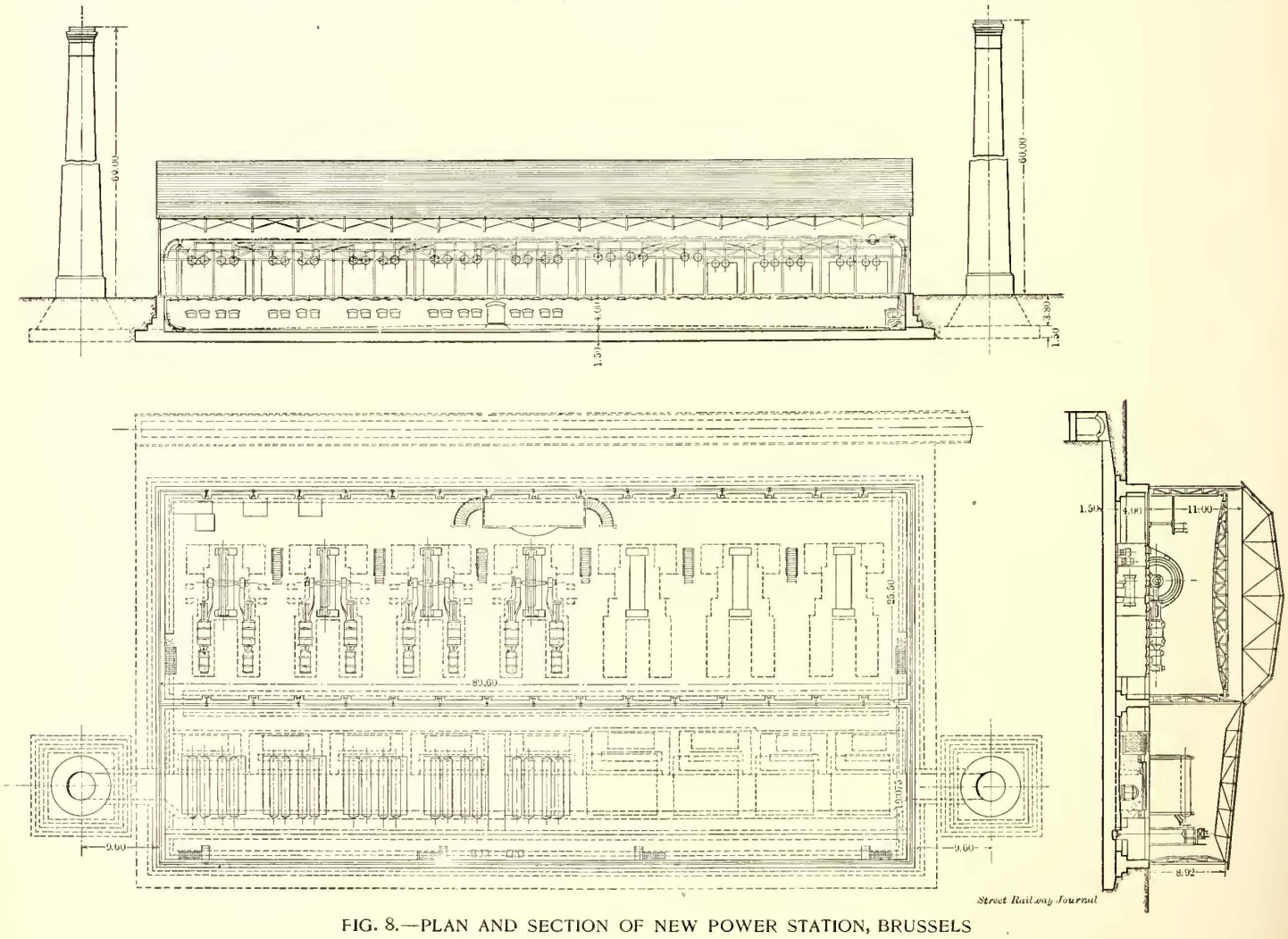


FIG. 8.—PLAN AND SECTION OF NEW POWER STATION, BRUSSELS

rotary converters of 550 kw each, and two, each containing three rotary converters of the same size. Both power station and sub-station will be equipped with a storage battery and the present station will be used as one of the sub-stations.

The president of the Tramways Bruxellois, which now controls the Brussels system, is Léon Janssen, who is also president of the International Tramways Association of Europe.

Discipline of Street Railway Employees

BY W. E. HARRINGTON

There are various systems of discipline in practice, of which the Brown system is the best known. All have for their purpose the advancement of those employees to the most desirable positions who by good work and steady service have shown that they have the welfare of the company at heart. In some systems employees are discharged for failing to comply with rules and regulations, the men remaining in employ being advanced to the position previously held by the discharged men. The disadvantage in such a system is that frequently employees who should be disciplined in some way or other do not lose their position on the seniority list. The result of this is that men who by faithful service should receive some consideration for such service remain for a long time in a position which does not properly reward them for their good service.

In other systems, where the promotion plan is followed, men are frequently advanced for good service rendered in such a way that a feeling of bitterness is engendered in the breasts of other men who have not been advanced, as it is a well-known fact that employees are very jealous of their position and standing. To follow the promotion plan great care has to be observed in awarding promotions, and it is very easy, owing to the multitudinous cases that arise in street railway practice, to advance men unjustly over the heads of their fellow employees.

In the system where merits and demerits are employed the same objections apply as is shown in the promotion system, as it is exceedingly difficult properly to apply merits, and whatever practice be followed for crediting a man with a given number of merits, difficulty is experienced in deciding the number of merits to be given for each case of good service. In the strict application of this system, as long as a man's standing on the seniority list is not affected, he does not seem to care whether he has 60 or 200 merits or demerits.

It has been noticed among street railway managers and, in fact, in all industrial operations where large numbers of men are employed, that great jealousy exists on the part of the men as to their standing.

It suggests itself to the writer, after trying various methods of discipline, to take advantage of this latter feature, and on April 1, 1901, the demotion system was put into effect. After eighteen months' operation the following interesting results have been obtained. Prior to the adoption of the system great trouble was occasioned on the part of employees missing roll calls. There were repeated cases where men would miss the roll call a number of times. Taking figures at random from out files during a month, these offenses will run, at the time referred to, from nine to seventeen times for individual employees. After the change, the greatest number of times any one employee missed in a month has not exceeded six.

It is proper here to describe the essential features of the demotion system. The general rules of the despatching of conductors and motormen are outlined below in the appendix. Part first relates to regular men, and part second to extra men. In addition to the credits and demerits mentioned in the appendix, conductors and motormen are demoted by the general manager one or more points on the seniority list, as may be deemed advisable. In cases of petty irregularities and violation of rules, for instance, a conductor may be demoted five points for permitting smoking on his car, or the motorman may be demoted five points for starting car without receiving signal from conductor.

It has been noticed since the adoption of the system that men who have been in the employ of the company for years, and have been careless and negligent of their duties, have been demoted gradually until they have reached points well down on the seniority list. In looking over the files of the eighteen months in which the system has been in force, there are men who have been demoted as high as forty-three points and one thirty-seven points, and several, respectively, 27 points, 26 points and 22 points. This, as can be readily seen, throws those men who have been rendering faithful services, by the inverse process, in advance; that is, it has promoted them on the list.

It is an interesting fact to note in looking over the files, as an instance, a conductor who entered the employ of the company in 1891 is on the straight day run and is below men on the seniority list who entered the employ of the company in 1896. This is the best class of runs at the disposal of the company. In the straight from noon runs it is interesting to note that men entering the employ of the company in 1901 are ahead of men who had entered in 1900. In the swing runs, men who entered in 1902 are ahead of men entering in 1901. On the extra list men who were employed in June, 1902, are ahead of men entering in May. The above applies to conductors.

The motorman list also shows quite a fluctuation, but does not work as rapidly as the conductor list. We find, however, under the operation of this system, cases of men who are above other men who have been in the employ of the company for two or three years longer.

It took the first year for the employees to realize the full significance of the demotion system. During the last six months it has been found that the men exercise the greatest amount of care in order not to come under the ruling of the demotion system, and wherever they can, by explanation, they will endeavor to have the points removed.

It has been found that by posting on the bulletin board in the car house the names of those men who have been reported for irregularities that they will be demoted one or more points if the irregularity be not explained on or before a set date, that they take special pains to meet the general manager to clear their record, giving the general manager an opportunity to get in better touch with his men and enabling him to exercise judgment in enforcing the discipline.

The writer has noticed in many instances that a man who has reached a point in his demotions where the exercise of discipline would throw him, for instance, from a straight from noon run to a swing run, will often, even while admitting his fault, request that he be given one or more weeks' suspension, or that he be placed for one or more weeks at the bottom of the extra list, rather than be demoted.

Under this system any employee by good, conscientious service can advance to the better runs at the sacrifice of less capable men, and it has been found that the men approve the plan and appreciate the reward for faithful service.

This system permits the gradual weeding out of such men as are undesirable, by a natural process of the "survival of the fittest."

The following facts are noticeable in the operation of this method of discipline:

Men have a general knowledge of how the list stands, and when someone ahead of them misses they will look at the rack and see if their name has been advanced. They do not talk much about it or seem glad that someone else has been set back, but regard an advance as a reward for good service. The man missing says very little about it, usually being a person who does not seem to care much for discipline. The majority of men missing roll calls seems to

consist of young, single men who do not take the necessary rest when they should.

It is noteworthy that in many cases when an employee realizes that he is gradually going down on the list he wakens up, and from that time on becomes a more efficient employee.

In conclusion, prior to the adoption of the demotion system the percentage of men missing roll calls to the total number of men employed averaged monthly 42 per cent. After the adoption of the demotion system for the last six months has averaged 26 per cent.

The following is a copy of the rules of the Camden & Suburban Company, referred to above, and is descriptive of the system:

REGULAR MEN

(1) In case a regular man wishes to be excused from duty he should ask the day before, and, if excused, such runs will be marked up from top of extra list (as it stands on the next day) in the order of the reporting time of the runs to be filled.

(2) A regular man must report ten minutes before it is time for his car to leave the car house. For failing to report, either in person or by message for car, the first time in a month he will be demoted one point and given one day for each hour or fraction of an hour missed and he will have to report at each succeeding roll call, and in that time to receive work only after all men on extra list have been assigned.

Any employee having a clear record for the previous two months will be relieved from demotion for the first failure to report in a month.

The second time in a month a run is missed he will be demoted two points and given one day for each hour or fraction of an hour missed, and he will have to report at each succeeding roll call, and in that time to receive work only after all men on the extra list have been assigned.

The third time in a month a run is missed he will be demoted three points and given one day for each hour or fraction of hour missed, and will have to report at each succeeding roll call, and in that time to receive work only after all men on extra list have been assigned.

The fourth time in a month a run is missed he will have to report to general manager.

All the above rulings subject to appeal to the general manager.

