New Signaling Across the Great Salt Lake

Describing an Installation of A. C. Automatics on the "Lucin Cut-Off" on the Southern Pacific

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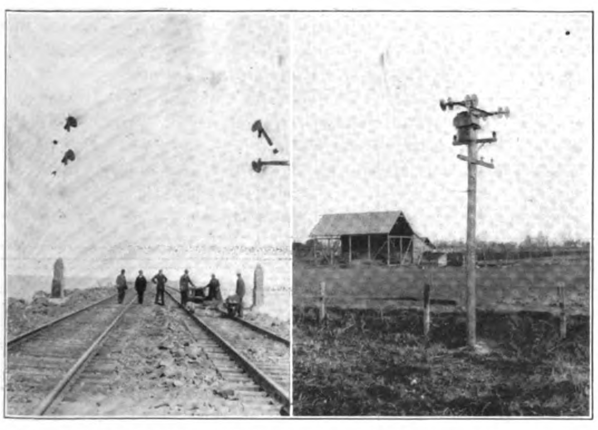
The Southern Pacific has just recently completed an installation of A. C. automatic block signals on the "Lucin Cut-Off," which territory is probably not equaled for unfavorable conditions for track circuit signaling anywhere in this country. This condition is due to the extremely low resistance of the ballast and the consequent heavy leakage between the rails, caused by the salt and alkali on that portion of the "Cut-Off" which is in the Salt Lake Desert and by the salt and soda deposit which forms on the tracks on the fill across Great Salt Lake.

The "Lucin Cut-Off" is a straight line track extending from Lucin, or more properly, Umbria Junction, east to Ogden, Utah, a distance of 104 miles. Of this distance 37 miles, from Beppo to Lakeside, is in the Salt Lake Desert; 34 miles, from Lakeside to Little Mountain, is across Great Salt Lake and is composed of 19 miles of rock fill, 12 miles of trestle (located in the middle of the west prong of the lake); and three miles of main land across Promontory Point. At a point midway between Promontory Point and Little Mountain there is a 600-ft. trestle which allows the waters of the Bear River, and numerous springs which empty into the east prong of the lake, to pass out into the main body. There is, flowing through this trestle, an extremely strong current and in the winter and spring large quantities of ice are present, necessitating the construction of a 630-ft. span in the pole line at this point, as shown in Fig. 2.

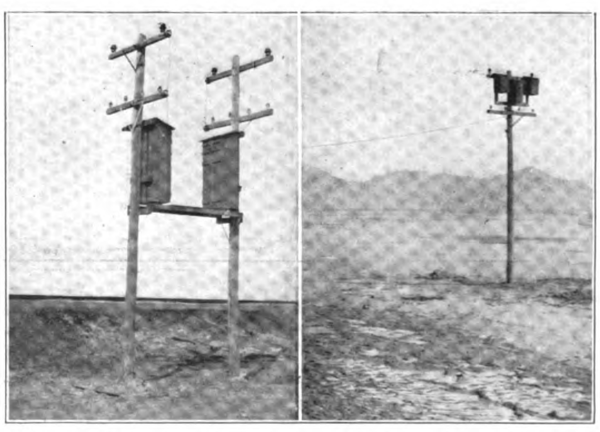
Fig. 1. The Transformer House on East Side of Salt Lake.

Fig. 2. Showing the 630 ft. Span Over the Bear River Channel.

Direct current signals were first installed in this territory but were not satisfactory, owing to the leakage conditions named above, it being impracticable to supply sufficient power to the track circuits by batteries. And after some preliminary experiments and tests on some of the worst of the track sections, with a portable power plant, composed of a gasoline engine and a single phase, 25-cycle alternator, mounted in a box car, it was decided that the track circuits through this territory could be satisfactorily worked with alternating current. Accordingly authority was granted for installing a system to use A. C. track circuits and D. C. signals, with the exception of about five miles of double track on the west end



Figs. 3 and 4. Showing (on the left) a Signal Location on Double Track on the West End of Salt Lake Fill, and (on the right) an 11,000 Volt Oil Switch Location.



