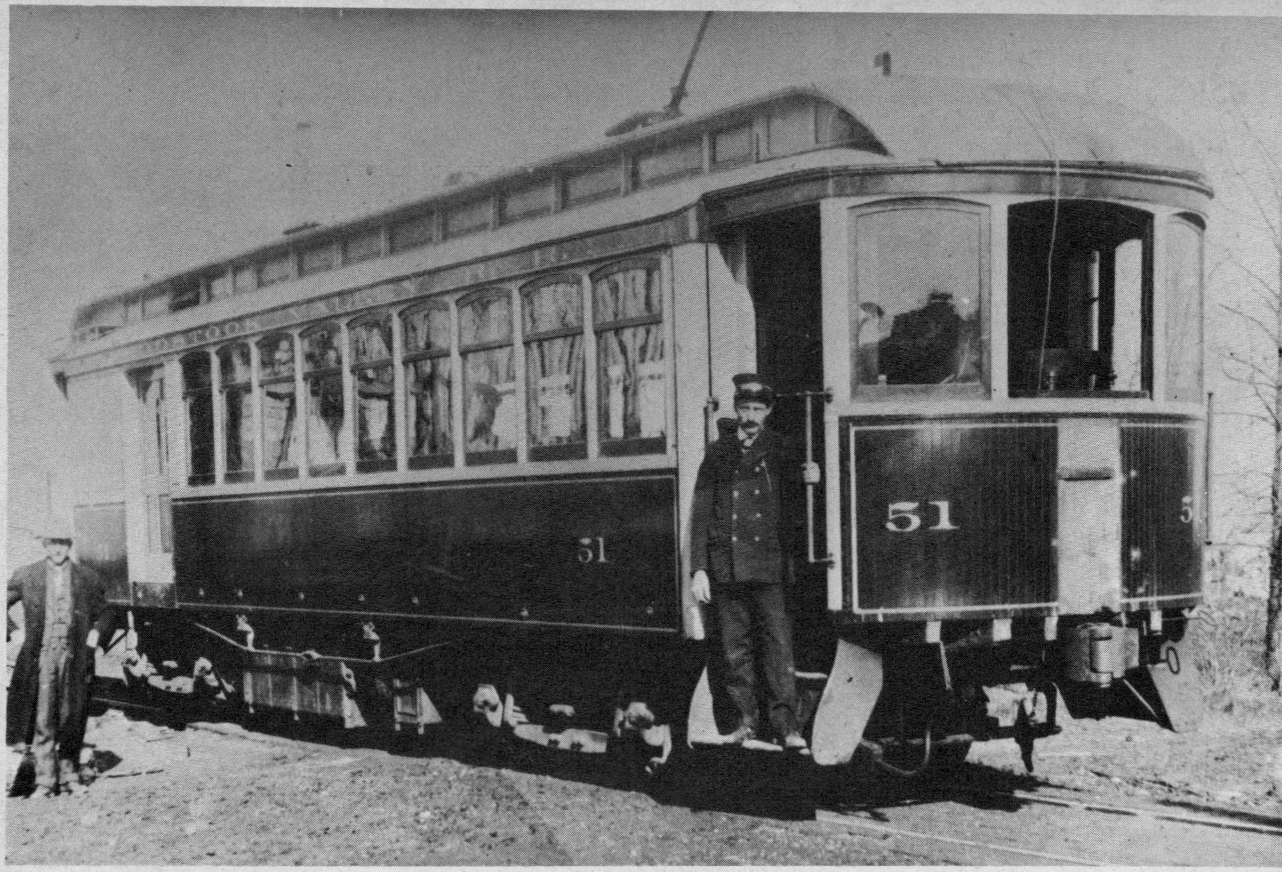


Brill-built combo 51 of Maine's Aroostook Valley RR was a 22 ton, 44 ft., 1200 volt car. Four passenger steps provided for double ended operation, along with reversible seats. Non-radial coupler was possible because of short car length and line's wide curves.

Interurban Electric Railways

by C. Mischke

Usually working within tight budgets, the interurban lines operated their trains in carefully thought out sequence dictated by economies of operation, and capabilities of sub-stations and signaling.

ABOUT 1890, perhaps with the Newark and Granville (Ohio), a perculiarly American industry was born. It grew and faded in the short span of 70 odd years, perishing completely with the abandonment of the Chicago, North Shore and Milwaukee Railroad in January 1963. Just why it mushroomed in several spurts to include 15,000 miles of track and then nearly vanished from the scene in but a decade (1930-1940) is a fascinating story in its own right. What it was and how it functioned is usually the primary concern of fans and modelers. It is my intention to sketch its composite character and examine its modeling potential in order to alert model railroaders to the possibilities inherent in reproducing the interurban railway in miniature.

Model traction enthusiasts are a minority among model railroaders but what they lack in numbers they compensate for in enthusiastic and resourceful model-making and avid pursuit of all things traction.

What Was an Interurban?

No definition of an interurban railway was evolved during its existence that enjoyed universal acceptance. The Interstate Commerce Commission made the following statement. "The service of such railways, however, is distinguished by its local and limited character and by the fact that the bulk of their revenues are derived from the transportation of passengers. Their facilities for handling freight are usually inadequate so as to disable them from engaging in its general transportation. The amount of business interchanged by them with connecting carriers is ordinarily very small."

It is interesting to note that the presence or absence of electrical propulsion is unmentioned. By this definition gas lines such as the Woodstock & Sycamore (Illinois) and part of the St. Joseph Valley (Indiana) could be classified as interurbans and the electrically propelled Sacramento Northern (California) and the Lackawanna & Wyoming Valley (Penna.) may not enjoy interurban status because their freight activity and interchange was substantial.

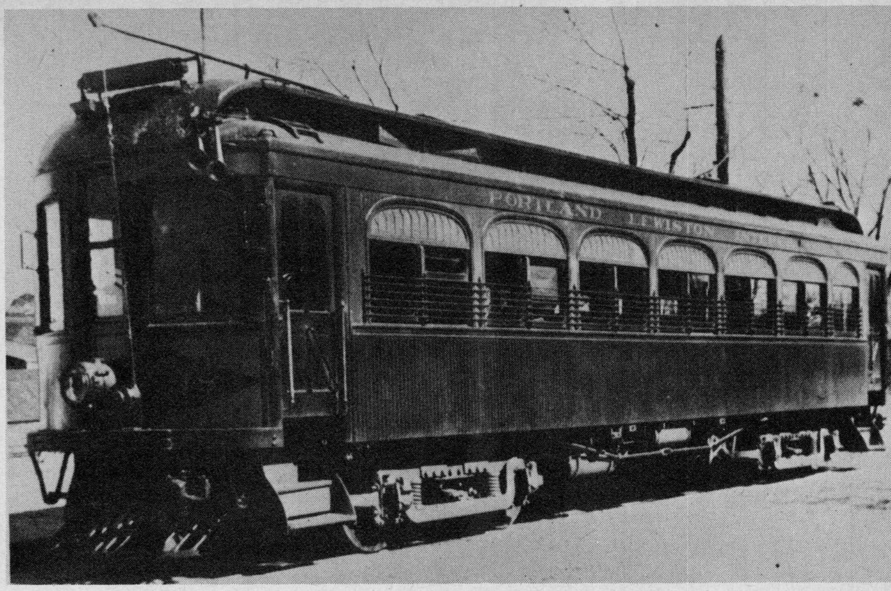
The interurban was the natural outgrowth and extension of a very successful streetcar technology. The electrified railroads were clearly of steamroad technology except for motive power. Examination will reveal a continuous spectrum of streetcar-interurban-railroad with no clear and distinct demarkations between them. The interurban borrowed ideas from both extremes of the spectrum and initially more closely resembled the streetcar morphology since that is where its promotion and financing was heavily concentrated. In later years it moved toward railroad technology.

Many things were unique to the interurban railway and contributed considerably to its charm. The picture that comes to mind of a light, electrified shortline railway engaged principally in intercity passenger transport with subordinate handling of express, LCL, mail and carload freight in company and interchanged equipment, is the picture most people would label as interurban. The usual original interurban line was electrically powered by pole trolley and surprisingly short (about 25 miles), operating single-ended combines as one-car trains at scheduled speeds of 20 miles per hour over single track, mostly on private right-of-way. Less-than-car-load freight (LCL), was handled in motorized box cars (often rebuilt, regeared passenger equipment) occasionally pulling a company trailer or, rarely, an interchange freight car. The trains left the principal terminus on city streetcar trackage and then ran, partly on the side of the road and partly cross country on private graded right-of-way, not infrequently paralleling a steam road. Intermediate towns were traversed on street trackage which was either owned or rented.

Where, then, are the speeding limiteds? Where are the multiple-unit trains, the signalled double track, the interchange freight trains trailing steeple-cab locomotives in multiple? They existed, to be sure, but the popular conception (or optimistic hope) that this was typical, or common, is misguided. During the later years of the industry, consolidations created some large systems and some superlatives which became associated with them. The consolidations which created the Sacramento Northern Railroad allowed a 183 mile run for #2, the Comet. The Cincinnati & Lake Erie run from College Hill to Toledo was 216 miles long. Interstate Public Service (Indiana) ran parlor-diner and sleeping cars (although not in the same train) the 117 miles between Louisville and Indianapolis. Each Electroliner of the North Shore sped the 88 miles from Chicago to Milwaukee five times daily, and under favorable conditions of load, wind and grade exceeded 80 mph. These long runs, and the splendid trains which made them, represent the finest of interurban service, but hardly the typical performance.

The interurban was often conceived as a rival to an existing steam road. Rather than offer a few long passenger trains daily as the steam roads did, the electric line sought to compete by providing many hourly short trains daily. This could be accomplished with fewer passenger cars, from more convenient terminals and way stations, and (hopefully) at greater speed. The most popular car style was the passenger-baggage combination car (combine), operated single-ended with the baggage compartment forward. This gave the largest possible margin of safety to revenue passengers (the typical interurban accident was the head-on collision) and permitted the motorman to assist in baggage handling without technically leaving his post.

A 15 mile line with a 20 mph schedule speed could comfortably maintain 90 minute opposing service with two cars and two crews on the line. When traffic required, two-car trains were provided, more often than not, made up as a combine pulling a trailer coach. Power supplies were usually so modest that extra motors in a train caused voltage problems. Often a train of three motor cars was run with the first two in multiple and the third pulled as a trailer with motors cut out (but with brakes operative). The Kansas City, Kaw



Laconia and Wason provided the Portland-Lewiston Interurban with nine cars, of which No. 18, Azalea, is an example. Little known road was first to use trolley shoe, Westinghouse coupler, and airhorn. The cars were equipped for multiple unit operation.

Sacramento Northern 1002, built by Holman, was part of group delivered to predecessor Oakland & Antioch. 10 ft. wide, a bantam sized combo was 45 ft. long, weighed 30 tons, was built for train service but orginal equipment prohibited mu service. A beauty.

Valley and Western (Kansas) had seven passenger motors and after some Kansas University football games in Lawrence, two three-car trains departed for Kansas City. The first section had to climb the Union Pacific overpass grade before the second section departed and the sections extinguished all lights (except headlights and markers) so that low voltage didn't make the movement intolerably slow.

The electric interurban car (or train) had only two (rarely, three) running speeds. One speed was approximately one-half balancing speed. Balancing speed is the free running speed on level tangent track in still air. Most cars had four motors, one geared to each axle. The cars could run at balancing speed with all motors in electrical parallel between the wire and the track. Half speed of indefinite duration was effected by connecting the motors of each truck in parallel, and the two car trucks in electrical series. The controller, which implemented this electrical switching also introduced and removed electrical resistors from the propulsion circuit. The car was started by placing a resistor in series with the half-speed motor circuit. As controller "points" were traversed, resistance was cut out in steps until the half speed circuit was connected. The starting (accelerating) points could only be used for a short time, otherwise resistor grids (under the car) would burn out. After the first running point was attained (all resistance out of the propulsion circuit) the following notches placed the motors in electrical parallel with resistors in series with them. This resistance too, was successively notched out until the second running point was attained. This was full speed. Still higher speeds were attainable in special cases by field shunting, but this was very rarely installed. How, then did the motorman sustain speeds other than those of his two running points? He did this by skillful applications of power, brakes and coasting, ever conscious of the momentum of the vehicle(s) in his charge. His was a finely developed art. Sustaining a speed of less than ten miles per hour in city traffic required skillful motormanship. Occasionally even skilled motormen used the first notches too much and some lines (the Puget Sound Electric Railway, for example) rewired their cars to include a full series running notch for sustained street running

On a line where multicar trains were typical, the Oregon Electric, some substations were provided with drooping voltage characteristics; so that the heavy train would pull a heavy current from the station, causing a severe voltage drop. The motorman would notch more quickly to his first running point and hold his controller there, and as the accelerating train reduced its current demand, the line voltage rose to near normal value. The controller was notched up one, and as the accelerating current demand again lowered the voltage, he could notch to the second running point, and accelerate in the second running position. In effect, the substation was accelerating the train. Instead of dissipating lots of energy under the car, the line voltage was varied to cause the same effect without the large energy loss. This was a typical installation, but it illustrates the clever approaches to problems that was a hallmark of much of the interurban industry.

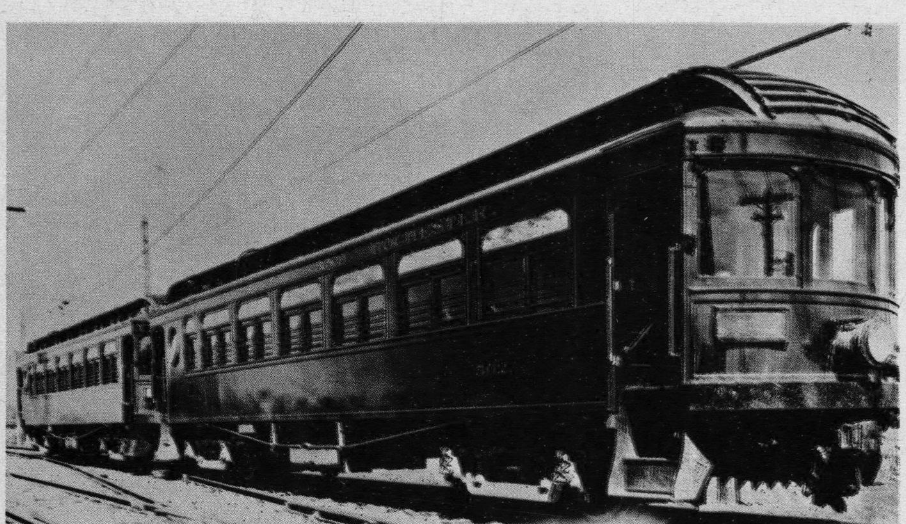
Equipment

The most prevalent car style was the combine, with the straight coach being second. Most cars were single-ended, although many had two trolley poles to help in wying or running two combos back-to-back. Some had hostler controls at the rear end (a two point controller and a brake valve) for backing movements or occasional switching.

