NORTH SHORE R.R.
MARIN COUNTY
ELECTRIFICATION

REGULAR PASSENGER TRAIN, CARRYING MAIL, BAGGAGE AND EXPRESS

The Western Railroader
For the Western Railfan

Vol. 28, No. 9  SEPTEMBER, 1965  Issue No. 308
The Western Railroader
"FOR THE WESTERN RAILFAN"
P.O. Box 668, San Mateo, California
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Subscriptions: 12 Issues for $1.60
Single Copy 50c
ELECTRICAL EQUIPMENT OF THE NORTH SHORE RAILROAD

On its suburban division, between San Francisco and San Rafael, Cal., the North Shore Railroad Company has recently introduced a system of electric third-rail traction which is marked by many interesting engineering features. The North Shore Railroad, up to the last few months, operated a narrow-gage steam railroad and ferry system between San Francisco and Cazadero, a distance of 87 miles, with branches to Mill Valley and San Rafael, the railroad proper starting at Sausalito, on San Francisco Bay, 6 miles north of San Francisco, and running in a northerly and northwesterly direction to the upper terminus. Throughout its entire length the road traverses an interesting country, and, on the southern end, between Sausalito and San Rafael, it passes through a section that is especially attractive. Many suburban homes have been built at several
points along this line, and as the mild California climate makes a suburban home attractive the year round, the result has been the establishment of several towns or communities of permanent residents whose business interest require them to be in the city every day. In building up these towns the suburban train service of the North Shore Railroad to Mill Valley, San Rafael and intervening points has been an important factor.

The importance of this line has been very generally recognized by steam railway men, especially those familiar with the California situation. It has been known, too, that Southern Pacific and the Santa Fe have been figuring upon getting control of this property, and now it is announced, semi-officially, that arrangements have been made by which the Santa Fe is to acquire complete possession of the property, offering a very generous price for the stock, so as to ensure not only a majority but practically, at least, complete ownership. It is said that the North Shore shareholders will receive $100 a share for their stock. This will mean a handsome profit over and above the $10 a share assessment recently collected by the company on its outstanding stock from all stockholders who bought into the company at the time John Martin and his associates assumed control of the property, nearly two years ago, and brought the North Shore Railway Company into existence. The details of the deal, so far made public, provide for the placing of all outstanding stock in escrow, payment to be made to the depositing stockholders when all their stock has been delivered. As a guaran-

four
of good faith on the part of the Santa Fe, the brokers who represent the company have, it is said, deposited with the escrow holders the sum of $1,200,000, equal to $20 a share for each of the 60,000 outstanding shares, with the understanding that this money deposited will be forfeited if the Santa Fe fails to complete payment for the stock placed in escrow. To meet the requirements of the Santa Fe's purposes, the main line of the North Shore will have to be straightened in places and converted into a standard-gage road.

About two years ago, John Martin, of San Francisco, to whom the electrical interests of California owe much of their pioneer development and present successful condition, secured control of the North Shore Railroad, with a party of capitalists, and decided to rebuild the suburban division and put on an electric train service which would be of the most modern type, and which would best meet the needs of the traffic. The reconstruction work, which has now practically been completed, consisted in rebuilding the entire roadway between Sausalito and San Rafael,
putting in double track for practically the entire distance, installing a third rail system of train operation, equipping the division with an improved automatic block signal system, building a high-tension power station, and erecting a new ferry depot and slip at Sausalito. The Mill Valley branch of the new system was placed in operation on Aug. 21, and the main line to San Rafael was opened on Oct. 17. This is the first third-rail road to be constructed and put into operation in California, and the second west of the Mississippi River, and it is a significant fact that the reconstruction work was done without interrupting the old schedule of steam trains.
ROUTE