Figs. 5 and 6. Showing (on the left) a Multi-Gap Lightning Arrester Location in the Salt Lake Desert, and (on the right) a Transformer Location in the Salt Lake Desert.

of the Salt Lake fill, where A. C. signaling is used exclusively.

This installation, which covers a total of 74 miles of line, is divided into two parts, one on either side of the lake and extending into it as far as the trestle, on which the signals are at the present time worked by D. C. track circuits. The line west of the lake running from Beppo to Rambo, a distance of 44 miles, is fed from an oil-burning steam generator plant at Lemay. This plant is in duplicate in every respect to provide against break-downs, and is equipped with Allis Chalmers 75 K. V. A., 25-cycle, single-phase alternators, direct-connected to 125 H. P. Skinner reciprocating engines, generating current at 440 volts which is stepped up to 11,000 and delivered to the line in either direction from the power house. The line east of the lake is supplied at 11,000 volts from a D. C.-A. C. motor-generator substation at Ogden, receiving the D. C. power at 250 volts from the railway shops power house. The apparatus in this substation is also in duplicate to insure continuous service.

The Lemay power plant is designed to supply power for 150 miles of double track A. C. signals, which it is the intention of the company to install in the near future, and which accounts for the large capacity of the sets.

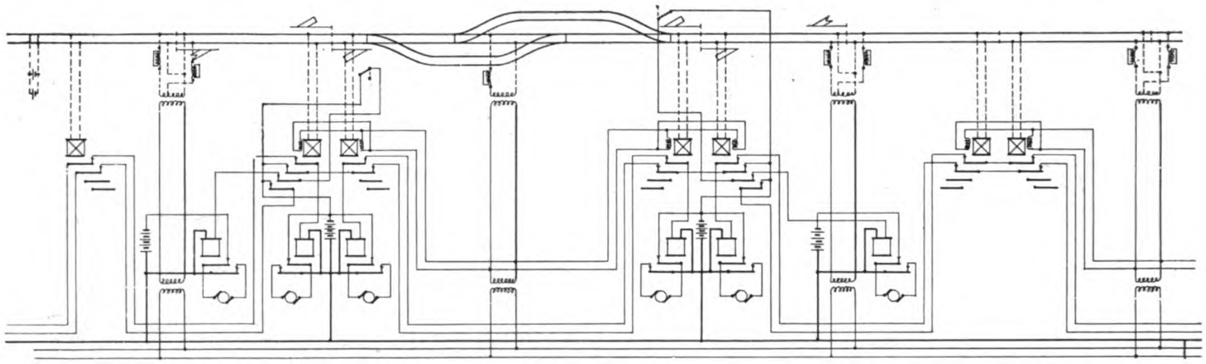


Fig. 7. Typical Circuits Showing A. C. Track Circuits

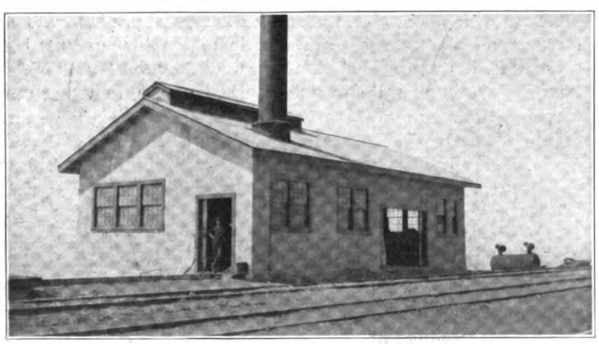


Fig. 8. The Lemay Power House.

