New Signaling on the Big Four

A. C. Floating Battery Installed for the Operation of 68 Miles of Double Track Automatics Shows Economy in Operation

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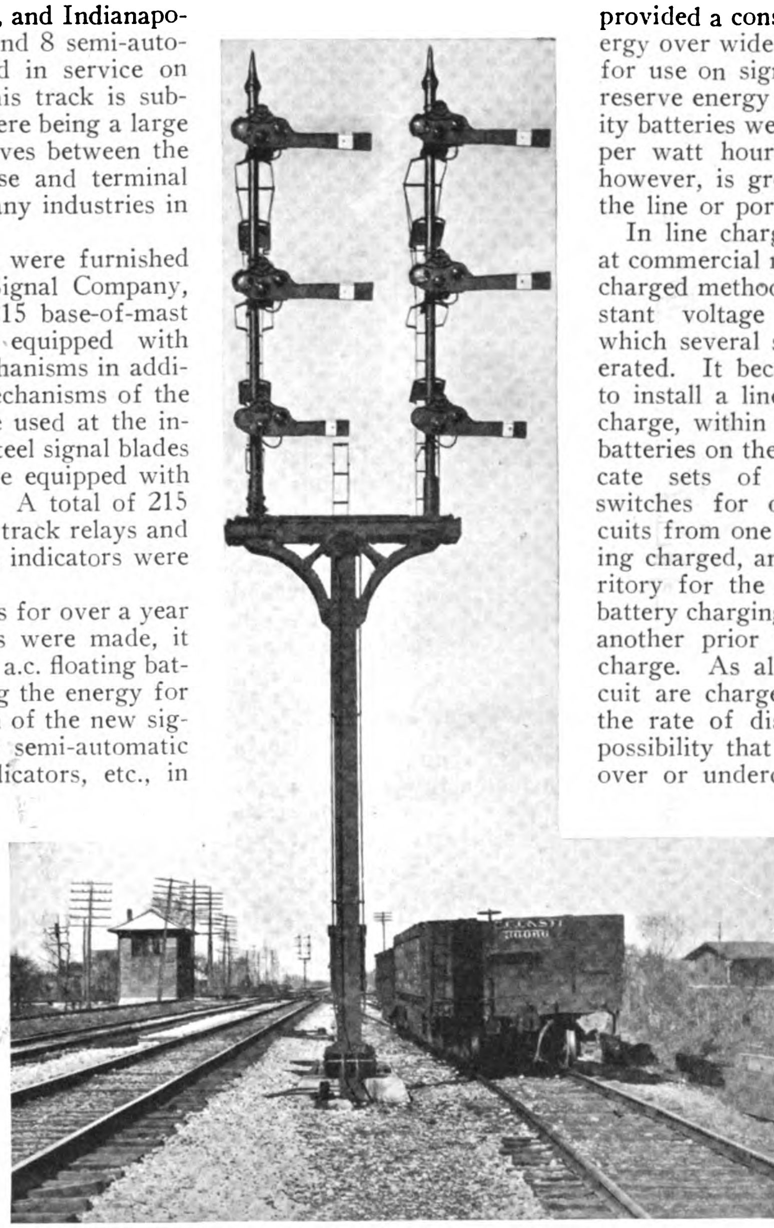
AUTOMATIC signals were placed in service March 21, 1922, on 63 miles of double track between Berea, O., and Crestline, using 109 automatic and 49 semi-automatic signals. This installation completes the automatic block signaling between Marion, O., and Cleveland and includes that part of the road east of the junction at Galion, O., where traffic from Cleveland to Indianapolis, Ind., and Cleveland to Cincinnati diverges. At the present time there is a scheduled train movement of 32 passenger trains and 16 freight trains a day over this territory.

A second installation of five miles on double track between Beech Grove, Ind., and Indianapolis, using 12 automatic and 8 semi-automatic signals was placed in service on December 29, 1921. This track is subjected to heavy traffic, there being a large number of switching moves between the coach yards, round house and terminal and also to and from many industries in this district.

All signals and relays were furnished by the Hall Switch & Signal Company, there being a total of 215 base-of-mast upper-quadrant signals equipped with Style L, 10-volt d.c. mechanisms in addition to 34 side-clamp mechanisms of the same rating, which were used at the interlockings. Enameled steel signal blades are used. All signals are equipped with staggered marker lights. A total of 215 line relays, 130 two-ohm track relays and 10 d.c. 1,000-ohm switch indicators were installed.