The San Francisco terminus of the line is at Ferry Building, at the foot of Market Street. Between this point and Sausalito is operated a splendid ferry system, the ride across the bay affording an interesting view of the harbor, with Angel Island and Alcatraz Island, with their military stations, and of the Golden Gate. At Sausalito, a town of 3000 population, the passenger passes through a new ferry building, in which are located the offices of the operating officials, to covered platforms, where the electric trains are in waiting. A general view of the depot and Sausalito yards and the company's fleet of ferry steamers is shown on page 5. The route from Sausalito, as may be noticed from the map on page 1076, skirts Richardson's Bay and passes through the picturesque and thriving towns of Corte Madera, Kentfield, Ross and San Anselmo, and terminates at San Rafael, a residence and resort city of about 8000 people. The line extends to San Quentin, where one of the State penitentiaries is located, but this extension is not in operation at present. The narrow-gage main line to Cazadero leaves the suburban electric line at San Anselmo.

The Mill Valley line, 2 miles in length, branches off at Mill Valley Junction. Mill Valley, familiarly termed “The Little Switzerland” in the guide books, is the lower terminus of the broad-gage scenic steam railway that runs to the summit of Mt. Tamalpais, one of the most popular resorts in the vicinity of San Francisco. The mountain is only 2592 ft. high, but on clear days its summit affords an excellent panoramic view of San Francisco Bay, the bay cities and the Pacific Ocean. Every mountain scenic railroad lays claim to some distinctive feature of construction, and the Mill Valley & Mt. Tamalpais Scenic Railway, in accordance with this fashion, is known as “the crookedest railroad in the world.” This will be readily appreciated after a glance at the view presented herewith. The road has an average grade of about 5 per cent, and in its 8 1-5 miles it has 277 curves, at one point the track paralleling itself five times, and being called the “Double Bow Knot.” The Mt. Tamalpais railroad is owned by a separate corporation, and is operated distinctly from the North Shore, but connections are made at Mill Valley.

TRACK CONSTRUCTION

The track of the North Shore Railroad, between Sausalito and San Rafael, is 11.95 miles in length, and the Mill Valley branch is 1.74 miles long, making a total mileage of electrically-operated road of 13.69. With the exception of the line from
San Anselmo to San Rafael, the Mill Valley branch and a tunnel between Alto and Corte Madera, the road has a double track. The road is built with 60-lb. A. S. C. E. section 30-ft. rail, laid to standard gage on 8-ft. x 6-in. x 8-in. redwood ties, spaced 2 ft. center to center. To accommodate the narrow-gage steam trains which run from Sausalito to Cazadero, and use the electric line as far as San Anselmo, an additional rail has been laid on the same ties, giving a 3-ft. gage with the outside rail. This steam rail weighs 60 lbs. to the yard, and is also of the A. S. C. E. section. Between Sausalito and Alto the road crosses several salt-water marshes, or lagoons, on substantially built wooden trestles, the remainder of the roadbed being well ballasted with gravel. The track construction throughout conforms to the requirements of the best steam road practice. The maximum grades are of 2.2 per cent and 1.91 per cent, and most of the curves range from 1 deg. to 18 degs., being on the single-track line just beyond San Anselmo. The tunnel before mentioned passes through a high hill on a 1 per cent grade, and is 2194 ft. between portals.
THIRD RAIL CONSTRUCTION

For the third or contact-rail 60-lb. A.S.C.E. section rail is used in 30-ft. lengths on more than half of the line, the rest being 56-lb. rail that formed part of the original narrow-gage track, and was thus used for the contact-rail as a matter of economy. The type of approach block for the ends of the contact-rail is illustrated, with a table of dimensions for the different sections of rail used.

In the matter of third-rail insulation and feeders there has been displayed much of Mr. Martin's pioneer policy of adopting a construction to meet existing conditions. In the yards and around the depot at Sausalito reconstructed granite insulators have been used, on account of the extra strength and insulating qualities required on that portion of the road. But on all the rest of the line the third rail has been mounted on wooden insulators, and this cheaper construction has been justified by the continued successful operation of the road in all kinds of weather since it was started. Leakage measurements, made during the third day of a heavy storm, showed an average loss of 1 amp. per mile.