(3) No extras are carried to relieve men who may miss their second car, as at dinner, supper or swing time. In such cases the early men will be demoted to the bottom of late runs, the late man will be demoted to the bottom of swing runs, and the swing man to night car. The night car man will be demoted to tripper runs and the tripper man demoted to extra list. In case of an extra, he will be demoted from his position on the extra list, three (3) points.

(4) The slate will be put out daily at a regular time suitable to the requirements of the depot, after which no one will be excused without reporting.

(5) A regular man asking off sick must lose two days work and must report at depot the day before he takes his car.

Telephonic or telegraphic messages or letters sent by mail or by employees will not be accepted as requests for leave of absence due to sickness or other causes.

The only recognized forms of request will be by letter brought to car house by some person not an employee or made personally at the car house, not later than ten minutes before the allotted reporting time.

Requests will be accepted only at car house.

Employees not complying with the above will be placed at bottom of extra list one day for each hour or fraction thereof for failing to report as above provided.

(6) No regular man is excused from work after taking his car, unless he is sick or disabled. He must work run out.

(7) Changes on account of vacancies will be made from first to tenth day of each month, unless in case of a run being vacant three (3) days or more; in that event it will be filled by the oldest extra not otherwise engaged, until such time as he may be called for regular position, or the man to whom it belongs returns.

(8) Promotions on account of discharge, etc., are made from extra list to tripper runs, from tripper runs to night car, from night car to swing runs, from swing runs to straight from noon runs, from straight from noon runs to straight day runs.

EXTRA MEN

On and after Monday, April 1, 1901, extra men will report as follows (at car house for morning work):

(1) After the noon roll call at the ferry the list is telephoned to the car house and despatcher books off the regular men for the next day, the first extra men booked up for regular runs are those working tripper runs, then come those who did not get work at noon. In event a man who did not get work at noon should get a six-hour run at night roll call he will be expected to take run he is booked up for the next morning, in event he is not booked up he will not have to report until 10:59 next day.

(2) Instead of extra men reporting at 4:30 a. m., a limited number of men will be delegated to report at 4:30, 5, 5:20 and 5:35 a. m.

On arrival at car house each man will report to despatcher giving name and time of report.

(3) For failing to report as scheduled, the following rules will be strictly enforced:

First.—The first report missed in a month will be demoted one point on the extra list and must stand on bottom of extra list one day for each hour or fraction of an hour late.

Second.—The second report missed in a month will be demoted two points on the extra list and must stand on bottom of extra list one day for each hour or fraction of an hour late.

Third.—The third report missed in a month will be demoted three points on the extra list and must stand on bottom of extra list one day for each hour or fraction of an hour late.

Fourth.—The fourth roll call missed in a month will have to report to general manager.

All the above rulings subject to appeal to the general manager.

Any employee having a clear record for the previous two months will be relieved from demotion for the first failure to report in a month.

(4) Extra men not otherwise excused from morning work will report as above.

Extra men not reporting and sending note that they are sick must take two days on bottom of extra list and must report at car house the day before taking place on list.

(5) Extra men taking straight from noon runs are not required to report until 10:59 report next day, if extra man has a noon run for more than one day, he must report ten minutes before it is time for the car to go out. Subject to Rule Third, Section 1st, 2d, 3d and 4th.

Telephonic or telegraphic messages or letters sent by mail or by employees will not be accepted as requests for leave of absence due to sickness or other causes.

The only recognized forms of request will be by letter brought to car house by some person not an employee or made personally at the car house, not later than ten minutes before the allotted reporting time.

Requests will be accepted only at car house.

Employees not complying with the above will be placed at bottom of extra list one day for each hour or fraction thereof for failing to report as above provided.

(6) Extra man taking six-hour run at night is not required to report at early report next day, except he is booked up for a run, then he must report ten minutes before car is due to leave car house. Subject to Rule Third, Section 1st, 2d, 3d and 4th.

(7) Extra men will take runs as booked and hold until regular man returns. Subject to provision, Rule 7, regular men.

(8) Early morning roll call at car house. See rule (second) extra men. Noon roll call is made at the ferry 10:59 a. m. daily; 10:50 a. m. Sunday.

Night roll call is made at the ferry 5 p. m. daily; 4:50 p. m. Sunday.

(9) After the noon runs are given out, all men not excused will report at car house, subject to Rule 2, extra men. Despatcher will appoint five or more men, as may be required, on extra list not working, to report at Federal Street ferry 5 o'clock p. m. roll call.

(10) An extra man relieving a sick man for part of a run will be entitled to such run until regular man returns. Subject to Rule 7, regular men.

(11) Extra men who have been excused from work will be turned down on list same as if they had been called for a car.

(12) Men appointed for roll calls or reports will not be excused for failing to report.

(13) Extra men holding straight day runs, not scheduled for Sunday work, must report at depot Sunday morning (as per Rule 2, extra men).

(Signed) The Camden & Suburban Railway Company,
W. E. Harrington, General Manager.

Instruction for Street Railway Employees

The question of securing competent men to operate their street railway lines is often a perplexing one, and it is constantly confronting the manager. A certain amount of training is required for nearly all positions in street railway operation, and, while some of these may be filled satisfactorily after a little coaching, it is now generally recognized that a regular course of instruction under competent teachers is of great assistance. As they become familiar with the construction and operation of the apparatus, it is found that their interest in the work increases and correspondingly better results are secured. Many of the large companies have met this demand by establishing departments of instruction, and in some of the articles descriptive of large street railway systems which have appeared in the STREET RAILWAY JOURNAL, during the last year, attention has been called to these training schools maintained for the instruction of employees. In the case of motormen, for instance, the novice is coached until he acquires a certain proficiency, and "runs extras" until familiar with his duties. It is found that men who have the advantage of such training may be entrusted with cars much earlier than others, and, other things being equal, they become much better motormen than those who have not had special training.

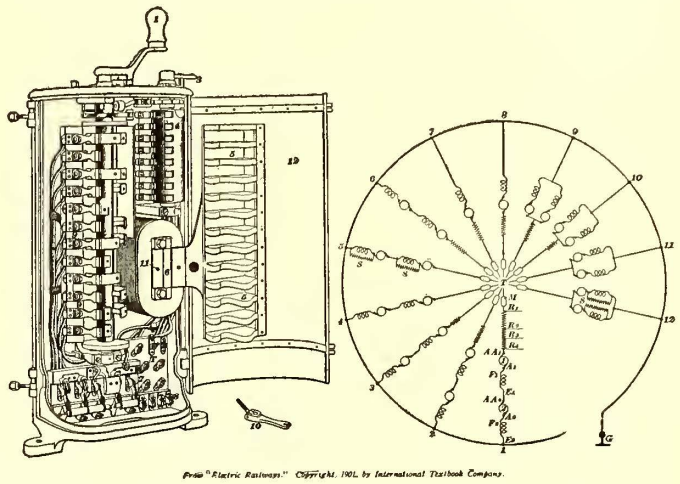
This fact has encouraged the belief that the special training of employees in other departments connected with the operation and maintenance of the system would effect still further reduction of expenses. Thus, a trackman having practical training on the subjects of bonding and track returns, a car-shop employee thoroughly conversant with the operation and proper installation of all types of car appliances, a pitman who fully understood the construction and underlying principles of motors, air brakes and trucks, and a dynamo tender with sufficient experience to install, operate, and repair any railway generator, would not only increase the efficiency of the service, but would also effect a saving in the maintenance and repair accounts.

Admitting its need, or great desirability, how can better and more specialized practical training be most readily brought about? For large companies to extend their educational systems to include all classes of employees would entail enormous expense, and necessitate the formation of a corps of instructors similar to the faculty of an established technical school. For small or medium-sized roads to give any education to their men, beyond such supervision and advice as is given a novice by an old hand detailed for that duty, would also be out of the question. On many roads the management has found it desirable to encourage the co-operation of correspondence schools, as this plan enables the men to pursue their studies without giving up their employment, and affords them an opportunity of combining theory and practice in the most approved manner. This plan has proved practicable in many other industries, and the International Correspondence School has prepared several special courses for street railway employees, embracing every feature of construction and operation, every system of distribution and all forms of apparatus. Methods of control are shown in diagram, and roadbed construction and rail-bonding are illustrated with numerous examples of every-day practice. The car-running course includes instruction on shop methods, wiring for lamps, motors, controllers and car appliances, all of which are graphically illustrated. In the accompanying cut, for instance, is shown the construction details of the G. E. K-2 controller with diagram of connections, presented in such a manner as to be readily understood.

To the man who aspires to rise to the higher positions in the railway and lighting fields, a more extended course of training is offered. The electric lighting and railway course comprises a technical training for the position of electrical engineer, superintendent of overhead or track construction, or manager with either a lighting or railway company. To become the electrical engineer of such a company, a man must thoroughly understand not only the entire electrical work required in a power station in connection with the machinery, switchboards, electrical appliances, and wiring for lights, but also must be able to handle any of the problems that arise in testing new apparatus for acceptance, the protection and testing of cables, etc. The superintendent of overhead or track work must be thoroughly conversant with the best methods of the day, and must be able to adapt them to special situations, or to originate special construction that will be entirely successful. Every manager should have a broad understanding of all departments of electrical work as applied to the plant under his charge.

Throughout the instruction theoretical considerations are subordinated to those of practical importance, but when a discussion of theory is necessary, it is given in a lucid manner, so that a thorough comprehension of it is readily obtained. Original illustrations and novel methods of presenting difficult points are used, making the instruction more effective than that of the ordinary text-book.

The value of this instruction is appreciated by prominent railway officials, and the methods employed have been approved by such men as President H. H. Vreeland and J. F. Kane, of the Metropolitan Street Railway Company. Mr. Kane took the course of instruction in electric railways, and he says that he found it invaluable to him in his work as chief instructor of the Metropolitan Street Railway Company. The electric car-running course papers are being used to advantage, Mr. Kane says, "in conjunction with my practical lectures in the instructing room." It is the purpose



METHOD OF EXPLAINING CONTROLLER CONNECTIONS

of this course to give a man a practical, as well as a theoretical, knowledge of motors and their connections. Instruction begins with clear explanations of the actions of an electric current, and how it turns the armature and makes the motor go. Every principle is presented simply, interestingly, and completely. Illustrations are freely used, some of them being reproductions from actual photographs. It enables the student to inspect his motor properly, operate it economically and intelligently, keep it in good repair, and meet emergencies in case of accidents. Operating lessons are given with every piece of construction explained, so as to qualify the student upon completing the course to direct the equipment of a complete modern car, and operate it safely under all conditions of weather and traffic.

The same methods are employed in all branches, thus making the electric railway course a series of practical instructions upon practical subjects for practical men.