Having carried on tests for over a year before these installations were made, it was decided to install the a.c. floating battery system for supplying the energy for the control and operation of the new signal system and also the semi-automatic home signals, locks, indicators, etc., in the eight mechanical interlockings in the territory covered. A review of the study of the a.c. floating battery system and several of the advantages considered important are given below.



Home Signal Boyd Interlocking Two Top Arms Power Operated

A Study of the Various Types of Energy Supply

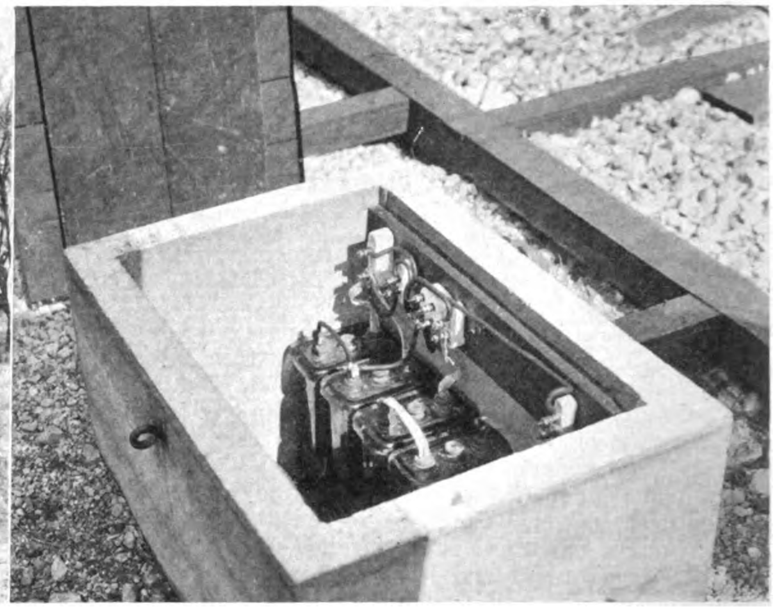
The advent of the use of storage batteries on floating charge from rectified commercial alternating current is the most recent progressive step taken in the art of railway signaling. The result is increased efficiency and economy in the maintenance and operation of signals and track circuits, as this system combines the advantages of low initial and operating costs for signal, track, and lighting circuits.

Storage battery for the operation of signal circuits has been successfully used for many years, in which three methods of charging is employed, viz., by gravity cells, direct current line, and central station charging of portable sets. The low charging rate of the gravity charging method insured a maximum life of the storage cells and provided a constant voltage source of energy over wide variations of temperature for use on signal circuits, together with reserve energy for operation if the gravity batteries were not renewed. The cost per watt hour, using gravity batteries, however, is greater than that for either the line or portable method of charging.

In line charging, energy is purchased at commercial rates and, as in the gravity charged method, there is provided a constant voltage source of energy from which several signal circuits may be operated. It becomes necessary, however, to install a line of sufficient capacity to charge, within a short period, all of the batteries on the circuit; to provide duplicate sets of batteries and charging switches for operating the signal circuits from one set while the other is being charged, and to cover the entire territory for the purpose of throwing the battery charging switches from one set to another prior to the beginning of the charge. As all of the cells on the circuit are charged in series regardless of the rate of discharge, there is a great possibility that some cells will be highly over or undercharged, which results in decreased life of the storage cells.

The portable method has the advantage of low initial cost, the use of commercial current, constant voltage, and proper charging. However, it has the disadvantage of the necessity for transportation and, generally, cannot be used economically in track circuits due to the necessity for frequent charging in that service. While the last two named methods

All Rectifiers at a Signal Location Are in One Box



Track Battery in Standard Concrete Box

involve the use of commercial current, they do not permit of the use of this current for efficient lighting.

The alternating current signal system has the advantage of immunity from foreign direct current in track circuits and its installation is usually justified from this standpoint. It also has the advantage of being operated by energy at commercial rates and has a low labor cost in maintenance. However, this system has the disadvantage of high initial cost, greater power consumption, while the continuity of operation is entirely dependent upon the power supply line, there being no reserve to maintain operation during interrunption.