For single-track construction the contact-rail is mounted on block insulators fastened to the ends of every fifth tie, so as to give the insulators 10-ft. centers. The rail is fastened to a 4-in. x 6-in. x 18-in. block, 4-1/2 ins. from its outer end. The block rests on a 2-in. x 6-in. x 21-in. cleat, that is bolted to the end of the tie by means of two 1/2-in. x 5-in. lag screws. The cleat projects 7-1/2 ins. beyond the end of the tie, and the block 12 ins. This arrangement brings the center of the contact-rail 27 ins. outside of the gage line of the track, and the top of the contact-rail 6 ins. above the top of the running rail, these being the standard distances throughout for the contact and gage rails.

For straight double-track construction two types of insulators have been employed. Where the roadbed will permit it the contact-rails are supported on 4-in. x 6-in. pieces laid across between two ties and fastened to the latter by wooden tree-nails. When an earth support is desired, the contact-rails are supported independently from the track by means of 2-in. x 6-in. strips, 3 ft. 6 ins. long, which are tree-nailed to the tops of two 4-in. x 6-in. posts driven into the ground, so as to give the correct elevation to the contact-rail.

In general these are the principal forms of insulators used. The material employed is California redwood, and it is all given a coating of asphaltic paint before being put into service. The insulators are comparatively inexpensive, they do not require extra-length ties, and, as no metal is used in their construction outside of the lag screws and small cleat nails, their insulating qualities are good.

CREDITS

The text and photographs are from the January 9, 1904 issue of STREET RAILWAY JOURNAL published by the McGraw Publishing Co. to whom we extend our thanks for making this material available. The original copies from which this issue was taken were furnished by Grahame Hardy, Railroadiana Dealer of Carson City, Nevada.
In the Sausalito and San Rafael yards and in one or two other places it was thought advisable to equip the contact-rail with a guard so that the possibility of accidents would be lessened. As the Potter contact-shoe is used on the motor cars it was possible to adopt a hood protection, and the construction features shown were adopted. It consists of a 2-in. x 4-in. x 13-in. post, clamped to the bottom flange of the contact-rail by means of a special casting and hook bolt, and supporting by means of another special casting a 2-in. x 6-in. x 8-ft. plank guard, 2½ ins. above the top of the rail.

**TRACK RETURN**

For track return the single standard-gage rail and the narrow-gage rail are bonded with Brown plastic bonds. The track rail that is common to both standard and narrow-gage trains is used for the block-signal system. A Brown grinding machine was used to polish the rail ends for the bonds. Opposite the power house the return track rails are connected to two return feeders, consisting of the same size aluminum rod as is used for the contact-rail feeders. These return feeders are carried across the salt-water marsh intervening between the station and track in a wooden trough, built about a foot above high-tide mark, and upon entering the station are connected to four 800,000-circ. mil bare copper cables, for connection through a double-pole, double-throw switch to the battery booster or generator negative bus-bar.
DANGER SIGNS

At crossings, stations and other exposed points, warning signs have been placed, the wording being a combination of the signs on two Eastern third-rail roads. The signs are made of white letters on a dark blue background, the whole being enameled. One of the signs is shown in one of the views here presented.

SINGLE-TRACK CONSTRUCTION, WITH CATTLE GUARD AND WARNING SIGN; PRIVATE RIGHT OF WAY FENCED ALONG HIGHWAY

CONTACT-RAIL FEEDERS

In adopting solid, bare aluminum rod for contact-rail feeders, the North Shore Railroad has departed from the practice of Eastern roads, but California engineers are prone to break away from established customs of the East by adopting their constructions to meet local conditions, and the results in this case, at least, are highly satisfactory. Throughout the whole length of the double track the two contact-rails are fed by two of these aluminum rods. The rods were received in 30-ft. lengths and joined together by 8-in. joints, by an hydraulic press giving a pressure of about 50 tons to the square inch.