The power line is of No. 6 Copper-Clad wire, 47 per cent conductivity, on the land and of No. 4 solid copper over the lake. The pole line on the lake itself is, more properly speaking, a pile line driven 100 ft. from the track with eight-foot cross-arms placed 30 ft. above the water. These distances were necessary on account of the spray, blown from the fill in times of storms, which is so heavily laden with salt that if allowed to deposit on the cross-arms and insulators might cause a heavy leakage between the wires and possibly short-circuit the line.

Owing to this possible deposit of salt and soda which forms slightly in that atmosphere regardless of any spray on the line it was not thought advisable to supply the line over the lake with 11,000 volts, and accordingly, a transformer house was located close to the shore on either side of the lake to step the voltage down to 2,200. The transformers in these houses are in duplicate and connected to the line on either side through oil switches.

The line is protected every 10 miles or less by lightning arresters. In the power house, substation, and transformer houses, Westinghouse electrolytic arresters are used and at other places along the line the General Electric multi-gap type were installed. The line is deadened on strain insulators and sectionalized by pole mounted oil switches every five to 10 miles, depending on conditions that are peculiar to the installation. Twenty-five thousand volt strain insulators and 15,000 volt brown glaze porcelain line insulators were used.

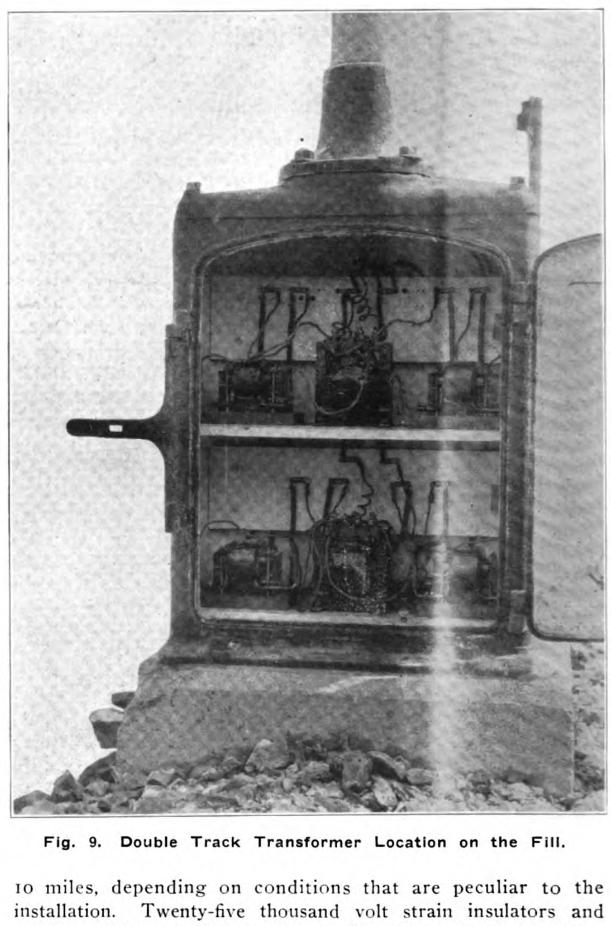
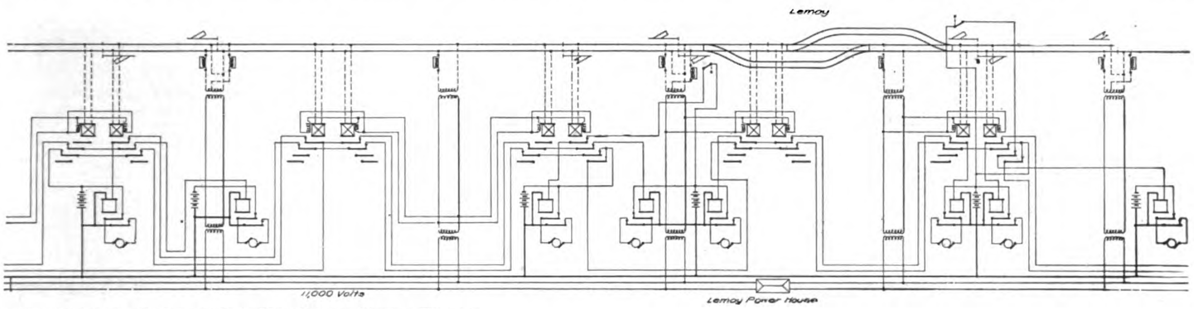


Fig. 9. Double Track Transformer Location on the Fill.