Signal and track circuit operation from caustic soda primary cells is quite commonly used because of the simplicity with which energy may be obtained at many isolated points. It has the disadvantage of the necessity for renewal, varying voltage because of temperature changes, decrease in voltage during service, and high cost per watt hour which the newsystem overcomes. The extension of power circuits into rural communities has made energy available at many points along the railways where it can be transmitted over the railway signal or telegraph pole lines from numerous points for short distances at low voltages. The development of suitable rectifying apparatus has made practicable the conversion of alternating current into direct current for the purpose of operating signal circuits and battery charging. With this combination it will be seen that storage battery with its manifest advantages and the previously mentioned disadvantages eliminated may be used at what might have been formerly considered isolated points. The size of the power line, due to continuous charging over a 24-hour period, may be kept at the absolute minimum for the service required. In many cases the size of the wire is actually determined by the mechanical strength required, there being no peak load involved. The system has the following advantages:

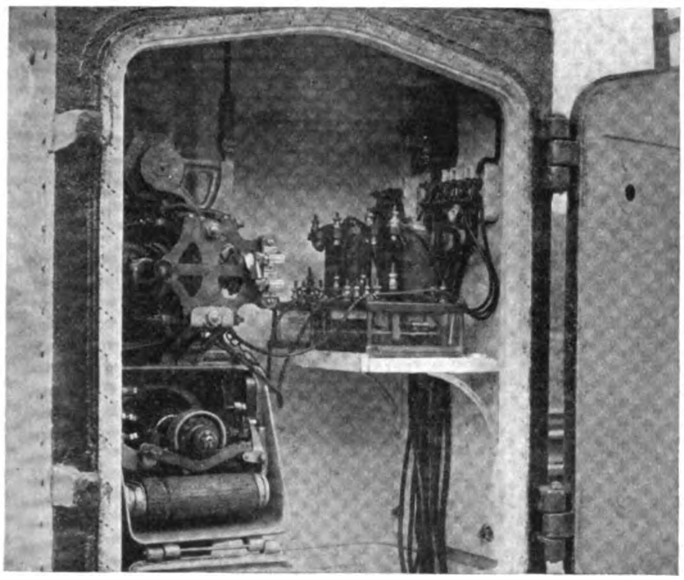
1. Continuous service. Reserve energy supply for all circuits.
2. Use of commercial power. No labor necessary in charging. Minimum maintenance expense of system.

Double Location Showing the Line Connection, Rectifier Box and the Battery Box

3. Efficient lighting from alternating current with direct current emergency reserve, continuous or approach.
4. Relatively low initial cost.
5. Means of regulating rate of charge to the minimum for the battery in each individual circuit.

Application of the New System and Operating Data

On the 63-mile signal installation between Berea, O., and Crestline, current is supplied at 6 points along the line at 220 volts, the average rate per kw. hour being 6 cents. The alternating current supply wires occupy positions on adjacent pins on the field side of the signal cross-arms on joint telephone and telegraph pole line. The size of the wire used is principally No. 6 AWG bare copper, there being in some circuits No. 4 AWG and No. 8 AWG to meet local conditions. The a.c. wires were placed on adjacent pins to avoid inductance and no interference



Signal Relays and Lighting Relays Are Placed in the Mechanism Case

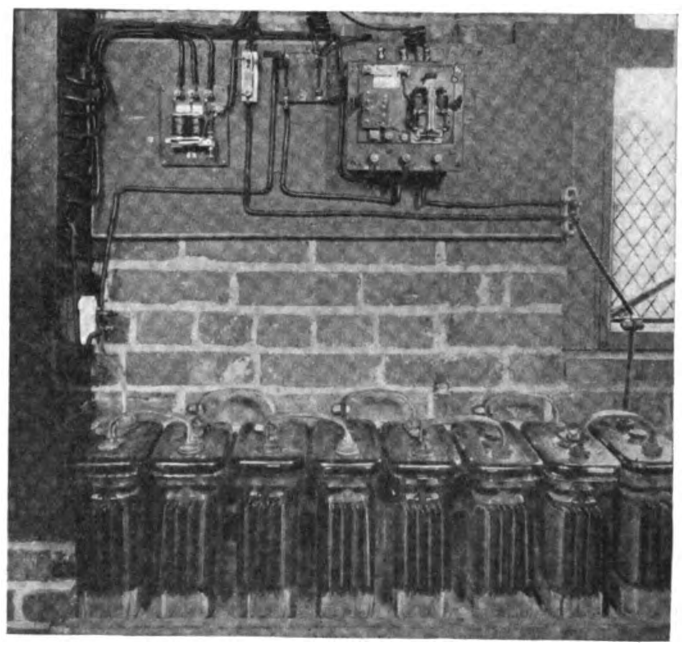
has been experienced in telephone or telegraph circuits. The maximum length of circuit is 9 mi. from the point of supply, the maximum load being 525 watts, which supplies 23 signals, 23 track circuits, and 46 signal lights. Lightning protection is furnished between the line and the apparatus by the use of ordinary low voltage arresters in the supply line leads. Alternating current circuits may be opened at each location by a double-pole hand switch installed for that purpose.