The Kingsland Surface Contact System

The Kingsland surface contact system, of which a short section is in operation in Wolverhampton, England, was briefly described in these columns about a year ago. Since that time improve-

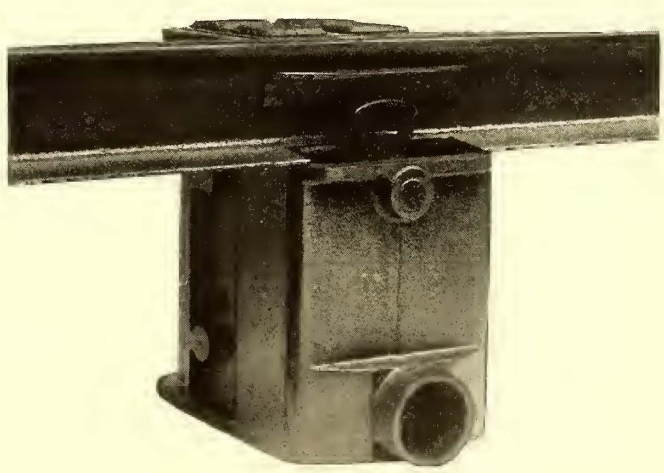


FIG. 1.—CONTACT BOX CLOSED

ments have been made in the system, based on the experience obtained in practical work. The principal feature of the Kingsland system is the use of a mechanical switch, operated by a lever

from the car, by which the contact studs are thrown in and out of circuit. In addition to the usual skate for collecting the current, which is in the middle of the car, there are two striker bars attached to side of the car, one in a forward position and one in the rear. The first throws the switch lever one notch, connecting the stud in the middle of the street with the main conductor, and the second switches the current off.

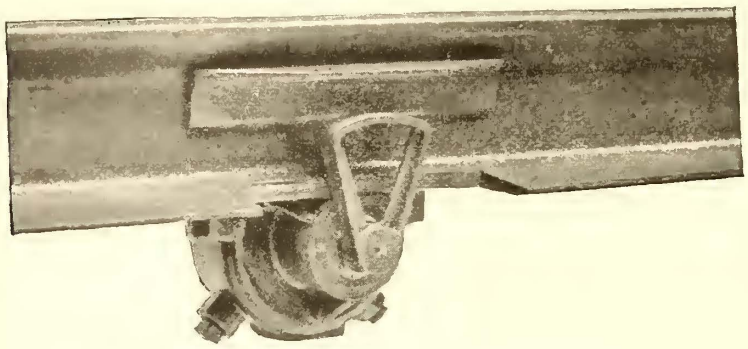


FIG 2.—CONTACT BOX WITH CASE REMOVED

As shown in the cross-section (Fig. 5) a slot or channel is provided outside one of the rails by means of a guard rail, making a shallow conduit the depth of the rail along which the striker bars can pass freely. With the exception of this guard rail and a small pit for the switch boxes, the construction is the same as with an ordinary railway.

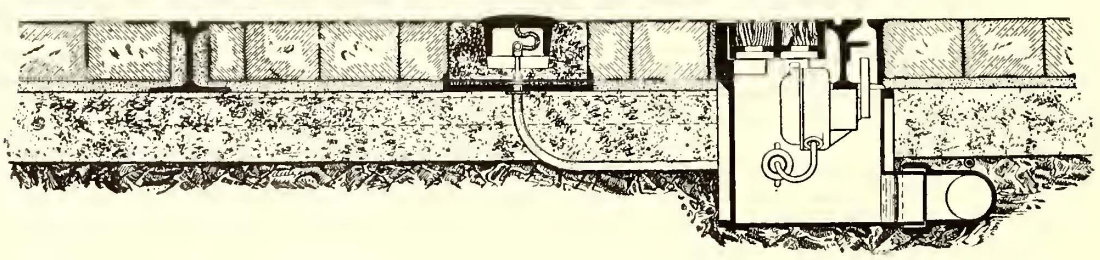


FIG. 5 —SECTION OF TRACK, CONDUIT AND STUD

The switch boxes are located about 20 ft. apart underneath this conduit, and one of them is illustrated in Figs. 1 and 2. These boxes project down about 12 ins. from the base of the rail, but this distance may be made less in special cases. The slot at the surface of the road is 5/8 ins. wide.

Fig. 2 shows a view of a section box with a portion of the rail. The slot rail is removed to show the switch lever. It will also be noticed in this and in Fig. 1 that there is also a bracket attached to the rail immediately over the switch lever. This bracket is for the purpose of preventing the lever from being tampered with by means of a stick or anything passed down through the slot. The striker bars on the car are curved so as to pass this bracket easily. It should also be noticed that the conduit contains no conductors, bare or otherwise, and that the switch is enclosed in a water-tight case. In this way the arrangement is not affected by water in the conduit; in fact, it is said that water is desirable in that it washes out the slot and the outer part of the switch box.

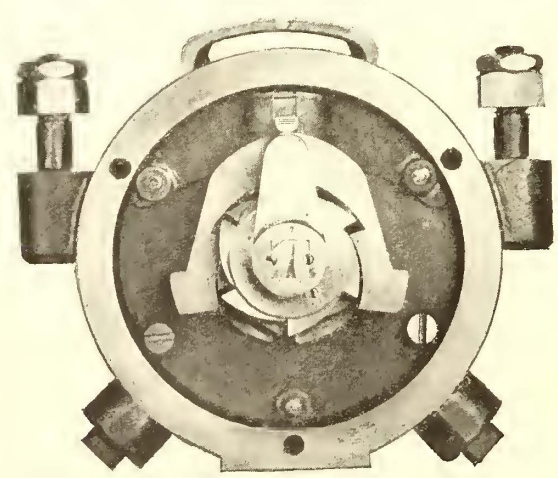


FIG. 3.—INTERIOR OF CONTACT BOX

Another feature of the system is that the stud in the street contains or covers no switch mechanism and the wearing portion can be easily and cheaply renewed.

The switch itself is enclosed in a water-tight case, which is bolted to the under side of the rail, a small portion of the base of the rail being cut away to accommodate it. The interior of the box is shown in Figs. 3 and 6. It consists of a center revolving piece of insulating material containing a metal ring with three brushes, *B*, which press against the inner circumference of the box, *A*. These brushes are set at an angle of 120 degs. with each other and two contact plates, *DD*, are also set at the same angle. At every operation of the switch the center portion is moved one-sixth of a revolution, so that the contact plates, *DD*, will be automatically connected and disconnected with the center by means of two of the contact brushes. This affects the alternate connection and disconnection of the stud with the main cable. As the distance between the front and rear striker bars is slightly greater than the actual length of the skate, a stud is always in circuit before the skate actually touches it and is not taken out of circuit until the skate has left it. This prevents any sparking within the switch itself; at the same time the switch is designed to break a large current at the full potential of 600 volts, if necessary, without damage. The distance between the studs depends upon the length of the car, but an average may be taken at 18 ft. to 20 ft.

FIG. 4 —STUD

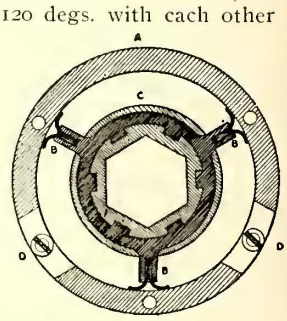
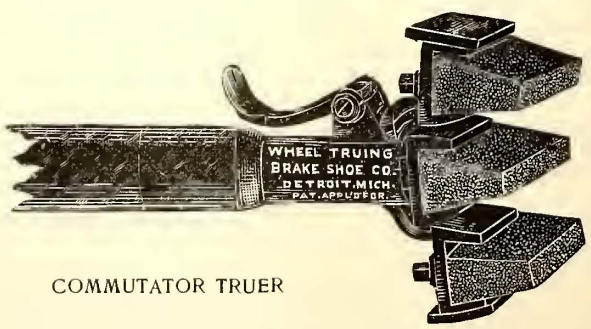


FIG. 6.—SECTION OF CONTACT BOX

Arrangements are also provided by which the blow of the striker bar will turn the switch just the right distance; that is, 120 degs., and also by which the switch lever is returned to its normal position with absolute certainty after being struck by the bar. The skate is suspended from the wheel axles by springs and may be of the usual pattern.

Device for Truing Commutators

The accompanying illustration shows a tool for truing commutators while the motor is running, and which is an improvement over the usual method of using sand paper or that of turning down



COMMUTATOR TRUER

in a lathe. The device is suitable for stationary motors and dynamos as well as for railway motors.

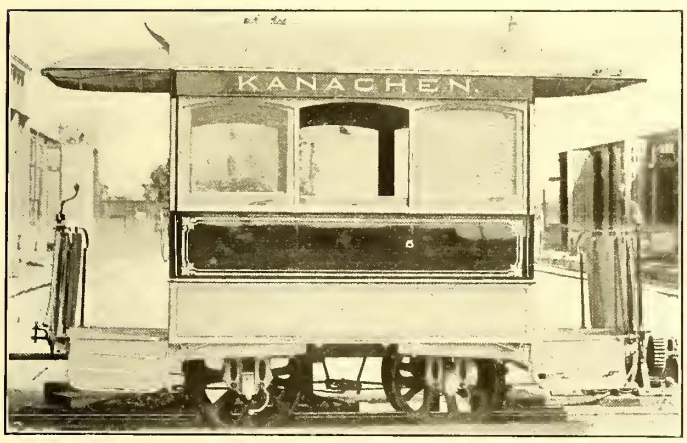
The construction and operation of the device can clearly be seen from the illustration. It only remains to be said that the central cutter can easily be raised or lowered, and then held in place by means of a short lever. As this changes the arc subtended by the cutters, the truer is automatically and very easily adjustable to any diameter of commutator. It can, therefore, be instantly applied to any commutator while the latter is running, and having a three-point bearing, it must necessarily cut truly. The tool is insulated so there is no danger of a short circuit. The abrasive used is a non-conductor, and no emery is used in its composition. The principle employed in this device is the same as that used in the wheel-truing brake-shoes of the Wheel-Truing Brake-Shoe Company, of Detroit, Mich., which experience has shown is both practical and economical.

J. M. Griffin, president and manager of the Wheel-Truing Brake-Shoe Company, who is also the inventor of the commutator truer, does not pretend that it will accomplish everything that can be done with a lathe, but he believes that by frequent use of the truer the commutator can be kept true, and therefore will not require turning, at least as often as formerly. The abrasive can be of any desired hardness, so as to cut rapidly or slowly, as may be desired.

The Old and the New

The accompanying illustrations show two types of cars recently shipped from the works of the John Stephenson Company, of Elizabeth, N. J.

The small car is a duplicate of those built by this company, in



SHORT MEXICAN HORSE CAR

the early horse-car days, some thirty years ago, and is one of several built for use on a private plantation in Mexico, running on a gage of 29 ins. The body is 8 ft. long and 6 ft. wide, and the total weight, including running gear, 4000 lbs.