The difficulties connected with constructing a 2200-volt line across Great Salt Lake cannot be readily appreciated by any-one who is not familiar with that particular body of water, but suffice to say that, owing to the high specific gravity of the water, if the lake is at all rough it is not safe to attempt to use either a launch or a pile-driver and that during the process of construction, difficulties were encountered that demanded arrangements that are unprecedented in the history



With D. C. Line Controlled Signals on Single Track.

of signaling. Problems had to be solved, and the fact that there were no similar installations made their solution all the harder.

The signals are line controlled, the control wires being carried across the lake in a five-conductor cable on a 3/8-in. steel messenger. On the land, open wires were placed on separate cross-arms three feet below the high tension wires.

The track is bonded with Copper-Clad bond wires and cut into 2,000-ft. sections with transformers at every alternate

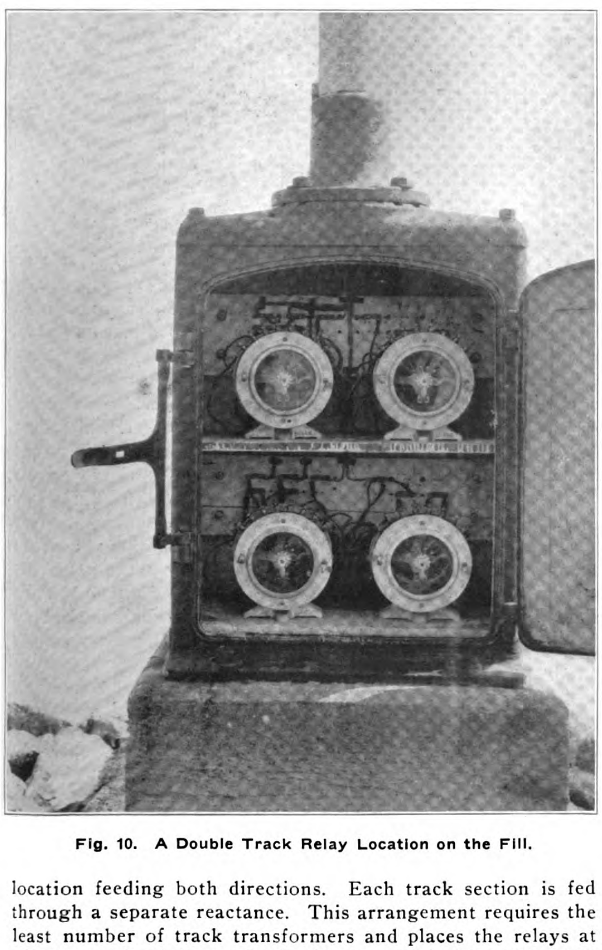


Fig. 10. A Double Track Relay Location on the Fill.

location feeding both directions. Each track section is fed through a separate reactance. This arrangement requires the least number of track transformers and places the relays at adjacent ends of the track circuits, thus minimizing the possibility of a relay holding up through any leakage current that might come from the adjacent section. The possibility of trouble from this source is further reduced by having adjacent circuits of opposite polarity.

The 11,000-volt and 2,200-volt currents are stepped down to 110 volts through Westinghouse one K. V. A. line transformers, for the signals and relay fields, and then change from 110, through a separate transformer, to the proper voltage required for each track circuit, which varies from 2.3 to 15 volts, depending on the condition of the ballast.