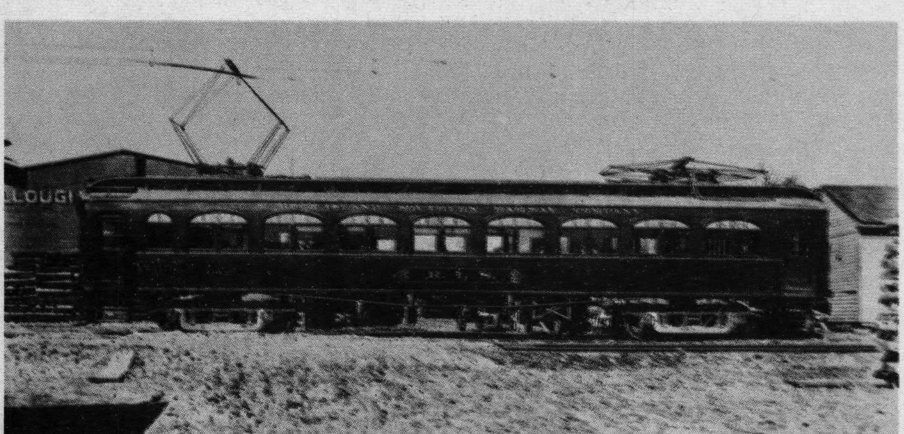
Running a combine backwards in revenue service as a single car presented problems. The interurbans picked-up and discharged passengers from both sides of the track and the usual combo had passenger steps only at the rear of the car. No matter where the motorman's position was, in running the combo backwards boarding passengers found him and his stool in the way. Roads which ran their combos backwards in revenue service either provided passenger steps at all four corners of the car or moved the rear steps one window width toward the baggage compartment, providing a separate motorman's compartment, as in the Sacramento Northern's 1003 series combos. A less common solution was moving the passenger entrance to the center of the car side as in Southern Iowa's 25-26 or Fort Dodge, Des Moines & Southern's 50, 52, 54. The commonest solution of providing four corner passenger steps required passengers to traverse the baggage compartment, an unsafe practice. Such cars were owned by Salt Lake, Garfield & Western; Chicago, North Shore & Milwaukee, Northern Electric, and the Pacific Electric.

Cars were equipped with train doors when multi-car operation was likely and the later equipment of the Chicago, North Shore & Milwaukee, Chicago, Aurora & Elgin, Sacramento Northern and Chicago, South Shore & South Bend provided train doors at both ends of every car. The usefulness and popularity of the combo usually placed it at the head end of every multi-car train. A road committed to this practice and adding a second car as required, placed train doors only at the rear of their combines, retaining the typical three window end on the front of the combine. Such combines were built for Interstate Public Service (150-7), Waterloo Cedar Falls & Northern (140-3), Buffalo, Lockport & Rochester (coaches 500-5). When combos were run MU they were usually mated back-to-back in order that both sets of passenger traps were adjacent for crew convenience and for making the revenue passenger space continuous. The Lehigh Valley Transit (Penna.) practice with their 800 series combos in train makeup was typical.

Double-ended equipment that was not turned, moved in predictable patterns. The North Shore kept their combos on the North end of their trains and the terminals reflected or caused this commitment. The Pacific Electric was not adverse to putting their combos anywhere in the train. Coaches were either powered with two or four motor equipments or operated as trailers. Coaches intended for train service usually had train doors at both ends, occasionally were equipped as control trailers, and sometimes powered. The coach trailers of Indiana Public Service (300's) had train doors and solarium windows. The trailers of the Milwaukee Electric (1212-21) had only two steps diagonally opposite. Indiana Public



Cincinnati built Buffalo, Lockport & Rochester 500 series were intended for one or two car train service so had traindoor at one end only. 35 ton cars were too peppy with original 125hp motors and were regeared to lower 60mph balancing speed, from 80 mph.



Niles-built 302 came to the Rock Island Southern from the Washington, Baltimore & Annapolis and ran singly or with trailer on the Illinois carrier. AC powered line with pantograph pickup.

Service combos had no train doors, nor did the cars that ran with them in train service.

Control trailers which could be the first car of a train necessarily had pilots, whistles and other appropriate head end equipment. Examples include CNS&M 185-197. A real rarity was control trailer 1018 of Sacramento Northern that was a *combo*, and it was often run back-to-back with a similar combination motor on their Pittsburgh branch.

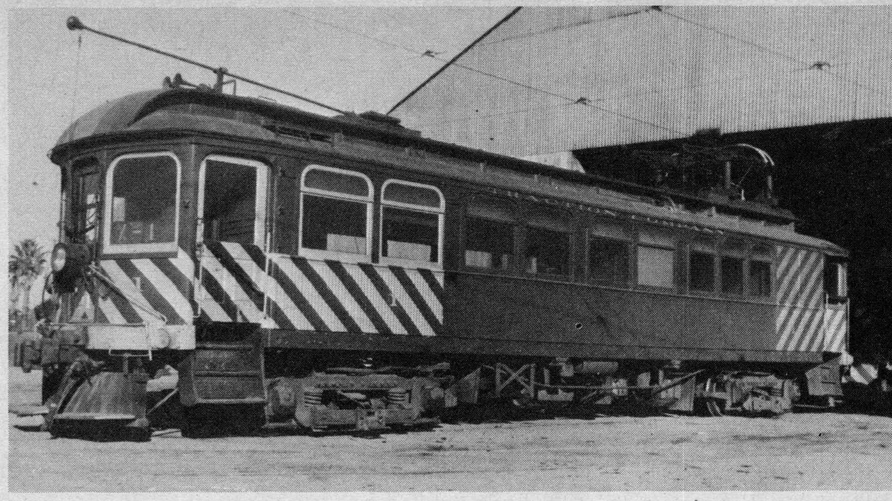
Interurbans occasionally tried diner, buffet-parlor, sleeper and observation cars. Diners of the North Shore were of both the control trailer and motorized variety. The buffet-parlor cars of Interstate Public Service were "half" motors (2-motors), designed to be the second car of a two car train, single ended, with solarium windows in the rear. Cars 100-2 of WCF&N were built as buffet-parlor-observation cars intended for use as the second car of a two-car train and equipped with four motors, trolley pole, a splendid observation platform, but no pilot. These cars were later made into combo-observation cars and equipped for operation alone or in train. These cars were particularly appealing products of McGuire-Cummings because of their generous proportions (ten foot width). Sleepers were tried by inois Terminal, Interstate Public Service and Oregon Electric as trailer cars.

Open observation cars were the *piece de resistance* of the steam road limited, and interurbans tried to imitate the luxury. Special operating conditions caused interesting details to be incorporated into construction. Four of the five observations of the CNS&M had pilots at both ends for backing moves. Sacramento Northern's Moraga was built as a double-ended observation with pilots, 4-motors, controls at both ends and pole and pantograph trolley. The lack of turning facilities in Sacramento and the long backing moves onto the Key Pier at Oakland required it. Later terminal changes allowed demotorization, and single end reconstruction, but pilots and backing controls were retained for pier moves. The Illinois Terminal had observation trailers as well as Salt Lake & Utah, FDDM&S, Oregon Electric and Inland Empire.

The *Bidwell* of Northern Electric and the *Sacramento* of Sacramento Northern had no steps or tailgate on the rear platform.

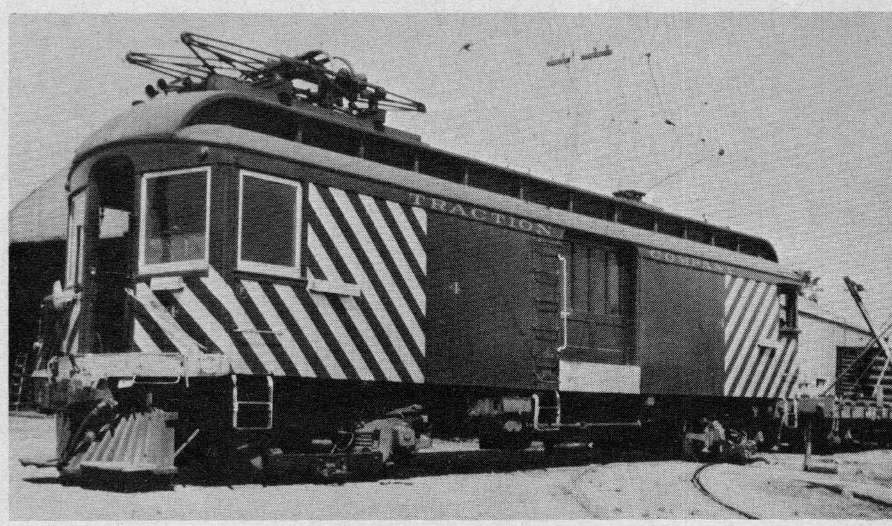
Equipment Usages

Train makeup was not simply a case of assembling and coupling cars. A one car train ran equally well in either direction. A motor and trailer operated well with the trailer following. In the opposite direction the trailer was given a definite shove by the motor car as each controller notch and the slack action is objectionable. A three car train consisting of a motor and two trailers operated well only with the motor leading.



50 ft. long American-built No. 1 of Central California Traction equipped with pole and pantograph, elevated to increase pressure on wire. Blanked out end windows marks baggage compartment.

Box motor No. 4 of Central California Traction was Holman product equipped with four 75 hp. motors, and used as loco in flat territory. Under-running third rail was first such 1200 volt installation. Pantograph was used for switching. Note visibility markings and shaded lights for night illumination of the husky wood body.

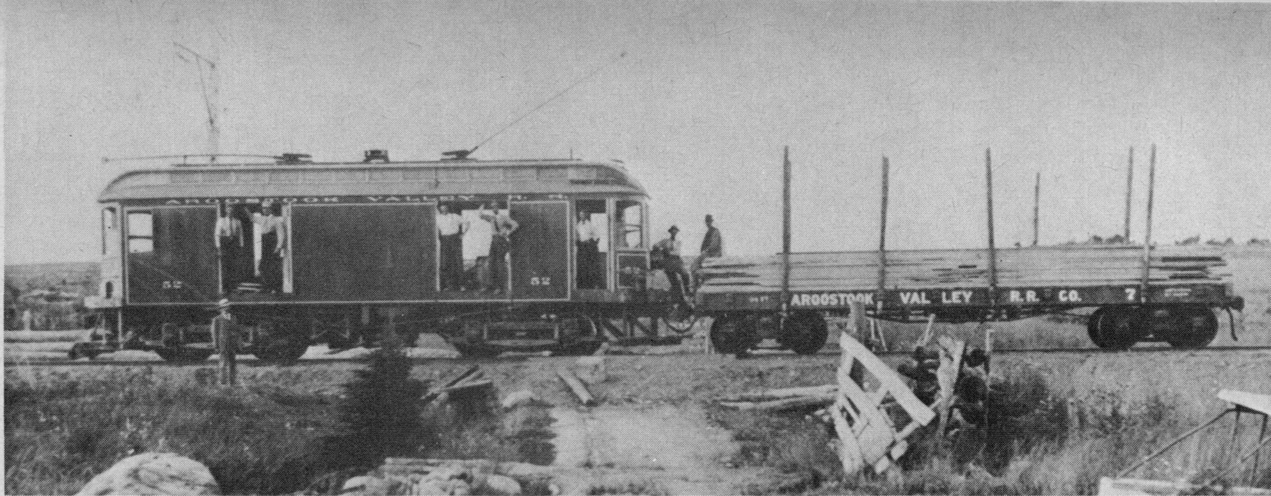


With the motor at the rear slack action was fierce and street car turns were a cause for prayerful transit. A three-car train of two motors and one trailer operated best as a motor-motor-trailer arrangement. When a reverse movement was necessary the compromise motor-trailer-motor consist prevailed. Even so the last motor was prone to leap and bunch slack. Of course, a three-car train of three motors operated well in either direction.

Incidentally the balancing speed of a three car train of identical motor cars is greater than the balancing speed of a single motor car. This is because the wind resistance *per car* is less in train than single. A train of cars has only one head and one rear end. The intermediate ends are sheltered and the effect on speed is observable. If a single car has a balancing speed of 70 mph a train of four motor cars will balance at over 80 mph. Long trains that tend to be too lively on schedules that can be kept by single cars are "diluted" with a trailer without affecting schedule keeping capacity of the consist. (Trains of RDC's are diluted with RDC-9's, which have only one engine, without impairment of schedule keeping ability, yet consuming less energy).

On a four-car train a single trailer operates best at the rear of the consist. When the consists runs in both directions, the trailer is buried in the train. A four car train with two trailers operates best as a motor-motor-trailer consist. Double ended operations require trailers-in-the-middle and slack action is bad. Sacramento Northern's school train of motor - trailer - trailer - trailer - motor consist was not only poorly powered for grades, but uncomfortable riding.

From the above consideration, and others, we can appreciate that initial decisions had to be made by operat-



Aroostook Valley Brill-built box motor No. 52 was a light 32 ft. car with hexagonal ends; shown with flat car 7, engaged in opening the line. After steeplecabs arrived, 52 was assigned to local freight.

ing companies when equipment was being ordered. The easy answer in stub terminal operations is every car powered, but this is expensive and particularly hard on power supply. If terminal operations permitted, the one-way operation of multi-car trains was the preferred method.

Train makeup, even with all motor cars, was not like shuffling cards. The CNS&M kept its combos on the North end, baggage compartment North. The Lehigh Valley Transit in two-man days ran combos back-to-back in two car trains. In three car trains the combos were run forward-backward-backward. This put the steps of the first two cars together and the third car was loaded for terminal to terminal traffic (little use of the third trap). This train had baggage compartments protecting both ends of the consist. The train, while technically double ended, was turned at the outer terminal in an interesting fashion so that the former head end combo was looped around the unlooped remainder of the consist and became the new head end car with baggage compartment forward. The returning consist again presented a forward-backward-backward attitude while running.

In one-man days a different makeup policy was used. Northern Indiana ran two car combo trains back-to-back even though there was no train door because the couplers were only on the rear ends of the cars. Train door equipment in multiple were operated with all revenue compartments in communication by train doors. A famous photo of an IPS combo-express trailer-parlor buffet can be suspected of being a publicity pose on the grounds of improbable makeup (trailer in the middle of a one-way train, and passenger compartment not in communication) or one passenger compartment is out of service (a deadhead move).