At every other joint in the contact-rail the aluminum feeder rod is tapped in. The top consists of an aluminum casting bored to fit the rod, with a piece of No. 0000 extra flexible copper cast into it, the whole being hydraulically squeezed into the rod. The two ends of the flexible copper are soldered to the ends of the rails at the joint, and the whole covered with asphaltum paint.
At station platforms the guarding of the contact-rail is carried still farther, as shown by the detailed drawing and views. The center platform between the tracks is formed of 2-in. x .12-in. x 3-ft. 4-in. planks, nailed to 4-in. x 6-in. stringers, which in turn are supported on 4-in. x 6-in. x 7-in. blocks, that rest on 3-in. x 12-in. x 2-ft. 9-in. mud sills, spaced 10 ft. apart. Entirely separate from the platform are the contact-rail insulators, of the post form, the third of these already described being used. Outside of the rails are nailed 2-in. x 4-in. pieces on edge, so the rails are very well protected and no one could possibly come in contact with them unless by deliberately placing a hand under the guard and on the rail. Between the track rail and the insulators are run two planks mounted on blocks, as shown, and with but a 1-in. space between the outside edge of the top plank and the end of the insulator plank. By means of this construction the tracks, with their longitudinal planking, the contact-rail insulators and the center platform are all independent of each other, so that an ordinary accident to any one of the three would not disturb the other two. A half-tone view shows the platform construction at Kentfield.
In addition to the block-signal system there are three disc signals stationed on the legs of the Y-track at San Anselmo. These signals are controlled by the station agent, who can give right of way to the station to a train on any one of the three legs of the Y. Annunciators operated by trains approaching San Anselmo are located in the station, and give the agent information as to the approach of trains.

SAUSALITO LIGHT AND POWER

The 4500-volt three-phase power circuit from San Rafael and the Alto power house terminates at the pump house in the Sausalito terminal yards, where it is transformed for motor work at the ferry, and for incandescent and series arc lighting. The machinery at the shops is driven by a 30-hp induction motor. In the pump house is a vertical triplex 9-in. x 10-in. Allentown fire pump with 8-in. discharge and 8-in. suction. This pump is driven by a 50-hp General Electric induction motor. A 5-hp induction motor drives a 3-in. x 3-in. Dow triplex pump for filling the accumulator at the ferry apron.

ROLLING STOCK

The motor cars are of the combined baggage and passenger type, and are 50 ft. long over bumpers, while the passenger coaches are of the standard light passenger type, and are 56 ft. 4 ins. long over all. The coaches seat sixty-six passengers, and the motor cars have a seating capacity of thirty-six and a 12-ft. baggage compartment. The North Shore Railroad Company has in service nine of these motor cars and twelve coaches, which were built by the St. Louis Car Company. Also it has rebuilt in its shops three motor cars and eight coaches, these eleven cars being Pullmans that were used on the road during its operation by steam.

thirteen
FOUR-CAR TRAIN, COMBINING PASSENGER COACHES, MAIL, EXPRESS AND BAGGAGE SERVICE

STANDARD MOTOR CAR, CARRYING PASSENGERS, MAIL, EXPRESS AND BAGGAGE
The motor trucks of the combination cars are of the Hedley type, and are equipped with two General Electric 66-motors. For the contact the new Potter collecting shoe, made by the General Electric Company, is used. It is mounted on an oak bar fastened to the equalizer, as shown. This shoe is practically the same as that used on the Wilkesbarre & Hazelton third-rail road, and while its general design is very satisfactory in that it permits perfect protection of the third rail at station platforms, etc., the management of the company believes that its details must be modified before it can be satisfactorily adopted for general use.

The cars are equipped for train operation with the General Electric Company's type-M multiple-unit control, the only special feature being that a bus line, consisting of No. 0000 copper cable, runs the whole length of the train. This arrangement was made necessary by long road crossings, its function being to supply all the motors with current if only one shoe is in contact with the third rail.

Other furnishings of the cars include Janney couplers, Anderson-Smith arc headlights and interior lights, Westinghouse automatic air brakes on all cars, and Westinghouse motor-driven compressors and governors. The motor cars weigh about 30 tons each, and a five-car train, including two motor cars and three coaches, or trail cars, weighs, equipped, 130 tons.