The two-element radial contact type of track relay is used with 110-volt fields. These together with the signals and other track appliances are of the Union Switch and Signal Company's manufacture.

It may be interesting to some to know that the normal load at the Lemay plant, as shown by the watt-meter on the switchboard, is, under the present arrangement, only five kilowatts. This load is divided practically as follows: One-half KW, exciting current in the 75 K. V. A. transformer; 2½ KW on the 11,000-volt line between Beppo and Lakeside, and two KW on the 2,200-volt line between Lakeside and Rambo, which supplies power for the five miles of double track mentioned above.

The leakage resistance between rails in the territory between Beppo and Lakeside is, as near as has been determined, 1-6 of an ohm per 1,000 ft., and on the fill it runs

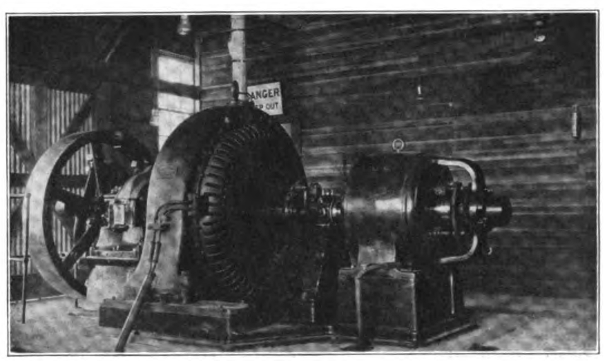


Fig. 11. The Engine Generator Set, Lemay Power House.

lower than the instrument can measure. From the observations made thus far, it goes at times to less than .05 of an ohm per 1,000 ft. This extremely low resistance occurs only when the tracks are wet with spray, but as this is liable to be the case at any time it must be considered as the regular condition in making adjustments of the track circuits.

Perhaps this low resistance between rails will be more easily understood when it is known that in times of storms sufficient water comes over the fill to keep the ties completely submerged, which fact, considered in connection with the following analysis of the waters of Great Salt Lake, seems to verify the statement in the first paragraph in regard to the unfavorable conditions for track circuit signaling. The

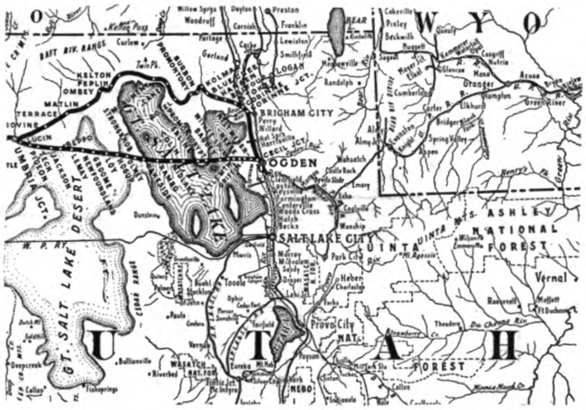


Fig. 12. Map Showing the Lucin Cut-off.

specific gravity of the lake water varies with the seasons, being lightest in the spring and heaviest in the fall. The sample from which this analysis was made was collected in October, 1903.

Specific gravity	1.2206
	Per cent.
Total solids	27.72
Constituents.	
Chlorine (Cl)	15.27
Sulphate (SO_4)	1.86
Magnesium (Mg)	0.155
Calcium (Ca)	0.045
Sodium (Na)	9.58
Potassium (K)	0.73

The above analysis was made at the University of Utah, Salt Lake City.

TESTING OUT A SIGNAL INSTALLATION.

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In installing the signals between Harvard and Evansville, Wis. (see *The Signal Engineer* for February, 1913), detailed wiring plans were used from which the relay boxes were wired. The boxes were wired in exact accordance with these plans, all boxes being in this manner made similar in that the relays used for the same purpose had the same position in each box, and so that the points on the various relays were always used for the same purpose.