Train Control

Interurban signalling ran the gamut from none, through manual block, to continuous track circuit signals of steam road type (although differing considerably in detail). The usual interurban line was single-tracked and relatively short. Although the road might have many passing sidings for freight train runarounds and meeting extra trains, the timetable schedule often revealed a single meeting point for regular passenger trains, approximately midway between the terminals. Dispatching and train control were simple and the central substation operator could provide protection for scheduled trains.

Interurbans, in order to compete with parallel steam roads, had to provide their physical plant at a fraction of the typical railroad cost per mile of track. Everything; track, bridges, signals and grading showed this economic consideration. Their low cost engineering answers were often clever.

A single-track steam road usually had many miles between passing sidings and several block signals between the sidings. Thus, when a steam train entered single-track, all opposing signals to the next siding showed red and those serving the train indicated red, yellow or green as required by track occupancy. Thus it was possible to follow a steam train into single track at an interval governed by block signal indications. The electrics liked this capability of trains moving in the same direction occupying single-track. However, the shorter distance between sidings and the leaner economics suggested a single signal advising of the condition of *all* single track between sidings, and displaying an absolute-permissive indication, i.e., indicating absolute stop to an opposing train and a permissive entry with appropriate caution to a following train. With Nachod signals a clear block was simply an extinguished light (not a fail-safe system). An occupied block with opposing movement showed a red light (absolute stop) in front of the train on single track and a white light (permissive entry) behind the train. This complicated signal circuitry since the system must sense train direction.

If the first train to enter single-track, giving an absolute stop indication to an opposing train at the next passing siding, is followed by a second section, how do you prevent the first section arriving at the meeting point from clearing the absolute stop indication? Early in interurban history continuous track occupancy circuits were not possible. It was necessary for the signal system to *count* the trains into a block and not clearing a block until it had counted the same number out. Before the development of continuous a-c signalling, the rails could not be used for signal circuits since they were both continuous for traction current return. The signals were actuated by trolled wire switches which noted the passing of a trolley pole (sensed number and direction). It was necessary for a block circuit to count poles into and out of a block in order to establish and clear a red signal. If a train entered a block with three poles on the wire then it had to leave with three poles on the wire or the signal would not clear. Thus a single line car could enter single track, work and return to place of entry and clear signals it actuated. (A work extra is protected by train order and flag, so the permissive indication in one direction was not an open invitation to disaster.) There were other novel features in the intermittent action traction signals as marketed by Nachod, Ward and U.S. that warrant further investigation.

The wandering West Penn (Penna.) used motorman - actuated manual block signals, circuited not unlike the domestic hall light-switch. The Buffalo, Lockport & Rochester operated without the benefit of signals. Part of the Indiana Railroad used two color light block signals and the North Shore used three color signals.

Dispatching ran the gamut from informality to railroad rulebook. The electric lines pioneered telephone dispatching in contrast to the then universal telegraphic method. The dispatcher talked directly to train crews rather than to station agents. Railroad rules, 19 and 31 train orders, train register stations, and clearance cards figures in many operations.

Typically, the interurban companies used 600 volts direct current, generated by the company, transmitted as high voltage a-c to substations wherein it was converted to 600 volts d-c and fed to the trolley wire and auxiliary feeder. Substation spacing varied with traffic and economics, but a ten mile figure represents a reasonable spacing interval. A thirty mile line might have three substations, spaced at the 5-15-25 mile points; each serving ten miles of track, five in each direction, each sized to power two trains in its territory.

Power collection was by pole trolley from a single suspension overhead held by single bracket poles which also carried the a-c transmission lines, auxiliary feeders and communication lines. It is true that some lines used pantograph or third rail power commutation (there were even a few original installations of bow trolley) or combinations of pole, pantograph and third rail. Lines that were predominantly third rail included Scioto Valley (Ohio), Northern Electric (Calif.), Philadelphia & Western (Penna.), Lackawanna & Wyoming Valley (Penna.) and the Chicago, Aurora & Elgin (Ill.). Pantograph power collection was used on lines such as the a-c Napa Valley (Calif.), the a-c Visalia Electric (Calif.), the d-c Portland, Eugene & Eastern (Ore.), and the a-c, d-c Denver & Interurban (Colo.). The Sacramento Northern and the Hudson Valley (N.Y.) used all three.

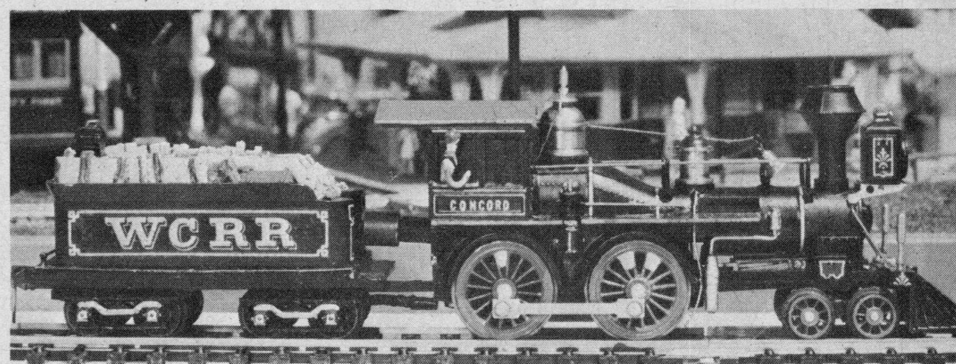
Some roads, operating more than one motor car per train but less than four, collected traction current from a single trolley pole raised on the lead car, and used a power bus running thru the train to distribute traction current to the rest of the train. The Sacramento Northern, the Chicago, Aurora & Elgin and the Milwaukee Electric made this connection at the roof. The Hershey of Cuba used ingenious trolley pole bus connection for 1200 volt d-c. This is something that some modelers may wish to investigate further. The Indiana Railroad lightweights (50-84) made this connection thru the coupler. A train bus can cause problems in third rail territory where there are long breaks in the third rail or a suddenly encountered dead section. A train of five motor cars on third rail (with a continuous power bus) upon entering dead third rail will have the last car pick up all power for the train, and the bus at that end of the train attempting to carry traction current for 16 to 20 motors. This overloads the bus and the danger of fire or ground is present. Also a load of unknown size could be energized by train bus. The CA&E, which used this system and operated trains up to eight cars, had power signals alerting the motorman to shut off before entering a dead section.

Interurbans operating long trains of motor cars did not use the bus and allowed each car to collect its own power. The loss of a pole meant a dead motor in the train.

A Hinkley by Default

by Bruce C. Bowden

Tyco's General locomotive becomes an inside connected Hinkley with a few evenings labor, creating a rarely modeled type of steam locomotive.



The author's Concord, an inside-connected 4-4-0 was built from a Tyco General. Changes were made in the stack, pilot truck, and cylinders. Loco is painted shiny green, red.

NUMEROUS photos and articles have appeared on these pages on modifying the famous Mantua (Tyco) "General". Here's a novel variation that resulted quite by accident.

The little lady, in keeping with early tradition, is named the "Concord" and is somewhat remiscent of the first Hinkley locomotives. Unlike many locos today she is all decked out in red and green livery. The domes and bell are highly polished and she's appropriately trimmed in silver and gold. The WCRR is the herald of the author's Weston Central, often referred to as the "Water Closet" line by his closer friends.

The original locomotive was acquired in a trade some years ago. She was plastered with a heavy coat of enamel and pretty beat up. After disassembly and once around with the paint remover I discovered that some of the zamac castings were on the verge of disintergration. This was typical of much of the zamac made shortly after the war. Too much zinc or something. The tender shell crumbled completely, but fortunately I was able to obtain a replacement casting from Mantua. To alter the appearance a new headlamp, smokestack, and bell had been ordered from Kemtron. Now with everything cleaned up and the parts ready to go back together the cylinder block suddenly went the way of the tender casting.

I have quite a sizable photo collection and among my favorites are several views of the little slim-waisted inside-connected Hinkley locomotives . . . this gave me an idea! I salvaged the saddle from the cylinder block casting and filed it flush with the sides of the main frame. Then I drilled and filed two channels in the main frame approxomately $1\frac{1}{8}$" long by $\frac{1}{8}$" wide in which were set the crossheads and side rods. These can be seen in the photograph just below the boiler. Two $\frac{1}{4}$" brass half circles were fixed to the front of the saddle just above the main frame to simulate two side by side cylinder heads.

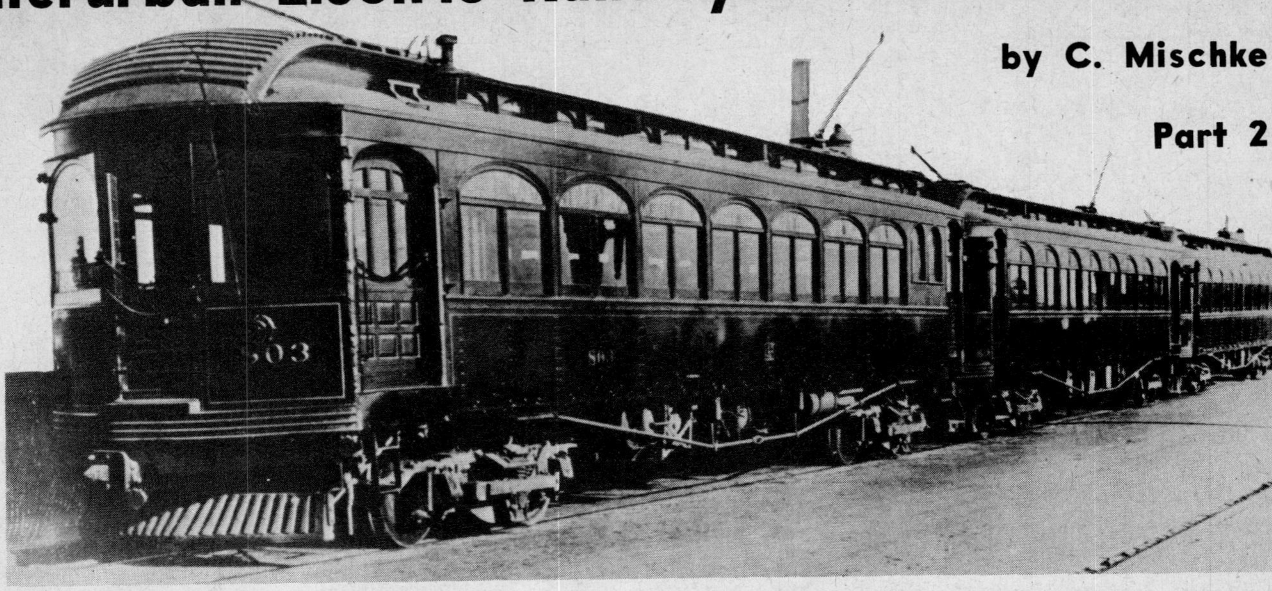
The remainder of the model was both natural and easy. Obviously what with no external cylinders there was no reason for the long wheelbase pilot truck. A new groove was filed in the original pilot truck frame and the excess length removed with a razor saw. The main frame directly behind the cow-catcher was similarly shortened with a saw. A little bit of paint, some patient decal work and you see the results above.

A short side story here. Seems as though everyone these days bent on realism insist that his locomotives be weathered. Grimy black, smoky soot, and greasy grey are names of the times. Not so for the author though, he finishes his fleet to look just like the day they rolled out of the shops. His techinque and still common among many rails is to apply a light coat of high grade dull varnish to all but the smokebox and stack. The advantages are that excessive handling will not affect the paint job and where decals are used it reduced the sheen and adheres them permanently.

Interurban Electric Railways

by C. Mischke

Part 2



Jewett-built Lehigh Valley Transit combo's nos. 803-804-805 in MU on Allentown bridge. Note how steps of first two cars abut for crew convenience. Baggage compartments protect both ends of the train. All poles are on wire in absence of train bus. Third rail shoes were used on final leg of journey over P&W into Philadelphia.

The interurban railroad is perhaps more accurately modeled than any other form of scale model railroad.

TASTE IN prototype and taste in operational interest (train watcher, train operator, or train dispatcher) to a large extent control the big picture in planning a model traction line of durable interest to you. However, prototype practices and common sense shape more of the model than is immediately apparent. The salient feature of any railroad is the L/W ratio; i.e., the ratio of its length to its width. This number is very high since the width of rights-of-way ran from 66 to 100 feet and the length from 20 miles or more. The caricature cartoonist obtains immediate recognition from his audience from the display and exaggeration of one or more unique or dominant features. So, too, the modeler seeks to do this. The L/W ratio is a dominate feature of all railroads and the use of along the wall shelf layouts is to be preferred to a ping pong table of the same area. In fact, catering to the L/W feature is the best way of obscuring the necessary shortness of any model main line. Also for this reason it is much more convincing to model a short line than a long one. A hundred feet of route can be a far more convincing imitation of a suburban spur than an intercity line.

Consider the features that would be observable in a model of a 30 mile rural interurban, circa 1910. The basic schedule is opposing 90 minute service, single car trains prevail, with occasional multiple unit consists and peak extras. Freight traffic is largely LCL handled in a box motor and a few tailers. Occasional interchange freight cars are moved to and from the interchange point. Almost all of this traffic is inbound, with empties returning to the steam roads.

The meeting point for regular passenger trains is in the temporal center of the route, i.e., at the *running time* midpoint. Considerable street running at one end of the line can move the meeting point from milepost 15 to milepost 12. The Terre Haute & Western (Indiana) connected Terre Haute with Paris, 21 miles away. Because of Terre Haute street running the opposing trains met at milepost 6:51 from Terre Haute.

The passing point is established midway in time along with the central substation. Street running enroute makes for bad schedule precision and delays at the meeting point. This exasperates a dispatcher (to say nothing of the passengers). The Puget Sound Electric Railway solved this problem on their 36.5 mile Seattle-Tacoma line by making the central passing siding *three* miles long, permitting non-stop meets with several minutes tolerance. For operating interest at least two additional passing tracks are needed in addition to terminal runaround facilities. If these are provided, opposing passenger trains and a way freight can be on the line simultaneously.

One should provide as many of the typical interurban features as space and ambition permit. If you are modeling a definite line (and this *is* the preferred situation) its features are condensed, compressed and incorporated to the extent that is possible. Typically, there would be some street running with twists and turns, some side of the road and private cross-country traveling, with the private r-o-w dominating. You will have curves (banked and unbanked), breaks in grade, steam road crossings at grade and overpass, some economical and spidery bridges, cuts and fills with ups and downs to mitigate initial costs. Stub terminals have their charms too, for it gives the most emphatic sense of going from here to there. The pole changing adds realism to the operations.

One should avoid the bowl of spaghetti layouts of model railroaders, since electric lines did not dominate the landscape. In cites, crossing and recrossing can be explained away as intersecting street car lines. Sharper curves are prototypical but they tend to justify usual model railroad standards rather than allowing hairpin turns. The sharpest curve in the Utah Idaho Central was 150 feet and the sharpest switches were #4, comparing favorably with NMRA *railroad* minimums. The CNS&M traversed 90 foot radius curves on the Chicago elevated line, which is about as sharp as you want to go with multiple unit trains.