In marked contrast to this car is that shown in the two other illustrations, which are of a car built for the Muncie, Hartford & Fort Wayne Railway Company, and the Fort Wayne & Southwestern Traction Company, under specifications prepared by E. P. Roberts & Co., engineers, of Cleveland, Ohio. This car shows the very latest type of construction for interurban electric roads. High speed and durability as well as elegance and convenience were the principal objects borne in mind in the building of these cars. The outside sills are double, having a heavy steel plate between them, and in addition there are four longitudinal sills, equally spaced, running the entire length of the floor. These, together with the double posts, double siding and heavy platform and vestibule construction, provide a car suitable for the highest speed desired, and in appearance very much like a Pullman car.

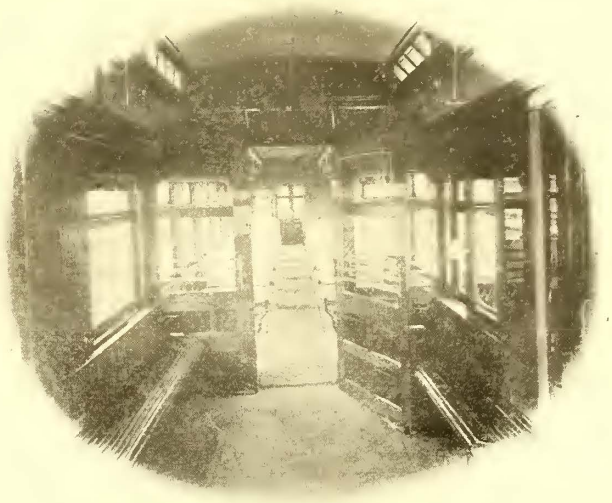
There is a small baggage compartment at one end, having hinged seats, so that it can be utilized as a smoker when necessary, and at the other end a toilet and wash room, equipped with water-cooler, etc.

The inside is finished in mahogany of plain yet elegant design, and is equipped with parcel rack, wrecking tool box, etc. The car is heated by the Peter Smith hot-water system, the stove being located in the front vestibule. The weight of this body alone is 24,000 lbs. The cars will be mounted on Peckham No. 26 double trucks, and will be equipped with four G. E. No. 57 motors, equivalent to 200 hp.

The illustrations show the range of work turned out by this energetic car company, and proves that, although the original builders of horse cars, it still keeps to the front in the larger and more modern methods of construction.

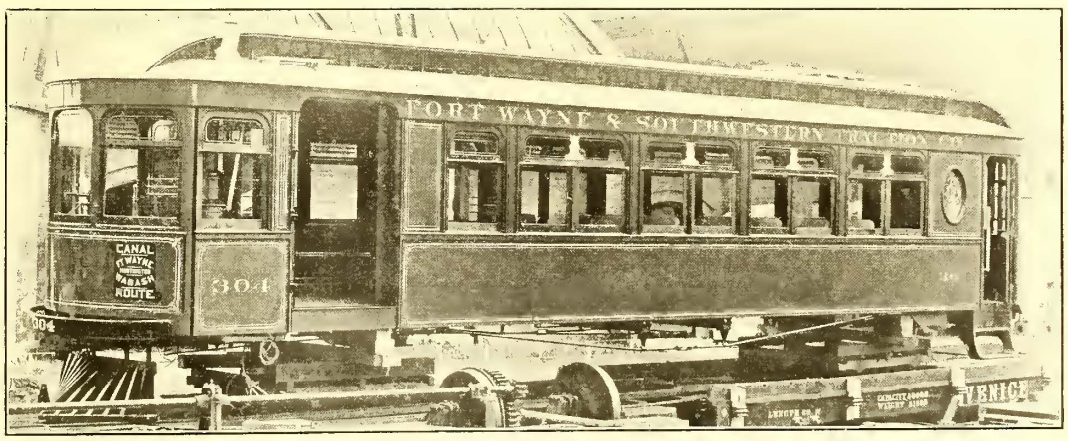
International Jury of Awards for St. Louis

The special rules and regulations providing for an international jury, and governing the system of making awards at the Louisiana Purchase Exposition have been announced by President Francis. The total number of jurors shall be approximately 2 per cent of



INTERIOR OF MODERN INTERURBAN CAR

the total number of exhibitors but not in excess of that number, and each nation having fifty exhibitors or more shall be entitled to representation on the jury. The number of jurors for each art or industry, and for each nationality represented, shall, as far as practicable, be proportional to the number of exhibitors and the importance of the exhibits. The duties of the jurors are carefully



EXTERIOR OF MODERN INTERURBAN ELECTRIC CAR

explained and their work outlined. There will be three classes of jurors, group, department and superior.

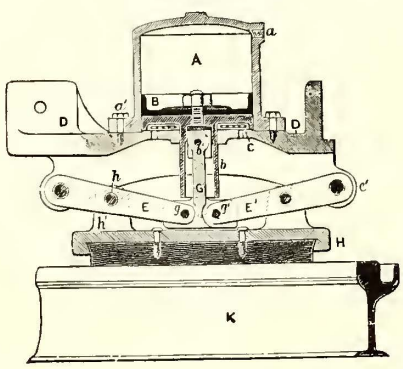
The duties of the department juries shall be to consider carefully and review the reports of the group juries, to harmonize any differences that may exist between the recommendations of the several

group juries as to awards, and to adjust all awards recommended so that they will be consistent with the rules and regulations. The superior jury shall determine finally and fully the awards to be made to exhibitors and collaborators in all cases that are formally presented for its consideration.

A Pneumatic Track Brake

The extended use of track brakes in San Francisco, where the grades are probably more severe than in any other large city in the country, if not in the world, has often aroused curiosity as to why track brakes were not employed to any greater extent in the Eastern States. S. L. Foster, the electrical engineer of the Market Street Railway, of San Francisco, offered an explanation for this fact in a recent issue of the Street Railway Journal. His theory was that track brakes, to be desirable, should be applied quickly, and that this was possible in San Francisco, because in that city the lever brake was in general use. His conclusions were that the ordinary revolving handle was not sufficiently quick in operation to secure the best results with the track brake, and that, consequently, on Eastern roads, where the room on platforms was limited, or considered so to be, the track brake would not appear to its best advantage. This difficulty, however, certainly so far as the quick operation of the track brake is concerned, has been overcome by Estler & Brothers, of London, through the design and application to a number of English cars of a pneumatically operated track brake; or, as it is called in England, a slipper brake.

The air pressure for this brake is applied by means of a short handle, which should be placed conveniently near the hand brake and the air pressure can be secured from any type of air compressor on the market. Four shoes are fitted to each car, whether the car is mounted on single or double trucks. Better braking is obtained on single trucks by the use of four shoes than two, as on descending inclines it has been found that the weight of the car is taken by the front brakes, but when only two brakes are used the weight of the car is taken by the front wheels and not by the brake shoes.



SECTIONAL VIEW OF PNEUMATIC TRACK BRAKE

A sectional view of the brake is shown and clearly indicates the construction. An air cylinder is carried on a bracket, *D*, attached to the truck. The piston, *B*, of the cylinder is connected by a swinging rod, *G*, to two levers, *EE'*, which have their fulcra on the bracket at *e* and *e'*. The levers carry the slipper shoe, *H*, on which is fixed a brake block of oak, beech, or other hard wood. There is nothing in the slipper brakes which is liable to get out of order, but the flexible connections should be examined daily with the air compressor equipment to insure their being in perfect condition, and no car should be allowed to leave the depot on which the slightest defect in the brake equipment has been detected.

The brake blocks can be used efficiently until they are worn down to within about a quarter of an inch of the steel shoe, and then it is only a matter of a few minutes to have them renewed.

The view already referred to, Fig. 1, and Fig. 2, which illustrates a car on the Dundee Tramways, give a very good idea of the construction and appearance of this brake. Some particulars of tests recently conducted on this tramway may be of interest. On a down-grade of 4½ per cent, the car was repeatedly brought to a standstill from a speed of 16 miles an hour within 21 yds. from the instant when the air brake handle was put into action. The stop was effected without any jolt, as the brakes seemed to act like an elastic cushion. On a level, the car was brought to a standstill in about 12 ft. from a speed of about eight miles an hour.

An important advantage of the brake is, of course, that it does not skid the wheels, and is less dependent upon the condition of the track than a wheel brake. Owing to the fact that air pressure is used, the brake can very easily be employed upon cars equipped with the ordinary wheel air brakes, and, in fact, a number of the cars on the roads which are using the brakes are equipped with air brakes. The brake can also be used with the storage system of air.

A number of the roads in Great Britain are using the slipper

CAR EQUIPPED WITH PNEUMATIC TRACK BRAKE

or track brake, including the Potteries Electric Traction Company, the Stockport Corporation Tramways, the Dundee Tramway and the Oldham Corporation Tramways. It has been employed at Oldham, where the grades are nearly 10 per cent, for more than twelve months, and the general traffic manager, Mr. Wilkinson, speaks highly of it.

Prizes for Railway Protective Devices

Frederick Weidl, of Dresden, calls attention to the circular offering prizes for protective devices for electric street cars just issued by the city of Dresden, the first prize for which is to consist of 5000 marks; the second, 3000 marks; and the third, 2000 marks. The successful inventor will receive a royalty up to 20 marks for a motor car and 10 marks for the use of the equipment on a trailer, while the invention remains the property of the inventor. Patent Attorney Frederick Weidl will be pleased to give to interested parties any desired information free of cost, and all conditions can be obtained from his office, which is located in Jahnstrasse 2, Dresden.

Opposition to Electric Line to Vesuvius

The faculty of science in the University of Naples has forwarded to the Government an urgent protest against the proposed electric railway to Mount Vesuvius from the naval arsenal in the city of Naples, thus affording increased facilities to tourists who visit the crater and who have hitherto depended upon the funicular railway. It is contended that the proximity of the line to the University Observatory on Vesuvius would interfere seriously with the scientific value of the records on the seismic instruments,

which register the slightest earth tremors, and measure their inherent energy with the utmost precision. The faculty further urges that a powerful electric train on the mountain, even at a distance from the observatory, could not help affecting injuriously other magneto-electrical scientific apparatus already installed or about to be installed there by the Royal University. Between 30,000 and 50,000 persons are carried on the present railway every year.

New Boiler Plants for the Pennsylvania Railroad

The Allis-Chalmers Company has received orders for a number of Sederholm boilers, for the Broad Street station of the Pennsylvania Railroad in Philadelphia, as well as for the Juniata shops. The Pennsylvania Company made the selection after a most searching investigation, and as a result of practical experience with pretty nearly every boiler manufactured.

BOILER FOR BROAD STREET STATION, PHILADELPHIA

These boilers have now been in successful use for several years and are distinguished especially for their perfect circulation and complete combustion, as well as their great accessibility, which permits of a most thorough cleaning, without the time-absorbing process of taking off hundreds of hand pole plates. They are in very general use on the sugar plantations in the Hawaiian Islands, where the Allis-Chalmers Company has furnished a great number of large high-lift pumping plants for irrigation purposes. In the islands the coal used is mostly Australian or Puget Sound coal, both kinds of which are difficult to burn without smoke, but wherever these boilers are installed the plants show a smokeless chimney.