The first check made was a so-called "mechanical" check. This consisted of comparing the wiring of the relay boxes, signals, etc., directly with the detailed wiring plans and the continuous circuit plans to see that all apparatus and wires had the proper position and that all wires were properly tagged. Where both ends of a wire could not be determined by pulling it, a pair of telephones were used for the checking. This check was made on wires between signals and relay boxes, and between pole line and apparatus. Anything wrong was immediately corrected.

The operating check was then made. The sections of signaling between stations were first checked, and then the sections through the station grounds. A portable magneto telephone set was placed at each signal location and connected between the common and ground wire. Conversation could be carried on quite satisfactorily over these connections when the telephone sets were in good condition.

One man, called the "director," had a sheet of paper ruled off with lines and columns. At the beginning of each line was a signal number, and at the head of each column, in order, were the track relay and switch-box numbers. As it was not possible to obtain a train for making an operating check of all the signals, two motor cars were used. The man with the head motor car was provided with several short pieces of wire. He would put the wire on the first track relay and the despatcher would call for the position of all signals throughout the section under test. The director would record the information and note correctness. And when all this information was received he would direct that the next track relay be shunted, and after this was reported done, would direct that the shunt on the first track relay be removed. When this in turn was reported done, the director again obtained and recorded the information as to the position of all signals. In this way the motor cars proceeded through the section, and when they reached the station at the end of the section the shunts on the track relays were removed and the switches at that station thrown and the information recorded. Then the motor cars started back and the information was recorded in the opposite direction in a similar manner. If a train was reported approaching, all tests were suspended; but the shunts on the relays were left as they were until the train had left the section under test. This left everything in the same position as it was previous to the approach of the train. On the last day a work train was obtained for a short time and the test made with it. This test proceeded very much faster than that with the motor cars.

The sections at the stations were tested independently of the sections between stations. Here the switches were thrown and the signals observed. The track circuits were also shunted and the positions of the signals observed. The switch indicator circuits were tested by a man on a motor car who shunted each track circuit, which affected the indicators, and each indicator was observed. Field glasses were used to very good advantage in making the test on the straight track. With the field glasses the signals could be seen sometimes for six or seven miles, depending on the light.

In addition to the foregoing, local checks were made as follows: Each track relay was shunted to see that the 45-deg. control relay and the 90-deg. relay dropped properly, and that the stick relay picked up, provided the signal was in the 45-deg. position or higher, and stayed up while the 45-deg. control relay was de-energized, but that it would not pick up by shunting the track relay if the signal was below the 45-deg. position. The stick relays were picked up and the opposing signals observed to see that they assumed the zero position.

When all these checks had been made it was pretty certain that the signals would operate properly. And they did.

A CREDITABLE PERFORMANCE.

The performance record of the automatic block signals on the San Francisco & Oakland Terminal Railways, popularly known as the "Key System," for the year 1912, shows a maximum of 1,400,000 blade movements (45 deg.) per month, a minimum of 940,000, and an average of 1,097,683.

The number of signal failures per 100,000 blade movements in any month of 1912 showed a maximum of .74 and a minimum of .16, with an average of .50, making only one signal failure for every 200,000 blade movements of 45 degrees. This record has been carefully kept each month, the number of movements being registered by a counter attached directly to the signal mechanism.

Before the installation of the signals (they have been in service since February 18, 1911) the schedules were often demoralized on account of the dense fogs and congested traffic conditions. Since that time, however, the trains have been operated practically without delay and with entire safety under all conditions of weather and traffic.

IF THE THREADS ON A BOLT or nut are covered with rust, or fit tightly, clean them out with a mixture made as follows: Mix some powdered emery with any kind of grease and smear the threaded parts, both inside of the nut and on the bolt, then turn the nut on the bolt and run it back and forth over the threads. This method will be found effective even in the most stubborn cases.

A PIECE of old insulation from track fibre, smoothed flat, makes a good contact breaker for switch boxes, and is handy to wrap sandpaper around to clean contact.