**TRAIN OPERATION**

Under usual operating conditions three-car to five-car trains are operated, and four trains is the maximum number on the track at one time. At certain hours of the day three trains leave the Sausalito depot within 1 minute of each other, and this necessarily brings a heavy tax on the power plant, but with the aid of the storage battery the load on the generators is smoothed out. At other periods of the day, when no trains are moving, there is practically no load on the station, and here again the battery comes into play, as it is charged during such periods, and thus keeps a more even load on the station.

The trains operate at a schedule speed of about 25 m.p.h. to 30 m.p.h., and have maximum speeds of between 50 m.p.h. and 60 m.p.h. During morning and evening an express service is given between Sausalito and the San Rafael end of the system. The entire railroad, steam as well as electric, is operated under the American standard railroad rules. The engine drivers of the old steam system are used as motormen, and they go from steam to electric train, or vice versa, as they may be assigned.
SPECIAL TRAIN OF TEN CARS OPERATED AT OPENING OF LINE TO SAN RAFAEL
POWER SUPPLY

The railroad receives its power supply at the standard direct-current railway potential of 550 volts, from a main power station at Alto, a little over 4 miles north of Sausalito, and from a motor-generator sub-station at the San Rafael terminus. The Alto power house is designed to receive three-phase current at 50,000 volts from the transmission lines of the Bay Counties Transmission Company, and after transforming it down to 4500 volts, to convert it to the direct-current railway voltage, by means of two motor generator sets. To serve as both reserve and auxiliary plant a modern steam equipment has been installed, consisting of a direct-connected, direct-current railway generator unit, and an engine connected by means of rope drive to the motor-generator sets, so as to operate the inductor alternators of these sets to supply alternating current to the transmission line when necessary. This latter arrangement has been made so that the North Shore station may be used as a steam reserve for the Bay Counties system, supplying power, in case of a shut-down on the high-tension system, to the California Central Gas & Electric Company, which is the distributing sub-company of the Bay Counties system in the vicinity of San Rafael and Sausalito. That this arrangement is a beneficial one to the Bay Counties system has been demonstrated many times since the Alto power house was started up, as it has enabled the management to cut off the main supply from this part of the State during certain parts of the day, thus affording opportunity for repairs or new work without shutting off the supply to customers in this section. It is also interesting to note that the Alto power house is the terminus of the longest transmission line of the Bay Counties system, it being 180 miles from the power house at Colgate.
PLAN AND SECTION OF POWER HOUSE

eighteen
The Alto power station is situated on the side of a hill close to a salt-water marsh and lagoon, which connects with San Francisco Bay. Water for condensing purposes is thus convenient, and a short siding, connecting with the main track, affords facilities for delivering material and fuel.

The building was designed by Dodge & Dolliver, architects, San Francisco, and is constructed of brick, with steel roof trusses and slate roof. The general dimensions of the building are 61 ft. x 171 ft., and it is divided by cross partitions into a storage battery room, 35 ft. x 61 ft.; an engine room, 98 ft. x 61 ft., and a boiler room, 38 ft. x 61 ft. A three-story high-tension tower, with interior dimensions of 10 ft. x 20 ft., adjoins the engine room at its northwest corner. There is a clear height below roof trusses of 19 ft. in the engine room, and of nearly 23 ft. in the boiler room, thus providing excellent ventilation. The floors consist of a 6-in. layer of sand and a 6-in. layer of concrete. In the engine room on top of the concrete has been laid a select tongued and grooved 1½-in. floor with an oil finish. In the high-tension tower and battery room the flooring consists of vitrified brick laid on edge.
DIRECT-CONNECTED RAILWAY UNIT AND ENGINE WITH ROPE DRIVE IN MAIN POWER HOUSE
STORAGE BATTERY AUXILIARY AT ALTO POWER STATION

In order to regulate the heavy fluctuations on the station on account of the intermittent operation of the trains, a storage battery has been installed. It consists of 288 type G-15 chloride cells, with a discharge capacity of 560 amps. for an hour, and a capacity for fluctuating work 50 per cent greater. In connection with the battery there is operated a differential booster of the Western Electric type. The battery switchboard has the same arrangement as the direct-current boards, only negative circuits being controlled by it.