Operating highlights can include closing up of train sections at meeting points, and close following of the interurban behind the local street car. If freight operation fascinates you, modeling a remnant of an interurban such as the now freight-only Southern Industrial Railway (ex Southern Iowa) has potential. Before the Centerville (Iowa) power house closed down, the railroad used to trundle as much as twenty hoppers from on-line mines to the Centerville power plant, and interchange hoppers and other freight cars at the present extremes of Centerville, Moravia and Trask. Two box motors and one Baldwin-Westinghouse steeple cab locomotive of 1917 vintage perform the chores. Then on-line Iowa Railway Historical Museum operates CA&E

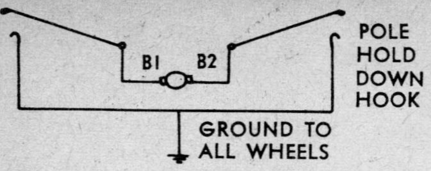


FIG. 1—Commonly used pole reverse wiring of interurban models and city street cars.

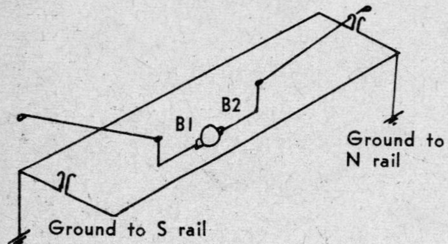


FIG. 2—Modification of common pole reverse wiring to allow any model car response to either N-rail rheostat or S-rail rheostat.

320, CNS&M 727 and WCF&N 100 on weekend excursions to add further occasional passenger interest.

Those modeling larger lines can include operational highlights such as shifting from overhead wire to third rail enroute, the dropping or adding of cars enroute as traffic requires, or the splitting of trains into fragments for various terminals (ala CA&E at Wheaton or Michigan Railway at Monteith).

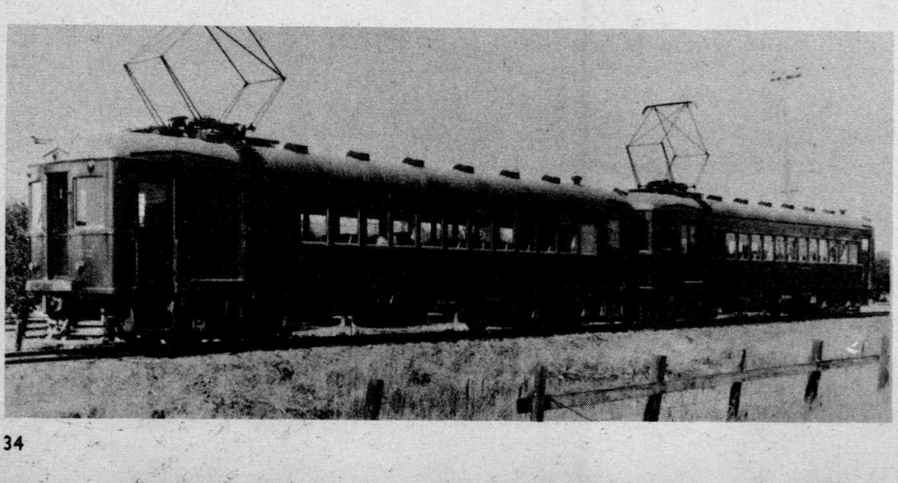
The most impressive feature of model traction lines is the traffic density. It is sufficiently greater than usual model railroad situations (just as in the comparison of protype traction and steam roads) to merit investigation. A model traction motorman can have enough demanding his attention that he cannot afford to engage in playing the toggle switch concerto of ordinary layout operators for two reasons. First, the traffic density and movements he wants to duplicate introduce very complicated control panels, and second, his operating cohorts are likely to be strangers to his railroad. This problem is neatly solved by taking advantage of the fact that a model traction line has three electrical conductors (the wire and two rails) and usually uses permanent magnet field motors wherein the polarity reverse is seldom used, and the pole reverse is more common. Separation of the running rails allows independent control of *two* trains, and elimination of the redundant reversing schemes allows *four* trains to be independently controlled in a block. This brings us naturally to the consideration of controls.

The most common wiring for interurban models is the familiar pole-reverse scheme depicted in Figure 1. Each pole base is insulated from the car body and connected to a brush of the permag motor. Each pole hold-down hook is connected to the grounded wheels. This system automatically directs the car in the appropriate direction for the raised pole. Two wasted control opportunities are present. One is the chance to ground only to one running rail and the other is the failure to exploit the permanent magnet field (model interurban cars are rarely backed against the pole).

The first possible modification is the provision of two holddown hooks one each end of the car (placed back-to-back to imitate some double-sided prototype hooks). The circuit sketched in Figure 2 allows the operator to place the down pole under the hold-down hook appropriate to the control rail desired. If two cabs are provided and each connected to one running rail and the overhead wire, then *any* car can be made to respond to either cab by selecting the corresponding holddown hook for the down pole.

Most model interurban lines would appreciate the opportunity to keep more than two consists active simultaneously with worrying about block toggles. This is possible with a selective rectification scheme successfully used by some Michigan clubs. Figure 3 and 4 show the control cab and the individual car wiring. The key to the system is the use of rectifiers in the cabs and in the individual cars, and the single transformer. In Figure 3 consider the situation wherein all controllers are off except rheostat A. This allows pulse power (forward pulse) to reach the left rail. Cars A and B are the only ones that could be affected by the open rheostat controller A. However, car B has a recti-

St. Louis built combines 62 and 63 of the San Francisco, Napa & Calistoga Railway, reputedly the last standard steel interurbans built in U. S. Intended for single or MU service, cars typically ran with RPO trailer. Cars approached mainline railroad design.



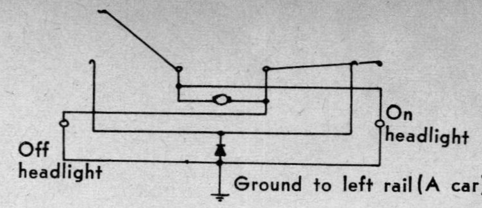


FIG. 4—Pole reverse wiring for an interurban.

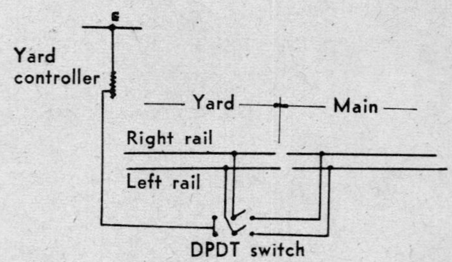


FIG. 5—Wiring of yard for yard or mainline.

fier which is opposed to the forward pulse, and so only car A responds to controller A. Any and all possible positions of the controller A, B, C, and D, results in corresponding obedience, letter for letter in cars A, B, C, and D. Thus we have independent four car control in a single block. In effect, a simple interurban model layout can be a single block railroad in that a car will respond to its controller only, anywhere on the line.

Examine the individual car circuit depicted in Figure 4 which is for a double-ended car, and of specie A. When either pole is on the wire the car will move in the appropriate direction but only in response to controller A. Now here is an interesting observation. If this A car which is now left rail grounded is picked up and replaced on the track en-for-ended it becomes a specie C car. This opens the door to interesting operations for double-ended equipment layouts and introduces a complication for single-ended equipment operating on a line with loop (or wye) terminals. However, if either railroad (three color) signals or Nachod signals are contemplated, the polarity control and signal circuits use the same relays, and allows up to three following movements with independent control.

For simplicity and clarity examine the point-to-point stub terminal line. Cars wired in accordance with diagram of Figure 4 have headlights which are unrectified. This means that the headlight will be lighted on the A car if controller A is on, or if controller B is on, or if both controller A and B are on. This means that on station stops or meeting points the headlight of a waiting A car will stay on if the B car is moving. What can be said of headlights is true of interior lights if dual lighting is provided. Note also that the poles control the lighting of the appropriate headlight. If no B car is running there is nothing to prevent the A motorman from cracking the B controller (no B car poles up) and assuring himself of continuous headlights and interior lights.

If enough switching occurs at a

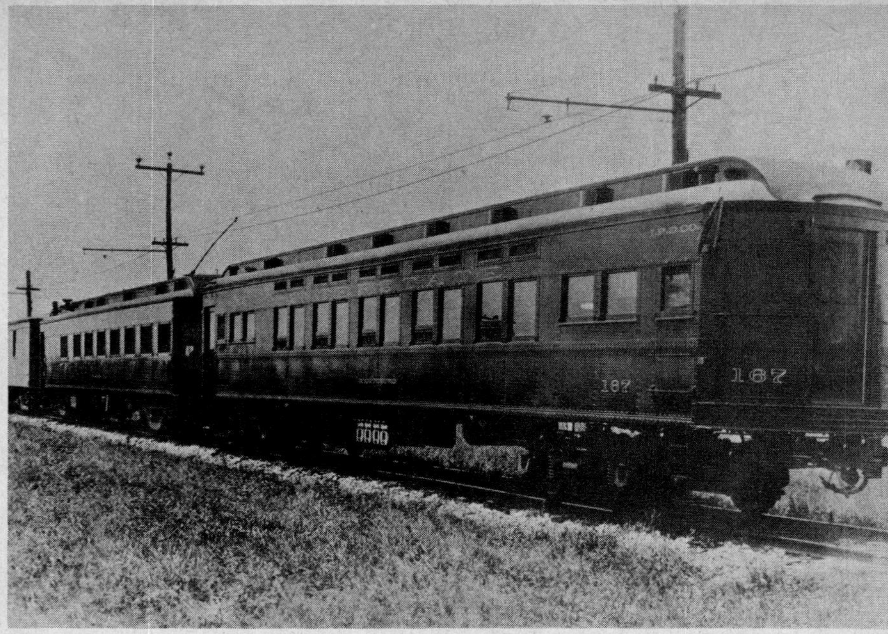
terminal involving passenger equipment, it may be useful to establish a yard limit and introduce a yard control and its attendant yard motorman. Figure 5 shows that this is simplicity in itself. In the yard the rails are tied together and unrectified a-c is supplied to the wire and common rails by the yard controller. Under these circumstances *any* car with its pole up within yard limits will move and respond to the yardmaster's controller. The identity of the cars need not concern the yardmaster in general switching moves *in his control*. For example, if he must assemble a two car A train on track one, he identifies the two A cars in the yard that he wants to use in the consist. He moves them or other cars without concern for identity and solves his switching problem by raising poles on cars he wants to move and lowering them on cars he wants to stay dead. After the consist is properly located and ready for the road, he flips his single toggle which unties the rails from each other and connects them to the main, establishing the A, B, C, and D, car control within yard limits, and the main line A motorman can leave the terminal independent of arriving trains of other identity. As soon as a train is annulled by arrival at the terminal, the toggle is flipped again to establish yard limits and universal hostler control. Refinements are of course possible which give the hostler yard limit controls of any or all combinations, but only in the busiest of terminals would this be needed.

Having established the idea of a single block main line and the notion of yard limits in selective rectification context, it might be useful to examine how these tools may be applied to protraying interesting operations. A toggle introduced in controller A to bypass the rectifier, when closed will allow the A controller to operate both A and B cars simultaneously. In effect an A and B car can be run m-u from the A controller. This capability would be useful when trying to imitate the dividing of a train during its run for two separate destinations, as was done by the Michigan Railway at Montieth. The A motorman makes the run from the terminal of origin to the branching point. The B motorman makes the branch run while the A motorman continues with the forward part of the consist. The division can be automated as follows. With the A cars leading, the train is stopped with appropriate coupler over a Kadee Electromagnetic ramp, and A cab opens shorting toggle. As the ramp is energized by the B motorman, he moves his part of the consist forward to bunch slack and stops. The A motorman departs with his section of the train and breaks the coupling. The B consist can depart as soon as necessary switches are lined.

When the separate consists return the makeup is accomplished simply by running the rear cut into the automatic coupling. This maneuver is predicated on use of Kadee Magnamatics (or CLW automatic couplers in O scale), which has implications in minimum radii and straightness of coupling and uncoupling locations. The station at which train division occurs can be the focal point of the railroad and opposing movements meeting at the junction point can result in impressive conjestion and flexible operation with no electrical blocking of track. The opposing passenger movements are obviously A-B and C-D combinations.

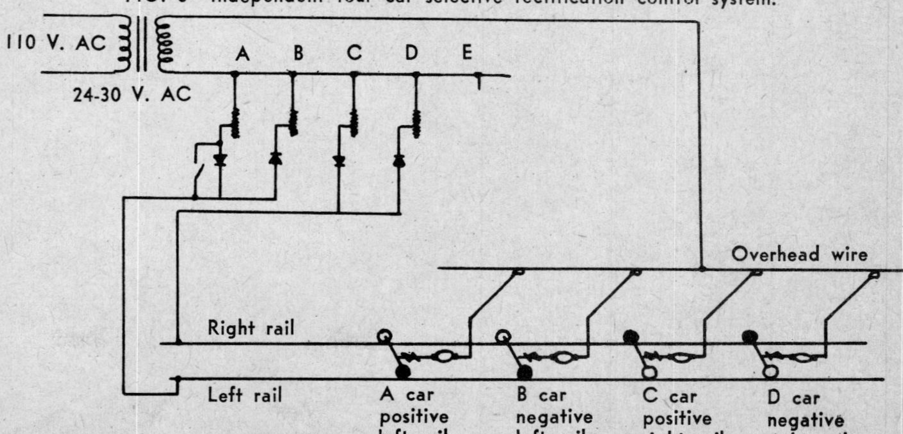
The assignment of all cabs to passenger operation in rush hours does not preclude the operation of freight in off hours consonant with the availability of all passenger equipment. The technique is to use all cabs for passenger movements in rush periods and use of A, B, C, and D passenger cars as required with up to four trains on the main simultaneously. As rush hour subsides and the road becomes available for general transportation, the C equipment is looped into A identity and the D equipment is looped into B identity. The freight motive power (which is C and D specie) can now move on the main, the name passenger trains made up of A and B cars (which include all passenger cars at this time).

Freight operations can be carried out with pole reversing if desired or preferred, using d-c on right rail and overhead. This eliminates two cabs during freight switching operations in which polarity reverse is used. The freight motive power used must have its car rectifier shorted out by the bypass switch. If it is a C car it will move forward in response to C cab and reverse in response to D cab. A pantograph can be used. The blending of a-c and d-c equipment is dangerous however, because an a-c car will run on d-c, but a d-c car will have its motor ruined by the a-c. For your own circumstance design a failsafe interlocking system to protect your equipment.