The rectifiers furnished by the Leich Electric Company are of the mechanical type, using a single wave. The primary circuits are provided with two taps, one for 200 and one for 230 volts. The purpose of this adjustment is to take care of line loss should future use of the line lower the voltage. The rectifiers are interchangeable as between track and signal batteries with the exception of the charging resistance, which is readily removable. The resistance for use with the signal battery is provided with 6 taps for charging at the minimum of 0.140 amp. in steps of 0.060 amp. to the maximum of 0.500 amp. It has been found that the lowest or the next lowest step will generally keep the signal battery fully charged under present traffic conditions. The resistance for use with the track battery is also provided with 6 taps for charging at the minimum of 0.400 amp. in steps of 0.100 amp. to the maximum of 1.000 amp. It has been found that a charging rate of 0.400 amp. to 0.600 amp. will generally keep the track battery fully charged. In addition to the battery charging terminals, a lighting winding is provided.

All rectifiers are placed on the pole line side of tracks regardless of the signal location and the supply circuit is brought to the rectifier case direct from the line through an aerial drop, entering the rectifier case on the side near the top through a condulet fitting. An independent rectifier is provided for each signal and each track battery. The charging and lighting circuits are run through surface trunking to the signal and battery box.

The storage battery is housed in a shallow concrete box, 20 in. by 30 in. inside dimensions, which has a maximum capacity of 12 cells. Each signal is provided with a housing located immediately adjacent to it for both the signal operating and the track circuit batteries. The battery box is cast with open bottom and was constructed when the signal and cable post foundations were installed.

The storage battery is type KXH, Exide, manufactured by the Electric Storage Battery Company, having an R. S. A. rated capacity of 75 a.h. Four cells in series are used on signal operating and emergency lighting circuit, and two cells in multiple are used on track circuits. The elements are in glass jars with sealed glass covers, equipped with filling plugs. This cell provides the maximum advantages for the purpose intended, the plates being visible and the covers insuring a minimum of evaporation. The jars have ample room for the electrolyte, making it unnecessary to add water frequently. The capacity of the battery was given careful consideration prior to its in-



Tower Battery With Light Relay and Rectifier

stallation and is based on the rate of discharge when the charging circuit is open. Subsequent tests have proven that the battery equipment will operate the signaling system for a period of about two weeks after discontinuing the charge, which, under ordinary circumstances, is ample time for the resumption of the service from the supply.

The track circuits are all end fed without cut sections, operated to a maximum of 6,350 ft. in length. The average resistance between the battery and the track is 4½ ohms. The rail is bonded with two No. 6 copperweld bond wires, 40 per cent conductivity, using Duplex channel pins.

Signals Lighted Electrically

The lighting relay which serves to light the signal and marker lamps from the transformer and from the 8-volt storage battery in case of interruption of the supply line circuit, is housed in the mechanism case and operated by the same a.c. tap which normally lights the lamps. The lamp cases used are of cast iron in accordance with R. S. A. standards, being equipped with adjustable receptacles for single contact, bayonet base lamps using S-11 bulbs and C-3 filaments, rated at 12 volts. To insure greater increase in lamp life the lamps are lighted under the rated voltage both by the direct and alternating current at 8½ and 9 volts, respectively. At these voltages the lamps consume less than 2 watts which produces ample light for night use, more than approximating the light of a clean oil lamp.