Brill Narragansett Cars for York, Pa.

When the Pennsylvania State Street Railway Association meets at York, Sept. 10, four new cars will be seen on the streets, which will doubtless greatly interest the members. The cars are worthy of careful inspection, for they are of a type which has satisfactorily solved the problem, long in the minds of street railway operators and builders, of how to obtain a double-step open car without going beyond the width of the standard single-step design.

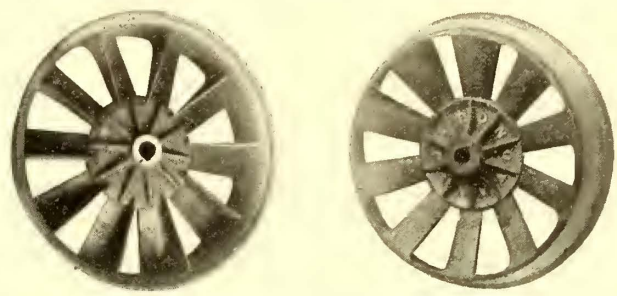
Present-day suburban and interurban service demands more than the single-step open car is able to fulfil. "Larger and faster open cars" has been the cry from many quarters, with the answer always the same, "Impossible! Double-steps are necessary and the width would be too great; besides, there are insurmountable structural difficulties, and loading and unloading would be too slow." Last year the "Narragansett" type appeared, making large claims and attracting wide attention. The claims were substantiated by a season's trial and this summer several large roads in different parts of the country have a goodly number in operation.

The "Narragansett" type secures the desired advantages without losing any of the good features of the standard single-step car. Some of the chief points may be briefly stated as follows: The width over all does not exceed that of the standard single-step open car; main sills of deep angle-iron, to which another angle-iron is bolted, together forming a Z-bar, not only provide an intermediate step, but afford an unusually rigid support to the long car body; the posts are set in deep sockets formed in brackets which support the panels, and are bolted to sills and panels; there is ample space for the radiation of high-speed trucks; the seats are standard length, and access and egress is rapid and convenient.

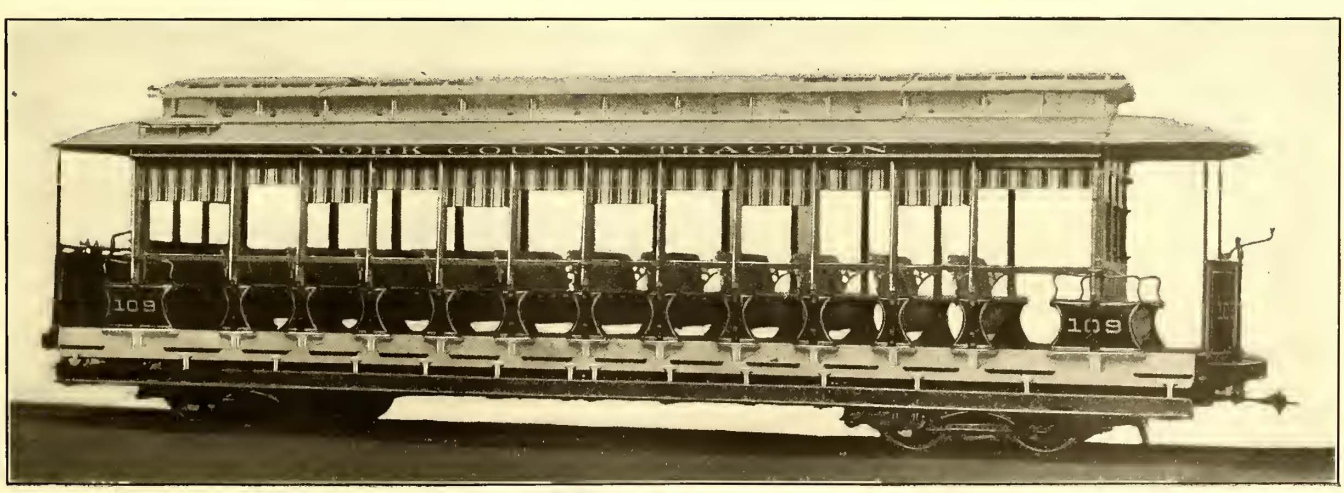
The York cars are 40 ft. 4⅜ ins. over the crown-pieces, and 8 ft. 1 in. over the sills. The inside finish is of natural cherry and ash, with ceilings of decorated birch. The cars are fitted with sand boxes, radial draw-bars, angle-iron bumpers, "Dedenda" gongs, ratchet brake-handles, and round-corner panels. The trucks are the Brill No. 27-G.

Roberts Track-Laying Cars

Several features of the track-laying car which is manufactured by the Roberts Car & Wheel Company, of Three Rivers, Mich., commend this product to contractors and railroad companies. The car is strong in every part, and is equipped with the Donovan improved pressed steel wheel. This wheel, by the way, forms a very important element in the car. It is made from one piece of steel, passing through a series of processes until the proper shape is obtained, giving the greatest amount of strength to the given amount of material. The metal, which in other processes is gen-



PRESSED STEEL WHEELS WITHOUT RIVETS OR BOLTS FOR ROBERTS TRACK-LAYING CARS



NEW CARS FOR YORK, PA.

erally cut away, is in the wheel cut on one side and both ends and bent at right angles, the center being dished. A lateral brace is formed which is pressed tightly against the tread, making a perfect support, obviating all tendency to spring or crack, and preventing any ringing sound when in operation. These wheels are made without rivets or bolts.

The iron parts of the Roberts hand and push cars are made without a single weld, which greatly increases their strength and durability. The company equips its cars with either roller or brass bearings, and insulated wheels are furnished if desired.

Reversible Electric Car Sign

The subject of illuminated car signs has received so much attention that the sign illustrated herewith, which is of an entirely novel type, will undoubtedly attract attention. It is being put on the market by the Reversible Electric Car Sign Company, of Richmond, Va.

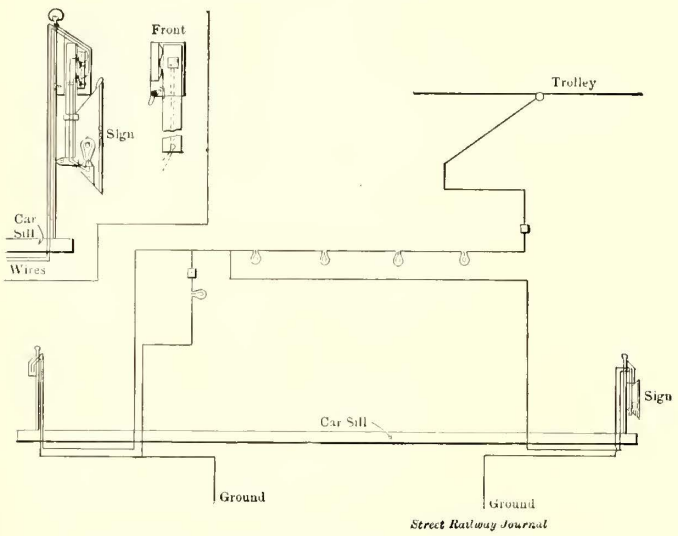


FIG. 1.—DETAILS OF WIRING FOR REVERSIBLE SIGN

The sign is reversible or interchangeable from end to end of car, so that but one sign for each car in service is required. The sign is also nearly indestructible, owing to its construction, and the points of destination can be readily changed by substituting others in the slide at the end of the sign. The connections are such that they cannot be affected by snow or sleet, and the sign is equally as efficient in the day as at night, and is visible at a great distance.

Fig. 1 shows one method of car wiring employed in the operation of the sign. As will be seen, the insertion of the stem of the sign in the dash socket throws the lamp in the sign in series with the other lamps in the car, while one lamp can be cut out to reduce the total number to five. Fig. 2 shows a front view of the sign. Fig. 3 is a view of the top contact case with the latch up. Fig. 4 shows the bottom support, by which the sign can be supported from below, if desired. With this method, there is absolutely no possibility of the contact box or sign support being affected by any weather, as it is entirely weather-proof.

The front of the sign is made of a transparent substance, and can be changed by the introduction of different destination faces, so that any sign can be used on any route.

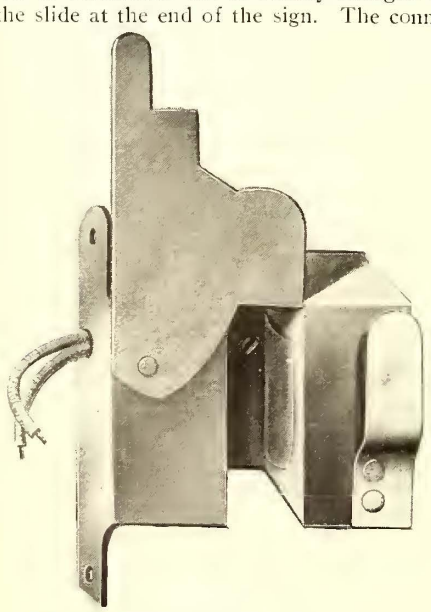


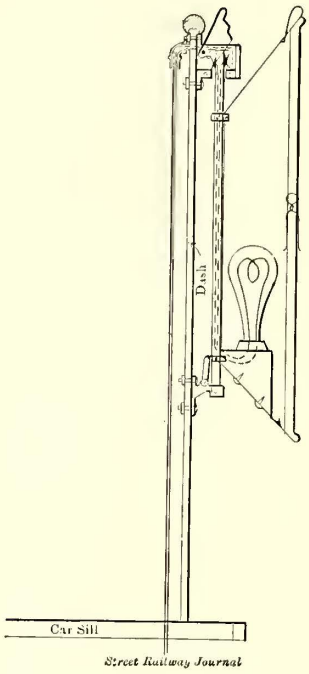
FIG 3.—TOP CONTACT CASE

FIG. 2.—BOTTOM SUPPORT

FIG. 4.—FRONT OF CAR BEARING REVERSIBLE SIGN

Single-Phase Motors for the Washington-Baltimore Line

Particulars are published elsewhere of the proposed electric railway between Washington and Baltimore. Information received after that article went to press indicates that single-phase motors, built by the Westinghouse Electric & Manufacturing Company, will be used. Specific details of the system, as proposed by this company, are lacking, but it is stated that it avoids the inherent limitations of the induction motor and the disadvantages of a polyphase system of conductors by the use of single-phase current in the trolley and the motors. It is stated, however, that the motor has a variable speed and characteristics that adapt it for railway service fully as well as the ordinary direct-current railway motor.



The controlling apparatus is of a new type, and is said to possess valuable features which have not been heretofore attained in railway operation, while avoiding many of the inherent difficulties in the ordinary systems of direct-current control.

The advantages in this system through the omission of rotary converters and attendance for them; also the reduction of copper over that which would be necessitated for operating direct-current motors at 500 volts, are among its notable commercial features. The adoption of 1000 volts as the motor voltage was deemed by the engineers of the railway company to be preferable to a higher voltage, on the ground of general policy, although there is nothing in the system to prevent the use of several times this voltage. A higher voltage would probable be used on longer roads or where the conditions made a higher voltage more advantageous than in the present case. The car equipments are designed for a normal speed of 40 and 45 miles, and a maximum speed of 60 miles an hour.