Combo 155, express trailer 477, unknown parlor buffet car, and trailer sleeper 167 of Interstate Public Service, arranged for good riding and tracking as single ended consist. Inclusion of express unit in train center would be unusual, perhaps accounted for by equipment shortage at other end of line or a special.

FIG. 3—Independent four car selective rectification control system.

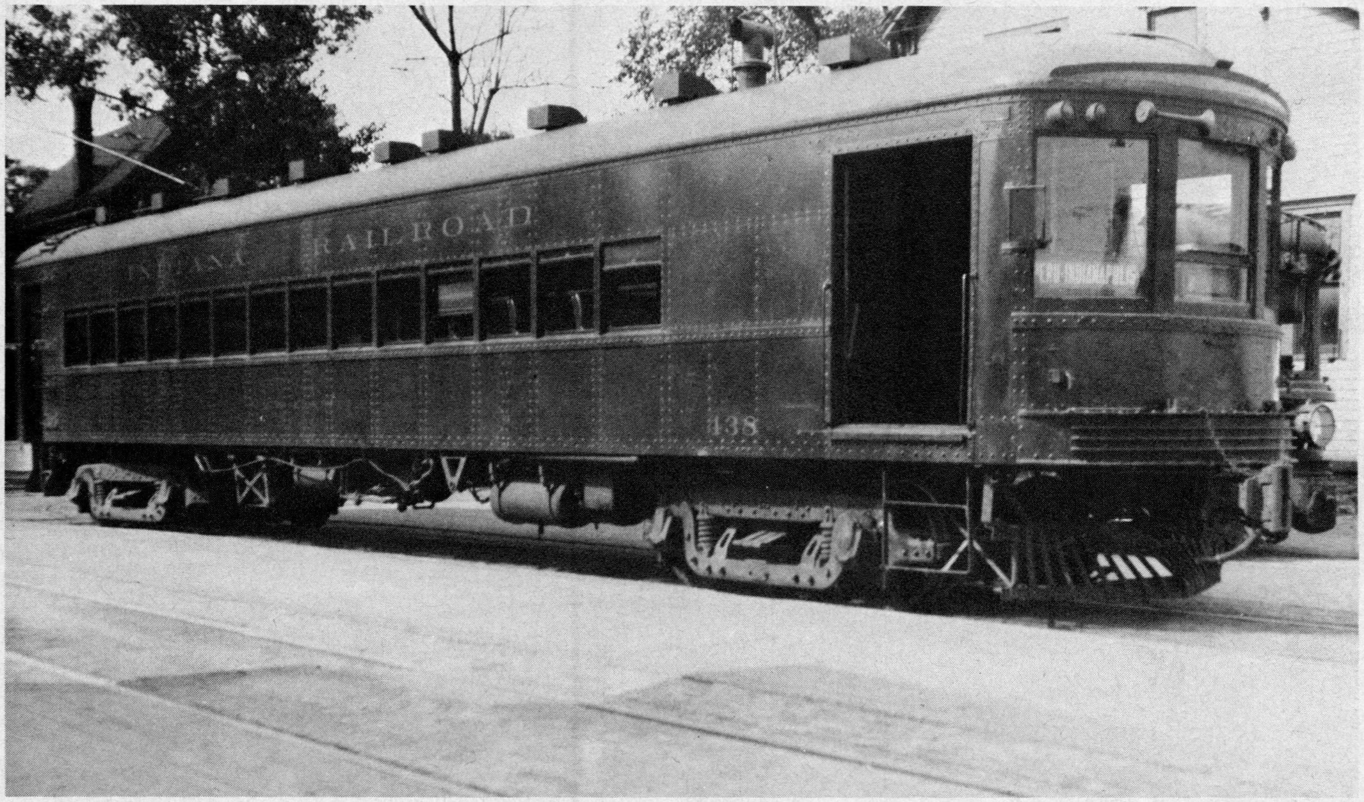


Interurban Electric Railways

Model interurbans have peculiar operating idiosyncrasies of their own, different from 2-rail model railroading, which can in most cases be turned into special benefits.

Part III

by C. Mischke



Indiana Railroad No. 430, ex-Union Traction, one of 15 St. Louis built steel combines equipped for multiple unit operation. Four 125 hp. traction motors permitted running with trailers. Deep knuckles were required for breaks in grade, keeping train together. Car is named "New Castle", was photographed at Ft. Wayne and almost completely obscures IRR lightweight car in back.

THE dynamic characteristics of miniature trains with one or more powered cars differs from prototype performance. In scaling down dimensions, matters of friction and inertia are not diminished in the same proportion. Additional complications are introduced by the manner of drive and the crudeness (relatively) of bearings, bolsters and couplers.

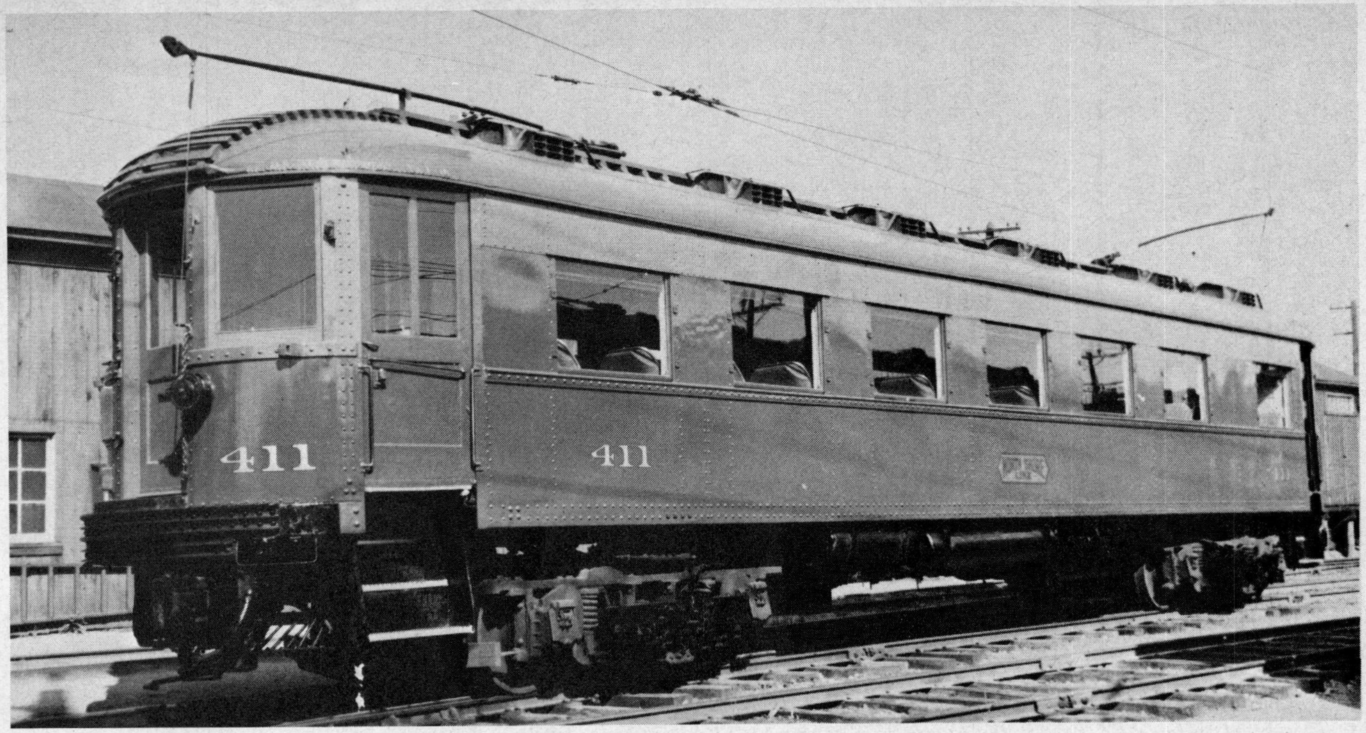
A model traction car is usually powered with one truck and, therefore, does not track equally well in both directions. The difference in performance with power truck leading and following is observable. This difference can be reduced by weighting the unpowered end of the car, particularly within the truck itself, as is done by Andeco power trucks in HO gauge.

A single car can have different speeds in each direction. This is usually corrected by moving brushes to the electrical neutral. Assuming that your power cars perform equally well in both directions and all power cars have about the same speeds at corresponding voltages, the problems of running model cars in trains should be examined.

Model trolleys are powered almost universally by a worm-gear drive and therefore will not coast, nor can they be pulled by others when the motor is not turning without skidding the wheels. Thus, when two model power cars are run in train, any disturbance that interferes with current supply can stop the train with one dead motor and one with the wheels spinning in vain. As annoying as this might be, it is fail-safe, i.e., you cannot flat a wheel on the dead car. Brass wheels flatten easily.

There are three weak points in the current path through a model traction car which require attention for satisfactory operation. These are the rail-wheel contact point, the holddown hook-pole contact point and the wire-pole contact point. The wire pole contact point tends to be self cleaning and nickel silver slider on nickel silver wire works well. Trolley men obtain satisfaction here. The holddown hook-pole contact is one that is subject to oxidation and vibration. Dirt and oxidation are minimized by staying out of the iron-steel family for both the pole material and the holddown hook material. The subtle enemy is vibration. I remember well two identical O gauge box motors that ran well seperately, but when coupled together ran poorly. The small variations in speed due to body vibration on the downpole wasn't too noticeable in single car operation, but when coupled together they added body jolts due to coupler slack action and the pair simply wasn't satisfactory. The rail-wheel contact is the same problem faced by two railers. The trolley man is better off because he has more pickup wheels.

The fact that the trolleys do noticeably better on dirty track than two rail cars is the clue to the solution to multiple car operation. Engineers faced with building a system whose



ABOVE: North Shore 411, built in 1923 by Cincinnati as an observation control trailer, was rebuilt in 1943 as a two motor coach, because of wartime traffic loads Colors, red and green.

BELOW: Waterloo, Cedar-Falls & Northern 101 was a full railroad-width 10'4" wide, and with four 125 hp. motors, was peppy. Car was built as parlor-buffet obs., later rebuilt with bagg. compt.

reliability must exceed that of components available, sometimes can resort to redundancy to meet specifications. If a rail-wheel contact is 90% reliable, i.e., completes a circuit satisfactorily 90% of the time, then two wheels in parallel to the same rail will exhibit 99% reliability, and four wheels in parallel exhibit 99.99% reliability. We have in the traction car itself (wired for selective rectification) four rail-wheel contacts in parallel, more than a two railer has on a diesel unit.

In a multicar train redundancy in the holddown hook-pole contact (the weakest link) and the wire-pole contact can be provided with a two wire train line which connects the cars. These two conductors place the motor brushes in parallel, and, in so doing, place (1) the poles in parallel and (2) the holddown hook-pole contacts in parallel, greatly increasing reliability. Thus a multicar train with active train line will operate if any one pole is contacting the wire well, if any holddown hook-pole contact is good, and any rail-wheel contact on each car is good. The important element is the paralleling of the holddown hook-pole contact.

If multicar trains are to be switched and consists adjusted, then it is necessary that trainline jumpers be detachable in a simple, convenient and reliable form. The smaller the scale the more important it is to have the connections above the anticlimber and, if possible, on the roof. The receptacle can be 1/16" diameter brass tubing, which, if over a half inch long, will make good contact with a slightly curved phosphor bronze wire as shown in figure 6. For semi-permanent jumper connections the scheme depicted in figure 7 is used by Fred Gibson in HO gauge.

A three motor model train, even with train wires, requires the motormans attention because a dead (wheels locked) car can be skidded by the two active motors. But this is merely paying attention to duty.

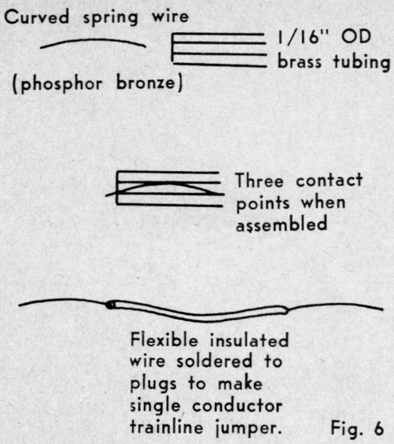


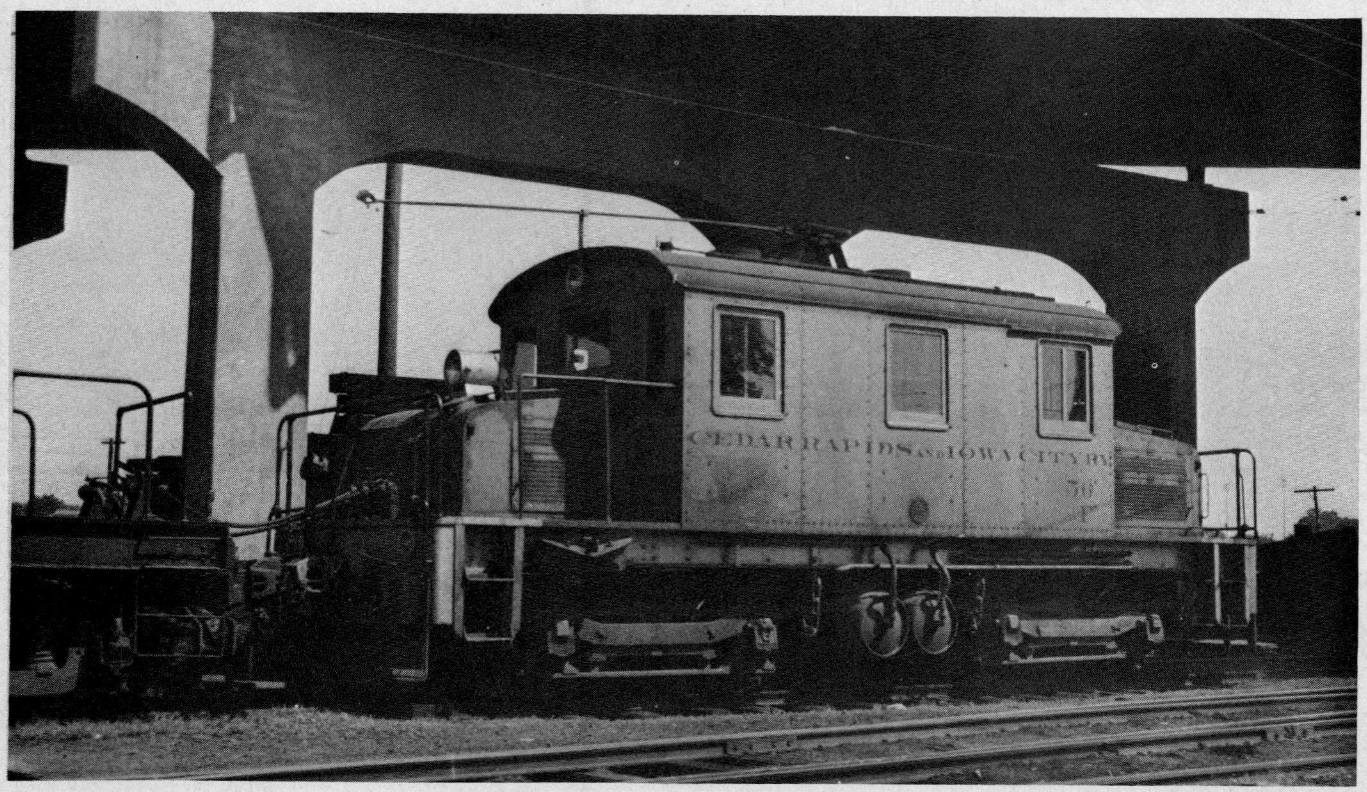
Fig. 6

Is the trainline really essential? The trainline becomes essential only when the holddown hook-pole contact has insufficient reliability. Harry Darst's beautiful HO Lake Shore Electric runs two selective rectification cars in multiple, flawlessly, without train wires. These cars are single ended with no second pole. Thus the wire-pole contact and the rail-wheel contact is sufficiently reliable for multiple unit operation without train wires. In double ended equipment, train wires can be avoided by bringing the holddown hook-pole contact to similar level of reliability. The convenience of avoiding train wires is worth a little extra care in making the holddown hook-pole contact a reliable electric switch. There is a motto that is good advice to all model railroaders. *"If you don't have time to do it right in the first place, where will you ever find the time to maintain it?"*

Loops, Signals and Track Polarity Control

Selective rectification circuiting is simplicity itself when applied to double-ended equipment operating on a point-to-point system. Even the occasion looping or wying to change the

Baldwin-Westinghouse built CR&IC No. 56 was typical of many such units on interurban and electric freight lines throughout U.S. and Canada. Design gave good visibility to crew during switching movements. There have been many models of similar locomotives.