Battery Installation at Interlockers

In the territory covered by this installation there are eight interlocking plants, all of which govern crossings or junctions with foreign roads. Seven of these plants, prior to the installation of automatic signals, were equipped with mechanically operated home signals which were changed to operate semi-automatically. The energy for the operation of the signals, machine locks, repeater relays, etc., at these plants is supplied from a central storage battery located at the tower. This battery also serves to light the same signals automatically in case of an interruption of the a.c. supply. The lighting relay shown to the left of the rectifier in the photograph of the tower battery is the same type as is used in all signal cases. The buildings are lighted from the a.c. supply. All energy used in these plants, whether for signal, track, or signal lighting circuits, is supplied by the a.c. supply line and rectified to charge the storage battery in that circuit at the tower.

Although the a.c. floating system is new and while it is expected that a great deal more will be learned about it in the future, it is quite interesting to note that the entire mileage above described was placed in complete service with a minimum of the difficulty and expense which is often experienced in placing new apparatus in use. For the maintenance of the above mentioned mileage, including the seven interlocking plants, there are employed seven maintainers without helpers, while prior to the installation of automatic signals there were six maintainers covering this territory. The entire installation was made by company forces.

A New Phase-Angle Meter

Device Facilitates the Adjustment of A. C. Track Circuit, Increasing Efficiency of Operation

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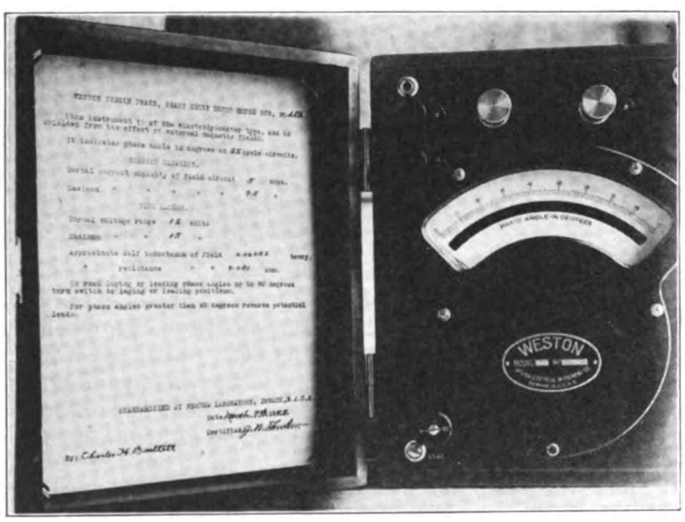
IN an article, "The Safe Shunting of A. C. Track Circuits," appearing in the October, 1921, issue of the *Railway Signal Engineer*, mention was made of the fact that the Long Island was negotiating with the Weston Electrical Instrument Company regarding the design of a light, portable, and practically direct-reading phase-angle meter to take the place of an instrument already on the market that was heavy, expensive and cumbersome.



Complete Directions for Operation Are Located in the Cover

This instrument has now been designed and tested out by the signal department of the Long Island with most excellent results. This instrument is to be used in the adjustment of polyphase A. C. track circuits where the highest efficiency and sensitivity as to train shunting is desired. It is obvious that this adjustment is possible only where two-element relays are involved. Satisfactory operation is secured when the currents in the track and local coils of the track relay are nearly in the proper phase relationship.

In order to secure the highest efficiency and shunting, without the excess or extravagant use of current, it becomes necessary occasionally to make phase-angle readings. Two-element track relays such as the Vane and Universal types are generally designed to operate most efficiently when the currents in the track and local coils are 90 degrees apart. In actual service I have found that rarely ever do the currents in these two-element relays ever lag or lead one another by the angle mentioned above; actually, the angle is nearer 28 or 30 degrees. This is due to poor bonding, low ballast resistance, drop in leads, relay design, etc.

The operation of this phase-angle meter is simple, as no mathematical calculations are necessary. The only calculation is the addition or subtraction of the angles read directly on the scale. This instrument as designed for our use was arranged for 25-cycle current and for relays whose local coils were wound for 12 volts. Therefore, it was necessary to use a transformer weighing three or four pounds for the reason that the winding of the instrument coils was designed for 110 volts, the idea being that where 110-volt relay locals were used the current could be applied directly to the instrument coils. This meter can be designed for any frequency or local coil voltage. The present instrument weighs 19½ lb. and is mounted in a mahogany case 8⅛-in. wide by 8⅛-in. high by 10½-in. long. An instrument designed for