This system has been developed by the Westinghouse Electric and Manufacturing Company, largely through the work of B. G. Lamme during the past few years. The final results were so satisfactory that the company was ready to undertake as an initial commercial installation a road of the size and importance of the one above described. The engineers of the railway company made a careful investigation of the system and of the motors which have been made and operated on the company's experimental railway track at Pittsburg, and as the outcome of their investigation they were satisfied to place the whole matter with the Westinghouse Company.

Hydraulic Press for Assembling Commutators

The accompanying engravings show an hydraulic press for assembling commutators, constructed by the West Hydraulic Engineering Company, of London, and Bradford, Yorkshire. The radial press (Fig. 1) consists of a heavy weldless steel ring, to the inside of which are bolted a number of hydraulic cylinders, with rams which transmit pressure to the loose die-blocks surrounding the commutator. This type of press is suitable for a

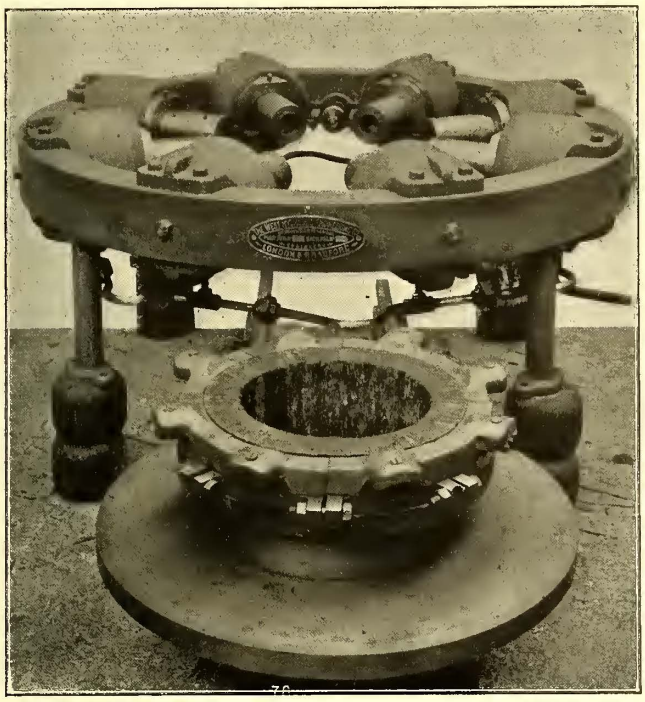


FIG. 1 —HYDRAULIC PRESS FOR COMMUTATORS

large range of commutators from 30 ins. diameter down to 6 ins. diameter. The vertical position of the commutator in the press is adjustable by means of a table shown in the center of the press. Distance-pieces of different lengths can be used to adapt the press for varying diameters of commutators, these distance-pieces fitting into pockets in the rams. A view of a commutator removed from the press is given in the foreground of Fig. 1. In order to obtain a clear view, the photograph was taken of a commutator without lugs.

When the ends have been machined, the commutator is placed on the table of the press (Fig. 2), which rises against the fixed tension bolt, and the retaining rings are bolted on under pressure, after which the die-blocks can be removed from the commutator. Instead of the two presses, Figs. 1 and 2, being separate, the press (Fig. 2) can be placed in the center of the radial press (Fig. 1), in lieu of the rising and falling table.

Australian Engineers in New York

Edward Noyes and W. G. T. Goodman, of Noyes Brothers, of Sydney and Melbourne, spent a few days in New York last week, and sailed for England on the "Lucania," Aug. 30. Their visit to this country was made largely for the purpose of placing contracts for apparatus for the electric tramway system in Dunedin, New Zealand, for which Noyes Brothers have been appointed the engineers. This system is being operated by horses. It comprises about 20 miles of track, and has recently been taken over by the city from the former private owners.

The rails will be of grooved girder type, will weigh 92 lbs. per yard, and will be supplied by the Société Belge at Antwerp. They will be laid on ties of hard Australian wood, 9 ins. x 4½ ins. x 7 ft. 6 ins., and spaced 2 ft. 6 ins. centers. The ties will rest on a ballast of 6½ ins. of broken stone. The special work will be supplied by the Lorain Steel Company. The bonds will be of the Brown plastic type.

Thirty-four cars have been ordered from the J. G. Brill Company, and all will be mounted on the Brill 21E truck. Fourteen of these cars will be of the California type with closed body and four benches at each end, fourteen will be standard box cars with 18-ft. body and 26 ft. over dashers, and six will be of the open type with ten benches. The cars will be equipped with two Westinghouse No. 68 motors each.

The poles have been ordered from the Mannesmann Works in Germany, and the construction will be partly single bracket, partly double bracket, and partly span. In the sections using the double bracket poles every other pole will carry an arc light. A new car house with a capacity of fifty-two cars has been commenced.

The city is proposing to operate its line from a water-power situated some 14 miles distant from the city of Dunedin. Until this plant is completed, a temporary steam plant will be installed. The transmission will be at 15,000 volts to within 2 miles of the city, when the voltage will be reduced to 5000 for transmission within the city to converter and transformer sub-stations. Connecting with the latter, a storage-battery plant will be used with

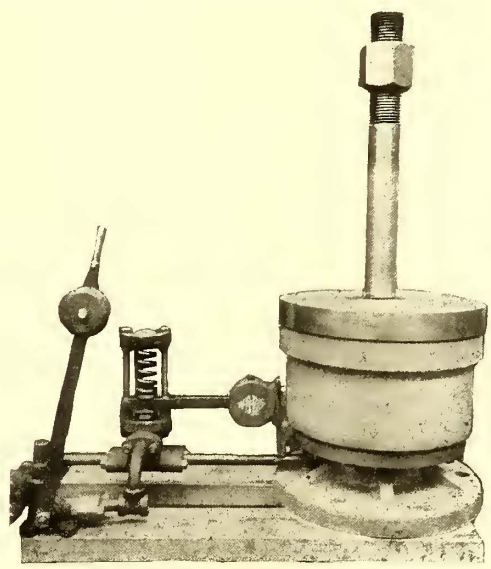


FIG. 2.—COMMUTATOR ON TABLE OF PRESS

accumulators of the Accumulatoren Fabrik Aktien-Gesellschaft, of Hagen. The generating station will contain two 600-kw generators, each directly connected to a turbine and two exciters of 25 kw each. The electrical machinery will be supplied by the Westinghouse Company, for whom Noyes Brothers are the Australian agents.

Trenton and New Brunswick Equipment

The Trenton & New Brunswick Railroad Company, which will operate its cars by electricity, has decided upon the equipment that will be used. The cars will be of the steam-car type, 45 ft. long, equipped with four 50-hp motors, Christensen air brakes, arc headlights, cross-seats, Pullman windows and aisle carpets, and the exteriors will be painted red. Express and freight cars will also be run over the road. A schedule speed of 35 miles per hour will be made between Milltown and the Interstate Fair Grounds, at Trenton, a distance of 24 miles. Each of the cars, in addition to being numbered, will be named after some town along or adjacent to the route of the road. The line runs entirely upon private right of way, 100 ft. wide, and the company has a steam railway charter, so that it may also run locomotives if desired. But one village is encountered between terminals, and all the traffic, or nearly all, will be through from Trenton to New Brunswick or points beyond. It has been suggested, locally, that the company might run excursions from Trenton to Coney Island and Manhattan Beach next summer, by connecting with steamers at some point along the Raritan. Trenton's pleasure resorts now are Willow Grove, Pa., and Washington Park, N. J., both near Philadelphia, and each more than 25 miles away, while Coney Island, by this route, would be but 50 miles. The opening of the Trenton & New Brunswick road will complete the trolley connections between Trenton and New York, and all the way to Philadelphia, with the exception of a break, about 2 miles long, at West Palmyra, and this will be closed during the present month.

A party of influential gentlemen from South Australia, including Sir Edwin T. Smith and Mr. Arthur W. Ware, ex-Mayor of Adelaide, will probably visit the United States and make a tour of inspection of the principal electric railways during October. The contract for the electrical equipment of the Adelaide Tramways has just been awarded to the British Westinghouse Company.

NEWS OF THE WEEK

Serious Accident in Pennsylvania

Twenty-five people were injured in a collision between two cars on the Youngstown & Sharon Street Railway near Sharon, Pa., on Aug. 27. The accident occurred a short distance beyond the switch at the car house. A car was going toward Youngstown, and it is said that it should have waited at the switch for the incoming car. The heavy fog is said to have prevented the motorman from seeing the approaching car until it was only 10 feet away.

The cars came together with frightful force, one telescoping the other. A dozen men seated in the smoking compartment were hurled through the wooden partition and landed under the wreckage, 10 feet forward in the car, and the other passengers were hurled about in confusion.

Strike on Hudson Valley Railway

The lines of the Hudson Valley Railway Company, operating between Warrenburg, Saratoga, Ballston, Troy and Schuylersville, N. Y., are tied up, because of a strike of motormen and conductors. The strike was declared on Aug. 30, and two reasons are given for its declaration. The company announced that on Sept. 1 there would be a reduction in wages from $1.80 to $1.25 per day, and to this reduction the men objected. In addition to this, dissatisfaction among the men was aroused because a motorman in charge of a car that was in collision was discharged by the company. The company said that this man was grossly negligent, and that there was no excuse for the accident. On the other hand, it was maintained by the discharged man that the accident was unavoidable. He claimed that the brake mechanism of the car was defective.

To Arbitrate Chicago Railway Troubles

Although the local union of the Amalgamated Association of Street Car Employees at Chicago, by an overwhelming vote on Aug. 26, refused to accept a proposition made by President Roach several days ago in behalf of the Union Traction Company and the Consolidated Traction Company, it is very probable that an amicable adjustment of the differences between the companies and their employees will be arranged. On Aug. 28, by unanimous vote, it was decided to submit all differences to arbitration. Clarence Darrow, an attorney, has been selected to represent the men, President Roach will select an arbitrator for the company, and both parties will agree to the selection of a third arbitrator. The time and place for the meeting of the board has not yet been decided.

Growth of the Electric Railway

The Census Bureau has just issued some statistics showing the rapidity with which the electric system has supplanted horse and cable power. According to the Census Bureau, in 1890 the street railway companies of the United States in operation numbered 789, of which 144 were electric. At that time there were 2895 electric cars in use, out of 32,505 of all kinds, and 1262 miles of track, out of 8123. By 1899 the number of cable cars had declined from 5089 in 1890 to 4250, and horse cars from 22,408 to 1489; but in the meantime electric cars had increased to the number of 50,658, and the number of miles of track to 17,969. The stimulus given the industry is further brought out by the fact that, whereas in 1890 the total capital and funded debt for all roads appears to have reached $363,150,000, in 1900 the total for 871 street railway systems, chiefly electric, was $1,023,819,987 capital stock and $777,862,571 funded debt, making a total of slightly over $1,800,000,000, or just five times the figures of ten years before. On this vast capitalization the returns from the operation would indicate a net earning capacity of from 4 per cent to 5 per cent. The Bureau quotes the annual report of the Metropolitan Street Railway Company, of New York, for the census year ended June 30, 1900, as indicating the saving that has resulted from the introduction of electricity. A comparison is made of the cost of operation per car mile and electric, cable and horse.