SAN RAFAEL SUB-STATION

In order to cut down the time of train operation over the 2 per cent grade near San Anselmo, a sub-station was installed at San Rafael. The outfit consists of a 225-kw, 550 volt General Electric direct-current generator, belt driven by a S.K.C. synchronous motor. This station is fed regularly from the Bay Counties system, but connections are provided so that it can be operated from the Alto power house, either over the 50,000-volt system or the 4500-volt line. The present sub-station is only temporary, but it serves its purpose admirably.
ARRANGEMENT OF APPARATUS IN TOWER AT ALTO
The road is operated by a train despatcher located in the depot at Sausalito, all despatching being done by telegraph. For the use of the officers and operating men a telephone system connects the terminal shops, power house and all suburban stations.

An automatic block signal has been installed by the Union Switch & Signal Company for the double track between Sausalito and San Anselmo. This system embodies certain interesting features which are novel in the art of railroad signaling, in that alternating current is used in track circuits, which in turn actuate the motors that operate the signals. Electric transportation having reached the speed and other conditions common to steam practice, it follows that similar protective devices are called for, but the customary track circuit supplied by a primary battery or other source of direct current, is in this case proscribed for the reason that, at least one of the rails must be used as a return conductor to the power station for the train current.

The general arrangement of the track circuits is similar to that on the Boston Elevated Railway except in the use of an alternating current in the signal circuit. One of the track rails is insulated from the other, and is also divided into sections of varying length by the use of track splices or insulated sections, such as used in standard steam railroad signal work.
At Mill Valley Junction a mechanical interlocking plant is being installed, the main line semaphores of which are semi-automatic, and this feature makes the automatic block signal system in reality continuous. Information of trains approaching the junction is given to the operator in the tower by annunciators. A mechanical interlocking plant of some size is also being installed at Sausalito to control the switching in the terminal yards.

Throughout the tunnel, near Corte Madera, incandescent lamps have been placed 10 ft. apart and the height of a car window. Signal No. 18 at North Portal is always red whenever a train is in the tunnel block. In this position it closes a small switch that supplies current to the primary coil of a General Electric contactor, which in turn closes the circuit from the power rail to the tunnel lamps, these being connected in the usual multiple-series arrangement for 500-volt lighting. The operation of the lights is thus entirely automatic.

CONCLUSION

The officers of the North Shore Railroad Company, who were in charge during construction, are: President, John Martin; vice-president, E. J. de Sabla; secretary and treasurer, F. B. Latham; auditor, O. F. Giffin; general manager, W. M. Rank; superintendent, E. L. Braswell; purchasing agent, S. F. Alden; general freight and passenger agent, George W. Heintz; electrical engineer, A. H. Babcock; engineer of maintenance of way and structures, B. H. Fisher; engineer of power station and steamers, George S. Ames; master mechanic, F. A. Stevens; car house foreman, W. W. Mason, Jr. Credit for the design and installation of the electrical equipment of the road is due Mr. Babcock. Mr. Mason, who came to Sausalito from the Boston Elevated Railway Company, has supervised equipping the cars with the type-M control system.

The entire steam power plant was designed and installed by Charles C. Moore & Company, of San Francisco, the details of design being approved by Mr. Ames. John Martin & Company, of San Francisco, supplied the electric generators, transformers, switches and switchboards, most of that equipment being of the Stanley Electric Manufacturing Company's construction. The aluminum rod used as feeders was furnished by the Pittsburg Reduction Works, through its agents, John Martin & Company.

Since this article was written the control of the property has passed to the Santa Fe, although that company has not taken possession as yet.