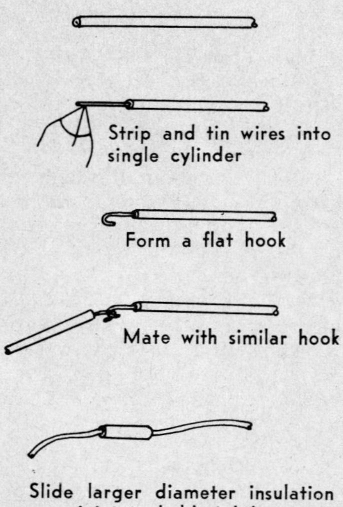


Fig. 7

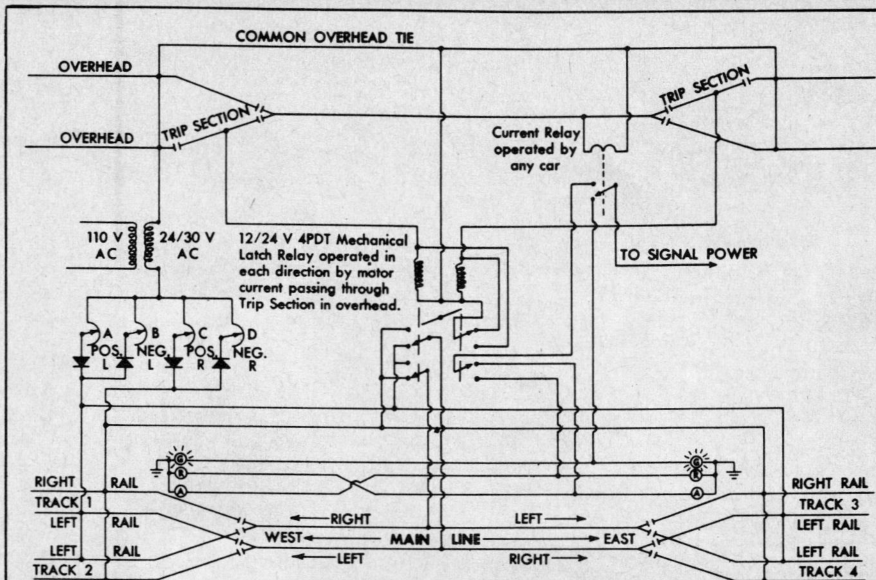
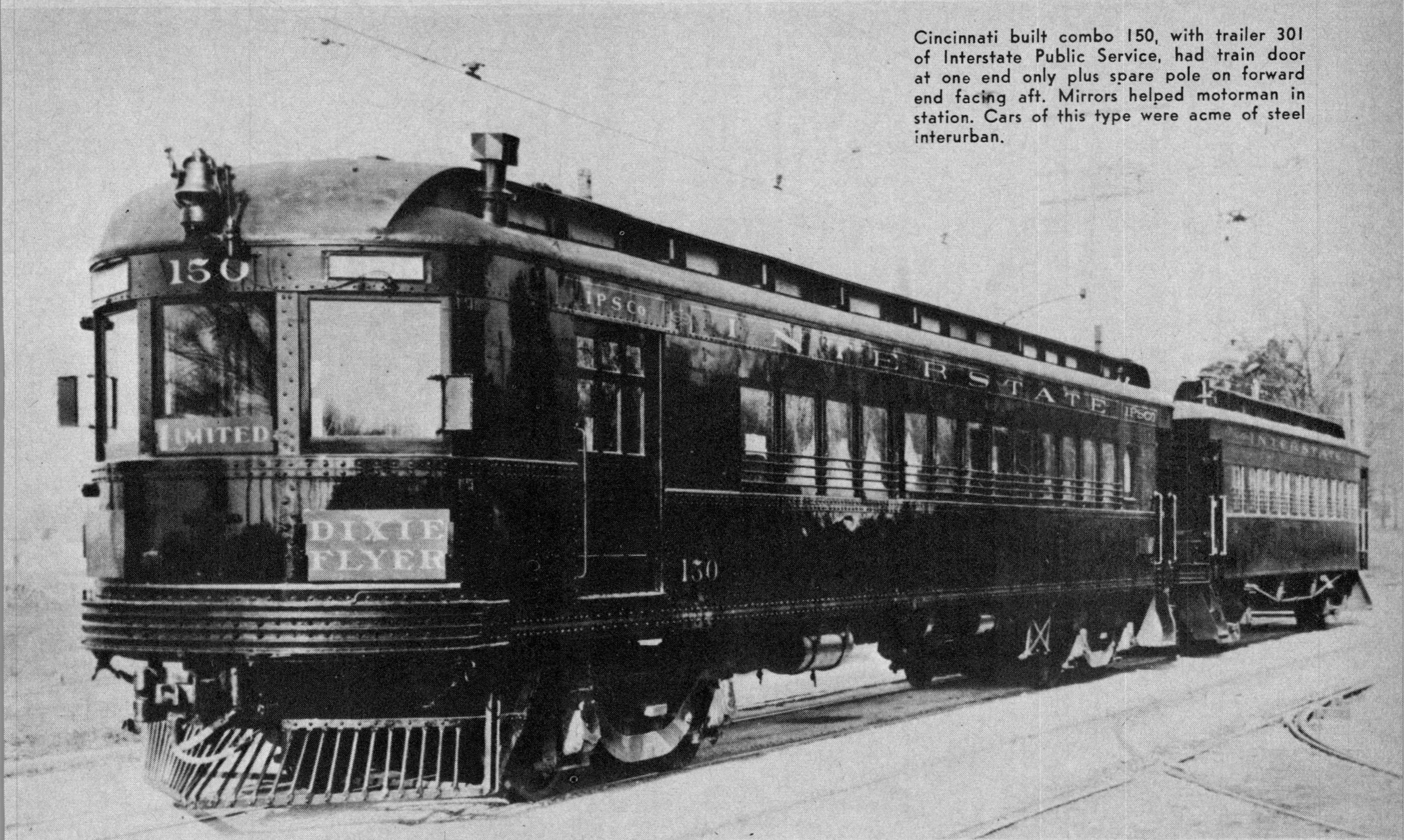


Fig. 8 Wiring diagram, polarity and signal system.



Cincinnati built combo 150, with trailer 301 of Interstate Public Service, had train door at one end only plus spare pole on forward end facing aft. Mirrors helped motorman in station. Cars of this type were acme of steel interurban.

identity of the cars (from A to C or from B to D, or vice verse) presents no problems.* This is because looping equipment is for the purpose of *changing* its specie. On a loop ended line using single ended equipment the purpose of the loop is to turn the car *without* changing its specie. This requires the track polarity of the mainline to be interchanged as the car comes out of the loop so that it will still respond to its specie controller. This requirement is met by dividing the single track and the passing sidings into blocks and using a 12/24 v. 4PDT mechanical latch relay operated in each direction by motor current passing through *trip section* in overhead wire shown in figure 8. Absolute-permissive three color light signals are incorporated into the wiring. For absolute-permissive interurban signals omit the green bulb (no light is clear block), substitute a white bulb for the amber (white light is permissive entry into occupied block) and leave in the red bulb (obsolute stop, opposing movement in block).

In order to visualize the electrical abstraction of figure 8, consider a double track, point-to-point line with end loops. This is the familar dogbone of layout planning lingo. We now have a single block, loop type railroad. The outer rail is the right rail and the inner rail is the left rail. When we attempt to replace a section of double track with single track we run into control problems because a westbound car wants one kind of polarity of running rails and an eastbound car wants another. The circuit of figure 8 aligns the single track polarity to agree with that of the first car to enter it, and simultaneously displays the appropriate signals to allow following cars and to indicate stop to opposing cars. A layout consisting of two return loops and three passing sidings will have four sections of single track.

The return loops and all the double track (passing sidings) are electrically one single block and the circuit of figure 8 needs to be duplicated four times to signal and control polarity on a single track, loop-to-loop line with three passing sidings. Of course the cabs A, B, C, and D exist but once. An eastbound car approaches single track, observes the clear block signal and passes through the spring switch from what is labeled track 2. When the pole enters the trip section of the overhead the left coil of the latch relay is momentarily in series with the car and the left contacts are raised and the right contacts are lowered. The raised contacts on the left align track polarity in the single track stretch to agree with that of track 2, and the lowered contacts prepare the circuit for offering an amber light behind the car and a red light ahead of the car.

As soon as the car's pole enters the single track overhead, the current relay is in series with the car and its actuation extinguishes the green light and illuminates the red and amber. Cars of different specie but in same direction can follow the car with completely independent control, subject to being able to clear stopped car.

If you wish to use Nachod type signals with only the white and red light, place the signal head about two car lengths into single track (on the model) so that the motorman entering a clear block with no light showing can see his own occupancy present him with a white light and he knows that he has protection. If no white light comes on, he is to presume that no protection exists and should come to an immediate stop, flag, and call the dispatcher as in prototype practice.

We have briefly surveyed the interurban world, examined some of its features and practices, considered how the model can be made to imitate its big brother in a convincing and convenient fashion. Just how all of this is particularized to specific models of a definite prototype, and how a layout can be synthesized as a convincing display as well as an operating challange can be the subject of another time.

Two railers speak wistfully of progressive cab control and how things would be "if only . . .". Traction men have it in independent four car control. Would you care to join us?

*See four car rectified control, Dorn, Oct., 1965, Jan., 1966.

FOUR CAR RECTIFIED CONTROL SYSTEM

by Richard Dorn

TRACTION modeling is very active in Detroit, and is unique in several ways. There are two strong traction clubs—the Michigan Electric Railway Club (O Gauge), and the Detroit United Railway Club (HO Gauge). One unique factor is that the two clubs operate on an associated basis. Any regular member of one club is automatically an associate member of the other. Meetings of each club are held periodically, and it is seldom that MER men are not present at the DUR meeting, and vice versa. In other words, there is no "battle of the gauges" in Detroit.

The O gauge group has a club layout in the basement of one of its members, and two of the members have home layouts. Prototype for the system is the old Michigan Electric Railway, which operated from Detroit to Fort Wayne. Rolling stock is almost all modeled after prototype Michigan Electric cars.

Several members of the HO Club have layouts at their homes and take turns hosting club meetings. Most of them have chosen one of the divisions of the old Detroit United Railway for prototype: there is the Birmingham Division; the Detroit Street Railway Division; the Flint Division; the Pontiac Division; the Detroit, Toledo and Lake Shore Division; the Orchard Lake Division and the Plymouth Division. In prototype each of these was originally an independent line, finally being all brought together as the Detroit United Railway. This means that equipment on the original lines varied widely and each model layout adheres pretty closely to the equipment originally used on that line.

Another point that is unique is the control system used by both clubs. It is the so-called Four-Car Rectified Control System, which allows completely independent control of each of four cars concurrently, no matter where they are on the line or what direction they are going, without resort to any blocks or sections. Where the system first was evolved is not known, but Leigh Wright and the late Ken Lindquist of MER are largely responsible for the refinement and development which has taken place in Detroit, and which has resulted in a very effective and realistic means of traction car control.

Figure I shows the basic wiring diagram for such a system. Power is fed to the layout at 24 to 30 volts AC. Overhead is common to all cars on the line. The key to the system is the rectification used on the other power leg, and in the individual cars. Two rheostats, in parallel, are placed between the transformer and each rail making a total of four rheostats or controllers. In series with each controller is a single wave rectifier, one positive and one negative for each rail feed. Controllers A and B go to the left rail, and C and D to the right rail.

It is necessary of course to keep the two rails insulated from each other, and to insulate all the wheels on one side of each car. Between the motor and the uninsulated wheels of each car another single-wave-rectifier is installed, in series with the motor. These rectifiers, both in the cars and at the controllers, must be able to handle at least a half amp current at fifteen volts. In Detroit we use in the cars either a single plate selenium, or one of the new tophat rectifiers which recently came on the market.

Now it will be seen that Car A can be controlled only by Controller A, which will have no effect whatever on the operation of cars B, C or D. Current flows from the left rail through rectifier and motor to the overhead. Rail polarity is usually used to designate type of car, so an A car is a Positive Left Rail car. Current is flowing from overhead to rail in car B, so it is known as a Negative Left Rail car, and so on. A small letter in the motorman's window is used to designate which type of car it is, A or B or C or D. What were Route signs in prototype can be used for this purpose.

Figure II shows the hookup in the car. For double-end operation the two pole hold-down hooks are connected together, then in series with the rectifier to the trucks. The two trolled pick-up poles are connected one to each brush of the motor.