The Pennsylvania Tunnel

According to reports from Philadelphia officials of the Pennsylvania Railroad are of the opinion that there will be no difficulty in securing the consent of the Aldermen of New York for the construction of their underground road, although no action has been taken by the Aldermen in regard to granting the franchise for the construction of the tunnel under Manhattan Island. An officer of the Pennsylvania Railroad is even quoted as stating that an understanding had been reached which was agreeable to all parties interested, and that within a short time a new bill would be presented to meet with the approval of the Aldermen, as well as the members of the Rapid Transit Commission and Mayor Low. Some of the changes which the Aldermen wanted in the tunnel bill have been complied with by the Pennsylvania, it is said, but it is understood nothing will be done in regard to the question of employing labor. It is contended by the railroad officials that they will have nothing to do with this. The work will be given to a contractor, and he will be responsible for carrying out the plans.

The Sensational in the Daily Press

An instance of the injury that may be done an employee and employer by the publication of a sensational newspaper story is furnished at San Francisco, where minor differences between a street railway company and its employees were so magnified and distorted by one of the yellow journals of that city that it was made to appear that a street railway strike was to be declared at once. The agreement entered into several months ago between the company in question and its employees provides that the company shall deal with a committee of the employees when there is any grievance. A few days ago the officials of the company were visited by a committee, but the company refused to deal with it, because one of its members was not an employee of the company, the agreement between the company and its employees stating precisely that a committee of employees only would be dealt with. Now, the refusal of the company to deal with the committee was worked up into a most sensational first-page story, full of inaccuracies and entirely without foundation. A meeting of the street railway employees was called at once, and resolutions were passed deploring this act of the yellow journalist, branding the whole story as a most outrageous misrepresentation of the facts of the case.

Connecting Worcester with Providence, Hartford and Boston

With the plan for consolidating as the Worcester & Connecticut Eastern Street Railway Company, the Worcester & Webster Street Railway, the Webster & Dudley Street Railway, the Worcester & Connecticut Eastern Street Railway, the Danielson & Norwich Street Railway, not yet built, and the People's Tramway Company, which companies control lines from Worcester to Norwich, Conn., attention is again called to Worcester as an interurban railway center. Now, in addition to the lines mentioned, which in themselves form an important system, there extend from the city the various suburban lines of the Worcester Consolidated Street Railway Company, the Worcester & Blackstone Valley Street Railway Company and the Westboro & Marlboro Street Railway Company. Then there is the Boston & Worcester Street Railway, under construction between Boston and Worcester, the Hartford & Worcester Street Railway, contemplating a line between Hartford, Conn., and Worcester, and the Providence & Worcester Street Railway, which contemplates constructing a line between Worcester and Providence, R. I.; but on the road under construction between Boston and Worcester and those planned to connect Worcester with Hartford and Providence interest is now centered. Interests identical with those that are backing the Boston & Worcester Street Railway are behind both the Hartford & Worcester Street Railway and the Providence & Worcester Street Railway.

The distance between Providence and Worcester, as it is proposed to build the new road, is about 40 miles, and the fare between the cities will probably be 50 cents. The run on the New York, New Haven & Hartford Railroad between the cities is about 40 miles, and the fare charged is $1.10. Entrance to Worcester will be made over the lines of the Worcester Consolidated Street Railway, and at Providence entrance to that city will be made over the lines of the Rhode Island Suburban Railway. Locations and franchises have been secured for this line, and charters are to be applied for at the next sessions of the Legislatures of Massachusetts and Rhode Island.

For the line between Hartford and Worcester it is said that little has been done in the way of securing grants. This line will

pass through a territory not so thickly settled as either the Boston & Worcester Street Railway, or the Providence & Worcester Street Railway, but the through traffic will be large. In this connection it is interesting to note what inducements the company can offer to secure through travel from the steam road with which it will enter into direct competition. The route of the electric railway will be about 20 miles shorter than that of the steam road, but the time required to make the run on the electric railway will exceed by one hour that which is required by steam. But frequency of service and a low rate of fare will compensate for this additional time. The fare by electric railway will be about $1.00 less than that by steam, it is expected.

The Boston & Worcester Street Railway, on which construction work is now progressing so satisfactorily, will pass through Brookline, Newton, Wellesley, Natick, Framingham, Southboro, Westboro, Northboro and Shrewsbury, some of the prettiest towns in the State. The length of the run from Boston to Worcester is 40 miles, and the Boston & Worcester Street Railway will practically parallel the lines of the Boston & Albany division of the New York Central Railroad. It is said that the running time of the electric railway between the cities will be two hours, and the plan is to charge a fare of 35 cents. Through trains of the Boston & Albany, making no stops between points, make the run between the cities in a little over one hour. The fare by steam, however, is $1.00.

For Perpetual Street Railway Franchises in Cleveland

The street railway interests of Ohio are intensely interested in the new code bill now being considered by a special session of the State Legislature. The section relating to electric railway franchises, as provided in the code submitted to the Legislature by Governor Nash, provides that franchises shall be granted only after advertisement and competitive bidding, the bidder who gives the most to the city and people, either in the way of money payments or lower fares or other concession, to have the franchise; that the life of such franchise shall not be for more than twenty-five years, with a revision of rates every ten years with a resort to arbitration if the city and company cannot agree.

Senator Mark Hanna, president of the Cleveland City Railway Company, of Cleveland, has had drafted an amendment to the franchise clause of the proposed code, providing that street railway franchises shall be perpetual, with a revision of rates every ten years. The proposed amendment is attracting almost as much attention as the code itself, and there is likely to be a long controversy on the subject. The arguments in favor of perpetual franchises, as given by Senator Hanna in newspaper interviews, may be summarized briefly as follows:

That it would give stability to investments in such enterprises; capitalists would not hesitate to invest their money, and to give to the public the highest class of service, as they would be sure they would receive a proper return from their investments. If a company's franchise is to expire within a short term, and there is doubt of renewal on favorable terms, it will not invest money in improvements and extensions, nor hardly keep up necessary repairs, because of the uncertainty of any adequate return. Further, the bonds of a company with a perpetual franchise can be floated at a much lower rate of interest, because they will attract those who purchase for permanent investment, and will possess the stability of government bonds.

The proposed amendment makes changes in sections 29, 30, 31, and 34 of the Nash code bill. The words inserted are capitalized. The words left out are designated by stars. The sections with the proposed amendments are as follows:

Section 29—Council shall have power to grant the use of the streets or other public places AND TO PERMANENTLY RENEW AND GRANT HERETOFORE MADE AT ANY TIME BEFORE OR AFTER ITS EXPIRATION, to any street railway company, natural or artificial gas company, electric or other light company, water company, pneumatic tube or package company, heat and power company, telephone company or any other similar corporation, and the right to use the streets or other public places may extend over, upon, along, across, or beneath the surface thereof.

Section 30—No such right shall be granted OR RENEWED except by ordinance of Council * * * nor shall any such ORIGINAL grant be made except upon written application to Council from the corporation desiring the use of the streets, and after advertisement for thirty days in some newspaper of general circulation in the city or village, inviting proposals to furnish the inhabitants thereof with the public service proposed in the application. No ORIGINAL grant shall be made except to the company offering the best terms to the municipality and its inhabitants, with respect both to the compensation or return to be given in the way of rental and repairs, and the rates of charges to be made; and where any bid includes an offer to pay the municipality an annual percentage of the gross receipts of the company, such bidder, if awarded the grant, shall permit Council, or any person or persons designated by Council, to examine its books at any time for the purpose of ascertaining such gross receipts.

Section 31—Council shall have power at all times to adopt police regulations with respect to the use of the streets or other public places by such companies, and, at the end of each period of ten years, to regulate the price, rate of fare, or other charges, TERMS AND CONDITIONS for the public service, by agreement with the companies, WHICH PRICES, RATE OF FARE AND OTHER CHARGES, TERMS AND CONDITIONS SHALL ALWAYS BE JUST AND REASONABLE, and every grant, AND RENEWAL OF GRANT, shall provide a method of arbitration to be thereafter pursued in case the Council and the company are unable to agree upon such regulation of the price rate of fare or other charges, TERMS AND CONDITIONS, provided, that the council shall have power at any time with the consent of the company, to secure more favorable terms to the municipality in the operation of any grant herein authorized, and any taxpayer shall have the right, in the manner provided in sections 1777, 1778, and 1779, of the Revised Statutes, to prevent a violation of this section of any abuse of the power herein conferred.

Section 34—Extensions of existing street railway routes may be made by the Council of any municipal corporation to any company owning or having the right to construct any street railway within the corporate limits whenever such extension is deemed beneficial to the public; * * * and the terms upon which such extension may be made shall not be less favorable to the public or to the municipality than those imposed in the grant of the original route; and provided further, that before any work is done upon the streets or other public places over which the tracks of the company are to be extended, said company shall produce to the council the written consent of a majority of the abutting property owners as required in such original grant.

In section 31, as designated by stars, the matter left out is as follows: "And no grant shall be valid for a greater period than twenty-five years."

In section 34, as designated by stars, the matter left out is as follows: "Provided that the rights under said extension shall expire at the same time as those conferred in the original grant."

Interurban Lines Secure Entrance to Indianapolis

After discussing, for about two years, the question of terms for admitting the interurban railway lines to Indianapolis, that city, as previously mentioned in the STREET RAILWAY JOURNAL, has recently solved the question in a manner equally satisfactory to the residents of the city and the companies seeking entrance. A franchise has been granted to the Indianapolis Traction & Terminal Company for the erection of passenger and freight terminal stations, and the construction of downtown loops to be used by the interurban cars in reaching these stations, and, in addition to this, franchises have been granted to the eight interurban companies that were seeking entrance to the city.

Provision is made for the payment to the city by the Indianapolis Traction & Terminal Company for 4 cents on each car entering the city for the first eleven years, 6 cents for each car entering the city for the next ten years and 10 cents on each car entering the city for the following ten years, and payment is also to be made to the city by each of the interurban companies receiving franchises of 1 cent for each car entering the city during the entire time of thirty-one years for which the franchises are granted. Under these provisions the revenue to the city, during the franchises, from the car tax will be $381,383.

The city has fixed the freight rates to be charged by the companies. It is stipulated that the companies shall carry freight at rates not exceeding the rates now charged by other common carriers for the same classes of merchandise, provided that the companies cannot be compelled to charge less rates than 80 per cent of the present published rates of other common carriers. The city reserves the right to regulate the carriage of freight and to change the routes in the city limits used by freight and express cars in reaching the freight terminals.

The Indianapolis Street Railway Company is given the right to construct a new belt line, and it is estimated that this line, if double-tracked, will call for the laying of eleven miles of track.

Engineering Societies

THE NEW ENGLAND STREET RAILWAY CLUB will hold its annual outing at Hampton Beach, Thursday, Sept. 4, 1902. This is the last outdoor meeting of the club for the year, and it is generally expected that there will be a large attendance.

NEW YORK RAILROAD CLUB.—The first meeting of the club for the coming season will be held on the evening of Sept. 18. An interesting paper is promised by Chief Engineer J. C. Brackenridge, of the Brooklyn Rapid Transit Company on "Track Construction for Rapidly Moving Heavy Loads in Electric Railroading." The place of meeting will be announced later in the usual way.

PERSONAL MENTION

MR. C. W. MARTIN succeeds Mr. W. P. Cosper, resigned, as general agent at Chicago of the Consolidated Car Heating Company, of Albany, N. Y. Mr. Martin is ably assisted by W. S. Hammond, Jr.

MR. E. W. MOORE, of the Everett-Moore syndicate, leaves this week for a six-week's vacation in Europe. He will be accompanied by Mr. F. J. Wolfe, assistant passenger agent of the New York Central Railway.

MR. FRANCIS C. GREEN, former superintendent of the Consolidated Car Heating Company, of Albany, N. Y., has recently been appointed general manager of the company, succeeding Mr. H. P. Scales, resigned. Mr. Green has full charge of all the affairs of the company.

MR. T. M. GATHRIGHT has resigned as general superintendent of the Camden Interstate Railway, of Ironton, Ohio, and will be succeeded by Colonel W. W. Magoon, who has been treasurer of the company. Colonel Magoon will be succeeded by Mr. T. McK. Hays, who has been connected with other lines operated by Hon. Mr. John Graham, president of the Camden Company.

MR. O. W. BRAINE, who succeeded Mr. G. Fischer as electrical engineer of the New South Wales Government Railroad, is at present in London on business connected with important extensions now being carried on in the Sydney tramway system, which is owned by the New South Wales Government. Mr. Braine is planning to return to Australia by way of America, and will probably attend the convention of the American Street Railway Association at Detroit.

MR. W. O. HANDS, superintendent of the Northeast Division of the Metropolitan Street Railway Company, of Kansas City, Mo., has resigned from that position to accept a more lucrative position on the engineering staff of the company during the reconstruction of the system. Mr. Hands, fourteen years a constructing engineer, is especially fit for his new position. Mr. J. W. Sherman has been appointed to succeed Mr. Hands as superintendent for the Northeast Division.

MR. H. P. BRADFORD, who was formerly general manager of the Compania del Ferrocarriles de Distrito Federal de Mexico, of Mexico City, and previously was the general manager of the Cincinnati Inclined Plane Railway Company, has just been appointed general manager of the Compagnie Genevoise des Tramways Eleqtriques, of Geneva. This property, as stated in recent issues of the STREET RAILWAY JOURNAL, has recently been equipped electrically. The two largest stockholders in the company are Mr. H. A. Butters and Mr. John Hays Hammond.

CONSTRUCTION NOTES

LOS ANGELES, CAL.—The ordinance granting the California Pacific Railway Company the right to construct a railroad along certain public streets of the city of Los Angeles, to be operated in connection with the electric railway between Los Angeles and the city of San Pedro, has been adopted by the City Council.

WATSONVILLE, CAL.—W. J. Rogers, of San Jose, has applied to the Supervisors of Santa Cruz County for a franchise to construct an electric railway through the county. Bids for the franchise will be received on Sept. 10.

STOCKTON, CAL.—H. H. Griffiths has filed with the City Council his acceptance of the franchise recently passed by the Council. The franchise gives Mr. Griffith permission to build an electric railway over the principal streets of the city, and it is his intention to build not only such lines as are stipulated by the franchise, but lines to Lodi and other suburban points. It is the intention to begin work in the near future.

SAN JOSE, CAL.—The supervisors have granted L. A. Sage a franchise for the construction of an electric railway from San Jose to Saratoga, a distance of 12 miles.

NORWICH, CONN.—The Railroad Cimmissioners have approved the construction plans of the Danielson & Norwich Street Railway Company, for a proposed extension of its line from Killingly, through Falls Brook to Central Village.

ROCKVILLE, CONN.—Thomas C. Perkins, promoter of the Rockville-Stafford Springs Electric Railway, is quoted as authority for the statement that the bonds on the whole proposition have been underwritten by a Boston house, and that the stock has been subscribed for and a conditional contract let with a Boston firm of street railway contractors, subject to the local company's being able to get the rights of way, etc. It is said that Mr. Perkins has secured the rights of way from the Connecticut State line to Worcester, and that he will begin at once securing rights of way in the Connecticut towns through which the road is to pass. The road will be about 40 miles long.

INDIANAPOLIS, IND.—The Indianapolis & Eastern Railway Company has under construction 18 miles of road between Knightstown and Dublin, Ind., giving a line from Indianapolis to Dublin, a distance of 4 miles. At Dublin connections are made with the Richmond Street & Interurban Railway, thus completing a line from Indianapolis to Richmond. Between Richmond and Eaton, Ohio, a distance of 13 miles, contracts have been let, and in the spring it is expected that the line between these points will be completed. At Eaton connection will be made with the Dayton & Western Railway, thus giving a through line from Indianapolis to Dayton. The Indianapolis & Eastern will erect its own power house, which will be equipped with two 400-kw generators, two 600-hp compound condensing engines, and three 50-hp Sterling boilers. C. M. Kirkpatrick, of Greenfield, Ind., has the contract for the track work, the Carnegie Steel Company has the contract for the rails, and the St. Louis Car Company has the contract for the rolling stock. The cars are to be equipped with Steel motors. The authorized capital stock of the company is $1,200,000. Of an authorized funded debt of $1,000,000, $700,000 has been issued. The officers of the company are: F. M. Fauvre, president; C. E. Coffin, vice-president; J. W. Chipman, secretary, manager and purchasing agent; M. B. Wilson, treasurer; D. H. Robinson, superintendent.

MADISONVILLE, KY.—It is possible that an electric railway will be constructed from Morganfield to Sebree. It is proposed to run the line through the oil fields in Webster County, thence to Dixon and from there to Sebree. Should the project materialize, it will give connection with the Louisville & Nashville Railroad at Sebree, and the Ohio Valley at Morganfield.

SACO, ME.—F. A. Hobart, of Boston, has informed the local interests identified with the Saco Valley Railroad that he has closed a contract for building the road. The contractor gives a bond that he will begin work upon the construction of the road within sixty days. The contract stipulates that the road shall be constructed this fall to the depot of the Portland & Rochester Railroad at Bar Mills where the power station is to be located. The balance of the road is to be completed as soon as possible next year.

WATERVILLE, MAINE.—The hearing on the application of the Waterville & Oakland Street Railway Company for a location of its road from Waterville to Oakland, a distance of about 6 miles, has been closed. The Railroad Commissioners are expected to announce their decision shortly.

SANDWICH, MASS.—The Sandwich Street Railway Company, organized to build an electric railway from a connection with the Middleboro, Wareham & Buzzard's Bay Street Railway in Bourne, through Sandwich to Barnstable, a distance of 24 miles, has elected officers as follows: R. A. Hammond, president; C. M. Thompson, vice-president; John A. Holway, treasurer; Arthur Braman, clerk; C. B. Jefferson, A. H. Armstrong, Thomas C. Day, William A. Nye, George T. McLaughlin, Fletcher Clark, James L. Wesson, R. D. Woodward, R. H. Faunce, M. D., directors.

NORTH ADAMS, MASS.—A franchise has been granted the Hoosac Valley Street Railway Company by the Williamstown Selectmen to extend its lines to the Vermont State line.

MAYNARD, MASS.—The Selectmen of Maynard have denied the petition of the Lowell, Acton & Maynard Street Railway Company for a location in Maynard, because of the refusal of the company to pave between the tracks. The cost of paving will be from $2,500 to $3,500.

WORCESTER, MASS.—The Worcester & Connecticutt Eastern Street Railway Company has completed its line from Danielson, Conn., to Wauregan, Conn.

WORCESTER, MASS.—Brown & McLain, of Boston, engineers representing a syndicate, have acquired a large tract of land at Barre Falls in the town of Barre, with water rights on the Ware River, where they will erect a water-power plant for the generation of electricity. The water-power is estimated at 2500 hp, and the natural conditions are such that a small dam will create a large storage reservoir. Negotiations are being entered into with the Worcester & Holden Street Railway Company to supply power for its new line.

GREENFIELD, MASS.—The Greenfield, Deerfield & Northampton Street Railway Company has opened its line from Greenfield to South Deerfield. The company has built its line from Northampton to Hatfield, but there is a connecting link between South Deerfield, through the town of Whately still to be built. The matter of a location in Whately has been taken to the Railroad Commissioners.

SPRINGFIELD, MASS.—The Enfield & Somers Street Railway, a new feeder to the Hartford & Springfield Street Railway, has just been opened between Enfield and Somers, Conn.

GARDNER, MASS.—James A. Stiles, of Gardner, a well-known street railway man, has, with Samuel Williams and Ernest Jose, of Boston, bought the White Valley Street Railway, running from Bethel, Vt., a distance of 19 miles. The road was sold at auction by the receiver, R. H. Sawyer, for $55,000. The street road, which was built about three years ago, cost about $400,000, it is said.

BROCKTON, MASS.—The Norwell & Scituate Street Railway Company has been organized, with a capital stock of $150,000, to build an electric railway from the terminus of the lines of the Old Colony Street Railway in Assinippi through Norwell, Greenbush, Scituate Harbor, North Scituate and Cohasset, connecting with the third-rail system in the latter place. The distance is 15 miles. In Scituate Harbor the line will extend to the Sand Hills, a favorite summer resort for residents of the inland towns, following the highway recently laid out and accepted by the County Commissioners to North Scituate. Henry D. Smith, of Norwell, is interested in the project.

PLYMOUTH, MASS.—It is said that the Plymouth, Carver & Wareham Street Railway will form a connection at Tremont with the Middleboro, Wareham & Buzzard's Bay Street Railway for all points north and south, and also with the main line of the steam road from Boston to all points on Cape Cod and the Fairhaven branch to this city. An extension is also contemplated from Tremont south through Rochester, to Acushnet, connecting there with the lines of the Union Street Railway, of New Bedford, and the New Bedford, Middleboro & Brockton line of the Old Colony Street Railway Company.

ATLANTIC CITY, N. J.—An ordinance to grant the People's Traction Company, of which I. A. Sweigard, formerly general manager of the Reading Railway, is president, the right to build an electric railway here, has been introduced in City Council.