If your car is built of wood, cardboard, or other non-conducting materials, you need take no insulating precautions. If your car is one of the newer all-brass imports, however, it will be necessary to insulate the hold-down hooks from the roof, as well as the trolley pole bases, and to insulate the motor from the floor. If you are making a single-ended car, this last is not necessary, since the only insulation needed is at the trolley pole base, with its lead to the motor brush which is insulated. In this case, however, the rectifier must be between the trolley pole and the motor brush. Otherwise it will be shorted out. The other brush, if it is insulated, must be connected to the floor, or to the trucks if they are insulated from the floor.

Figure II is an A car—Positive Left Rail. Current will flow from the left rail through the rectifier to the lowered pole and its hold-down hook, through the motor, thence through the raised pole to overhead. (Of course all the right-hand wheels on this car must be insulated.) Installing the rectifier with an opposite polarity would change this to a B car—Negative Left Rail.

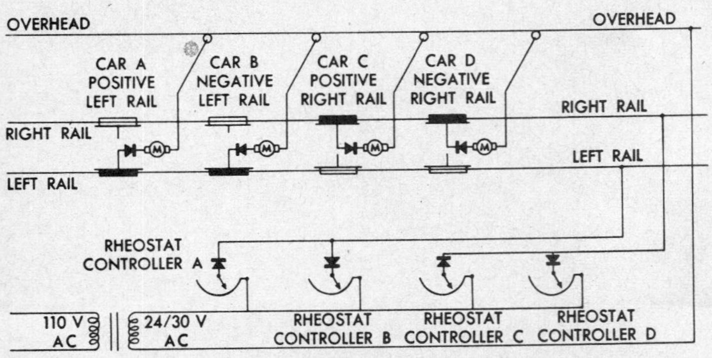
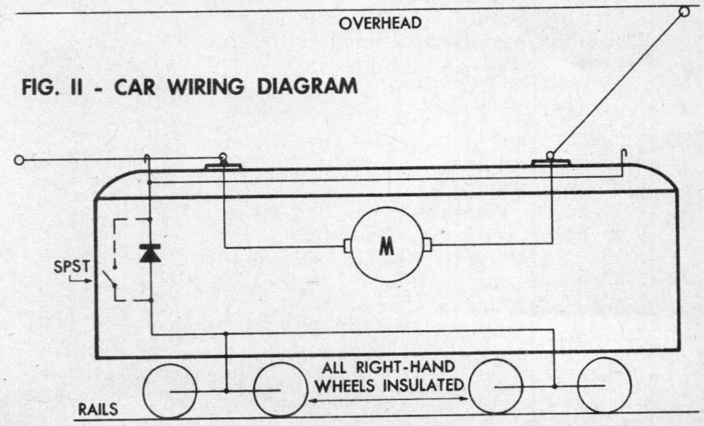


FIG. I - WIRING DIAGRAM - FOUR CAR RECTIFIED CONTROL

FIG. II - CAR WIRING DIAGRAM



Detroit's trolley modelers use a unique control system that permits completely independent control of four cars concurrently, no matter where they are on the line, or what direction they are heading, without resort to any blocks or sections, through use of a non-overheating pulse power system!

FIG. III—Four cars, all individually controlled without use of special blocks or cabs, rolling over tracks of the Detroit United Railway Club. Most of the equipment used follows Detroit proto-type but the Ohio influence appears to be well in evidence.

Each car is receiving half-wave DC, or pulse power. Some will wonder if this does not result in overheating for extended runs. The answer is NO. Overheating by pulse power is due to what is called a "back e.m.f.". This is a momentary back-surge of current which takes place between the cycles of the half-waves, and is induced by the motor windings and magnet. The motor in effect becomes a generator for the instant. But the presence of the rectifier in the car, right at the motor, prevents this back surge from flowing; so without the back e.m.f there is no overheating of the motor windings. Cars have been run literally for hours at a time at shows and exhibits, with only normal heating of the motor.

Incidentally, it is the fact that the cars are receiving only half-wave that determines the source voltage. Since only half of each wave is passed by the rectifiers, the effective average voltage at the motor from the 24 to 30 volt source is only 12 to 15 volts, less a small loss in the rectifier and any line loss which may take place.

Reference again to Figure II will show that the car can be reversed by changing poles. This changes the direction of the current through the motor, but not through the car. It is still from rail to overhead. But . . . now it is a C car . . . in other words, going the other direction it has become a Positive *Right* Rail car. But obviously, it still answers to the same controller. How come?

Particularly in the case of a freight motor or steeple cab, it may be desirable to have panel board reversing for switching operations. This can be accomplished by installing a bypass for the rectifier in the car with a simple SPST switch, as shown by the dotted line in Figure II. Then the car will respond to polarity reverse from the control panel. This means too, of course, that the panel must have an alternate arrangement to provide 12-volt full-wave DC to that section of track which will be used for the switching, such as in the yards, and that this section must be arranged to permit electrical isolation from the rest of the layout. Reversing can also be accomplished, when the rectifier is bypassed, by using the opposite polarity current. In the case of the A car, it will go forward when the A controller is used. When the B controller is used, polarity is reversed, and the car will reverse. Now, of course, we are using pure pulse power, without the non-heating effect of the rectifier. It is obvious that no other B car can be on the line when this is done.

CAUTION: Never have an A and a B controller both on when a non-rectified car is on the rails. You will be sending 24 volt AC to that car.

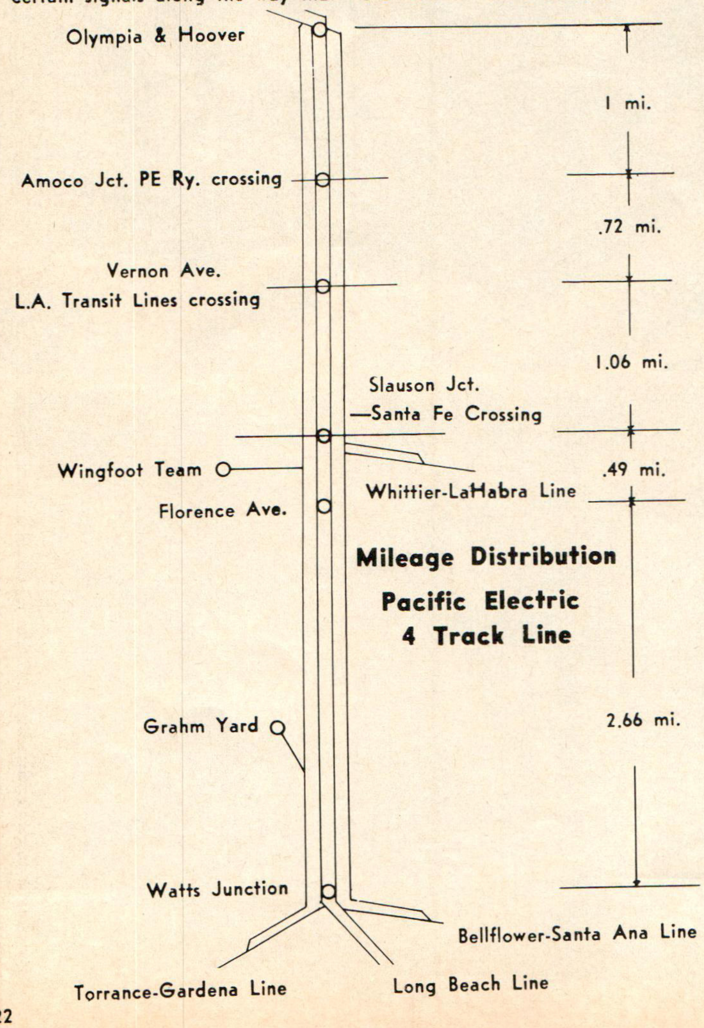
Figure III shows a busy moment at the Toledo station on Harry Darst's HO Lake Shore Electric lines. DUR No. 7534 is in front of the station, about to pull out. Lake Shore No. 170 is waiting its turn to get to the station. Meanwhile, the Lake Shore combine is about to start out on a local trip, southbound. While all this is going on, the old Lake Shore box motor, pulling a box trailer, stands by until it can take off on its daily milk haul to Detroit. All four of these cars are on separate controllers, and when the line clears, any one can be moved independently of the other three.

This brings up the question of proper polarity in the rails. If your track plan is a loop, then the left rail is always left, and the right rail is always right. But, if you have a loop-to-loop track plan, then some means must be found to get each rail connected to its proper controller.

PE's Southern District

by Sharpe Delaney

Baldwin diesel switcher No. 1022 with inbound string of banana loaded reefers from San Pedro. Trolley pole was used to actuate certain signals along the way that were tied in with overhead.



WITH the demise of Pacific Electric an era of classic interurban activity came to an end. Of all its 900 plus peak miles of electric traction, the 5.93 miles of four track operation that extended along P.E.'s Southern District represented the ultimate in traction business. Not only was this four-track wide 78 electric conveyor crowded with passenger equipment from several outlying lines but it also catered to a busy stream of freight trains and box motors. And all this in a setting of industrial scope where stub tracks were frequently straying from the main line.

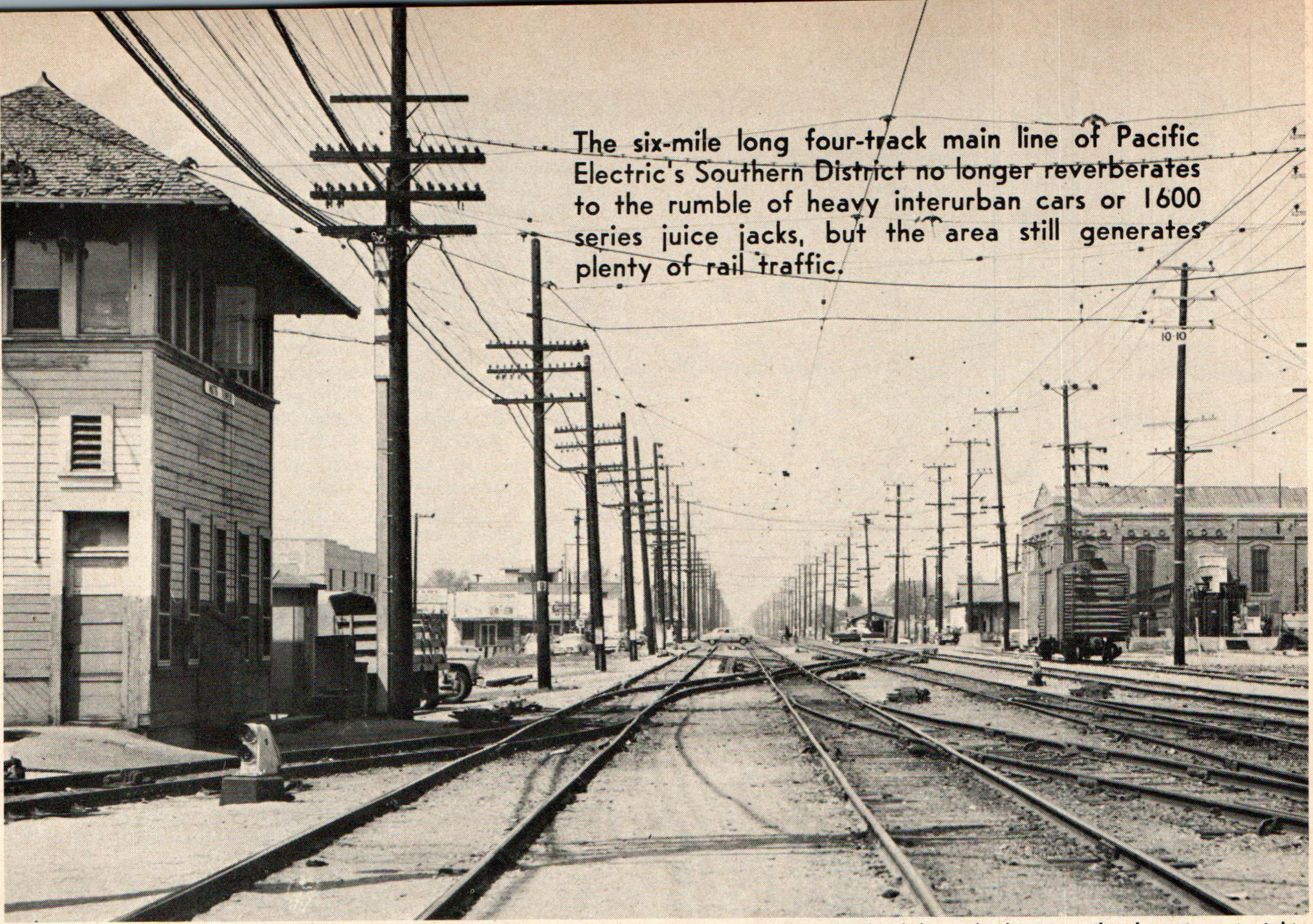
Though the four-track main line has passed over the hill as an interurban, finally succumbing to age in April, 1961, its profile still stands and much of it will probably remain, since the all diesel, all freight Pacific Electric of today is a prolific breeder of carloadings for its parent, Southern Pacific.

Let's examine P.E.'s four-track as it exists and as it existed in earlier years. If you're a "juice" fan forget any reference to diesel, and in its stead visualize a 1600 class electric job involved with freight trains. Since there is no passenger service, references to interurban cars are distinctly of an historical involvement.

At the intersection of Olympic Blvd. and Hoover Street in Los Angeles, 1.47 miles from the elevated Sixth Street terminal, two tracks leave the middle of the street and enter upon a domain consisting of private right-of-way. Immediately a process of cellular division takes place and the two tracks become four. This is the northern boundry of the four-track line, and the twin ribbons from the street siphoned off passenger service while freight continued on north for a couple of blocks to a yard and large freight house.

It was at this point that four tracks, coming in from a block long connection with Eighth Street freight station and yard, joined. During off peak hours passenger cars were frequently stored at Eighth Street, since the main line was in close proximity.

During the height of its interurban activity, P.E. maintained a small yard and several buildings for its electrical department on the west side of the main line, and a few hundred yards south of Olympic and Hoover, though in later this function was shifted south to Watts Jct.



The six-mile long four-track main line of Pacific Electric's Southern District no longer reverberates to the rumble of heavy interurban cars or 1600 series juice jacks, but the area still generates plenty of rail traffic.

Watts Junction to the left, with depots and sub-station at right.

While still in service, the small yard was always host to a half dozen or so of odd looking service equipment, the tower cars and other specialized rolling stock involved with maintaining a large interurban system.

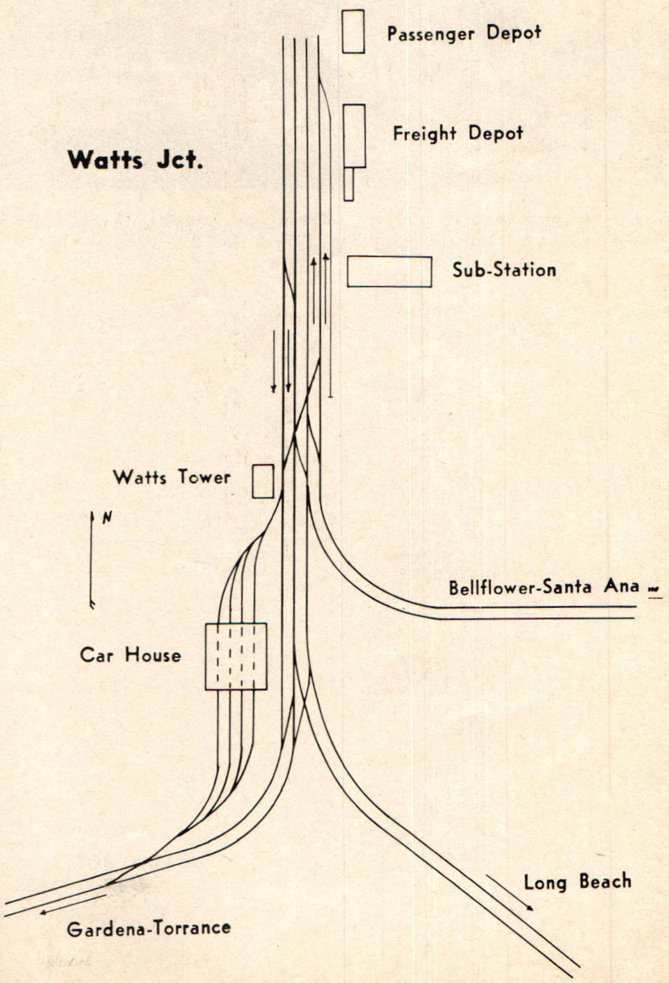
Exactly one mile south of Olympic and Hoover is Amoco Jct., an interlocking plant which should interest any model builder who is interested in the unique of prototype. Amoco tower is perched on top of an overhead bridge of steel girder design, much the same styling as can be found in overhead signal bridges. So it would be a simple task to alter one of the commercially available signal structures to accomodate a small structure in lieu of the block signals.

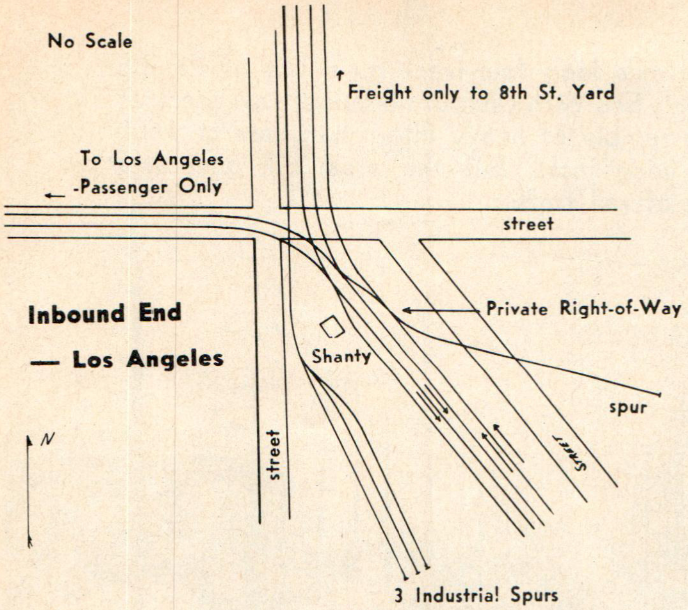
Amoco Tower's function is to control freight coming up from various Southern District lines, shunting it to nearby Butte Street Yard, busiest on P.E.'s system. It also shepherds freight traffic coming in from western beach cities, crossing it over to Butte Street, or perhaps funneling it through a series of crossovers to head for the Eighth Street facility.

The four-track main becomes involved with a crossing of foreign trackage at Vernon Ave., .72 miles south of Amoco Jct. Here a street containing the narrow gauge mileage of a city streetcar line is met. Originally this streetcar line operated under the Los Angeles Railway banner, a title subsequently changed to L.A. Transit Lines before the transit authority became supreme.

As a brief touch of background, consider that P.E.'s four-track line operates over a mostly signal-less territory at rather low speeds, since it involves the crossing of frequent street crossings at grade. This is true of both past and present. For this reason, maximums of about 30 mph have always been involved, even in the heyday of the interurban, with visual determination of track conditions the norm for motormen. What few signals there were, were located at interlocking plants so trains could be switched from one track to the other as conditions warranted.

Slightly over a mile from Vernon Ave., the four-track main stem becomes involved with another grade crossing of foreign rail, in this instance a single track freight line belonging to Santa Fe. Slauson Pct. is the name of this interlocking plant, and a more normal style of tower





controls this crossing as well as switches providing access to P.E.'s Whittier-La Habra line. In the current mode of diesel freight movement, this latter connection provides linkage to a very important S.P.-P.E. joint yard at Los Nietos. In bygone years passenger trains headed east from Slauson Jct., going out on a double track link that quickly melted to a single strand of overhead wire.

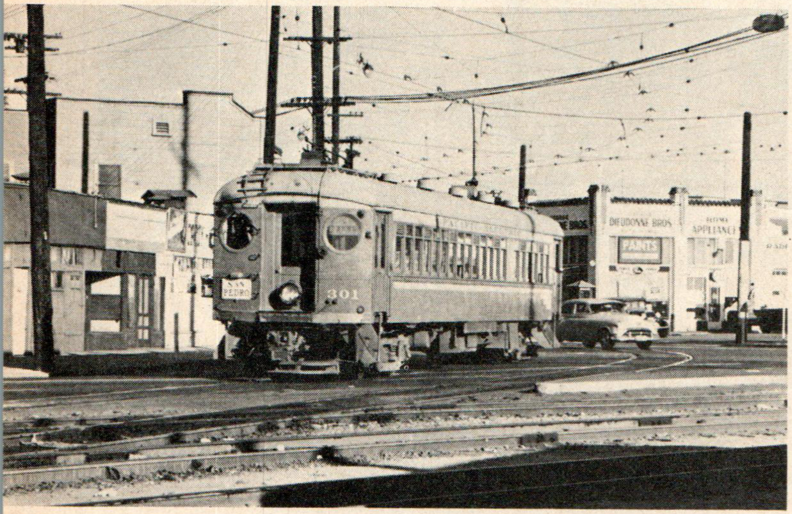
P.E. had a rule that inbound trains heading for L.A. were superior to out-bound movements, so the short stretches of double track leading away from the main line were important, usually serving as meeting points and keeping meets from tying up the main line. This is an important point to consider when modeling a track arrangement for interurban purposes.

South of Slauson Jct. there isn't a diverging line until Watts Jct. is reached, a 2.15 mile stretch. At one major street crossing in this neighborhood the track does show signs of modernization since it goes over the traffic artery on a bridge. And a few hundred yards north of Watts there's a lead that reaches into Grahm Yard.

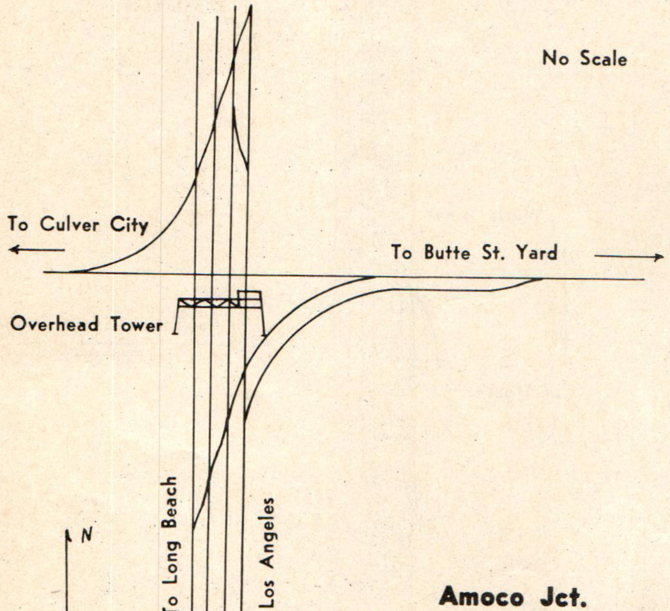
Grahm Yard is a stub-end-affair designed primarily for storage purposes and for the switching of industrial loads in the mid-south section of P.E.'s system. Through freight usually runs directly from the harbor to Butte St. or Eighth Street yards, so that Grahm is essentially a secondary facility, though during the electric era of freight service it did contain a small icing dock for locally generated perishable traffic.

Watts Jct. is the south limit of the four-track profile, and from a modeling standpoint much more in scope than the northern boundry. At Watts Jct. there is both a freight and passenger depot, a sub-station, a car barn (now dieselized) and an interlocking tower plus diverging track in three separate directions.

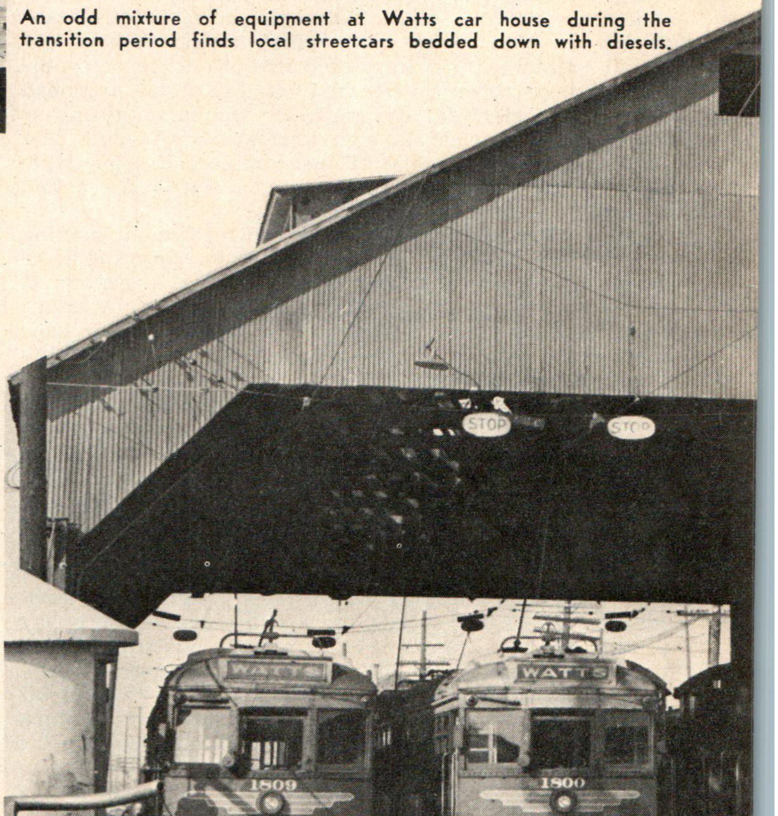
During most of its years, Watts car barn was used to service mainly local equipment on a line that shuttled between that point and downtown Los Angeles. Today its programmed to handle the small horsepower diesels which are the mainstay of P.E.'s freight operations. Except for a few minor alterations and the absence of



Olympic and Hoover looking towards Los Angeles, northern limit of the four-track main, with San Pedro car 301 entering PROW.



An odd mixture of equipment at Watts car house during the transition period finds local streetcars bedded down with diesels.



catenary, the metal sided car house has undergone little change.

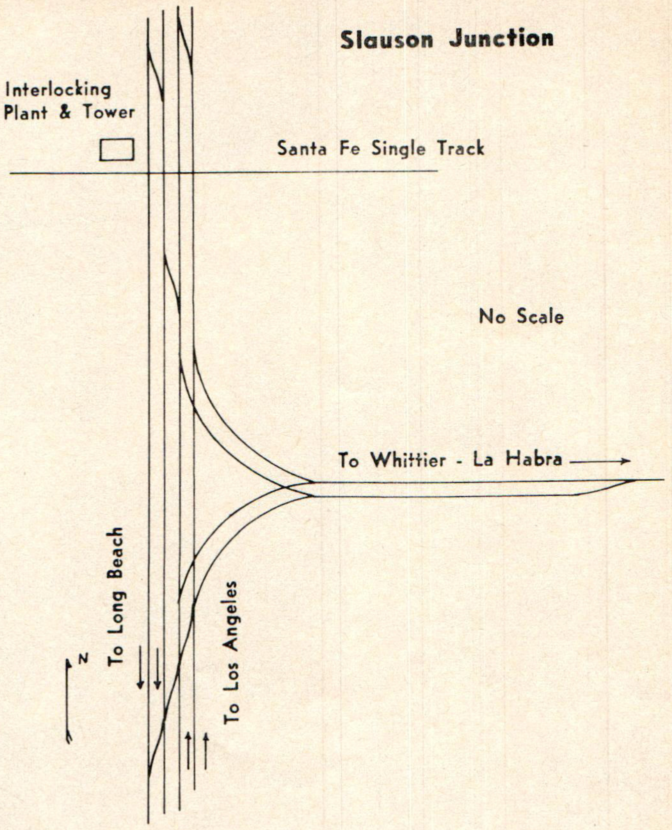
Just about parallel with the tower two tracks split eastward, providing access to the Bellflower-Santa Ana line of P.E. This two-track line doesn't last long, but slims to one in short mileage.

Alongside the car barn, the four-track roadbed splits into a Y effect, with two tracks curving slightly southeast, while a similar duo turns southwest. The former line remains two tracks and is the Long Beach-San Pedro line, while the latter, which soon becomes a single track, is the Gardena- Torrance connection.

The operating potential of Watts Jct. is legion, what with three lines fusing into one broad alley. Against this scene of a steady flow of interurban trains the towerman must find time to switch local cars in and out of a car house, while finding time to shuttle freights through the plant, which sometimes means a long line of rolling stock strung across four crossovers and a like number of tracks. A derail here and the whole railroad comes to a halt. Pure speculation it's true, but it illustrates what can be done with P.E.'s prototype.

Pacific Electric's interurban rule book called for all local cars and freight trains to use outside tracks, while the center rails were reserved for through schedules, i.e. the likes of Long Beach, San Pedro, Santa Ana, etc. trains. Circumstances would create different patterns at times, but the three interlocking plants could shift trains back and forth as conditions dictated.

All told there are quite a few modeling possibilities in the prototype offered by Pacific Electric's four-track railroad. It's short, but loaded with detail. Some may find interest in the structures such as Amoco Tower or Watts car house. Others may prefer to appropriate the manner of operating a layout like Watts Junction, or perhaps a less complicated tower such as Slauson Jct. Whatever the interest, P.E.'s four-track main stem was a unique picture of railroading, and to the extent that it still survives, it creates something deserving more than a fleeting glance on the part of a model rail.



Car 1541 heads a two-car Long Beach train crossing the freight only single track at Amoco Junction. Unusual elevated tower crosses over two tracks. 1500 series cars were railroad width.