to stop at the crossing for switching and interchange work and therefore there is no loss to this line on account of unnecessary train stops.

Plant A is in low-speed territory, whereas Plant B is in high-speed territory for the heavy-traffic line. Therefore, distant signals are not required for Plant A but are required for Plant B. Roughly, the cost of Plant A was about $3,000 and of Plant B about $8,500. Plant B has color-light signals throughout, whereas Plant A has motor signals throughout.

The advantage of Plant A is its simplicity and low cost. The maintenance and interest amount to about $510 per year. If a train stop costs 51 cents, it is necessary that about 1,000 train stops per year, or about three per day, be saved, to carry this kind of a plant. If the average train-stop at slow speed is worth a dollar, then this plant becomes a 100 per cent investment, as it will not only carry itself but will pay for itself, in addition, each year, on three train stops saved per day.

Under normal conditions at this crossing approximately 2,880 passenger-train stops and 3,650 freight-train stops are eliminated per year. If the passenger train stop is worth 51 cents and the freight train stop $1.50 (5 minutes at $18 per train-hour), the savings are about as follows:

Train stops saved—	
2,880 passenger trains at 50 cents	$1,440
3,650 freight trains at $1.50	5,475
Total	$6,915

Crossing-Signal History

"A flashing-light highway crossing signal, incorporating two red lights mounted horizontally and flashed alternately, was placed in service on the Pennsylvania Railroad at New Bethlehem, Pa., on June 27, 1923. Were there any earlier installations of such signals?"

First Flashing-Light Signal on New Haven Had Only One Unit

By C. H. Morrison
Signal Engineer, New York, New Haven & Hartford, New Haven, Conn.

Because highway-crossing bells did not give sufficient warning to noisy trucks and closed automobiles, the New Haven developed an electric flashing-light highway-crossing signal consisting of a high-powered bulb in a lantern, equipped with a polished parabolic reflector and a red cover-glass. The flashing was accomplished by the use of a commercial sign flasher. A disk was installed on the post supporting the lantern, reading "When Red, Stop, Train Coming." This disk was illuminated at night by an oil lantern and a "long-time" burner. The first signal of this kind was placed in service September 11, 1920, at Woodway Grove in Springdale, Conn., and gave very good service. Later on, a signal known as the "Morrison" signal was developed; this signal is shown in the illustration. The relays used for accomplishing the flashing light, prior to the development of the flashing relay, consisted of two standard slow-acting relays, adjusted in such a manner that the lights flashed once in two seconds, but the duration of the period of light was twice that of the period of darkness. The first signal of this type was placed in service on August 2, 1921.

On or about 1922, the Signal Section of the American Railway Association, appointed a special committee on highway-crossing-signal protection. In the early spring of 1923, a meeting of the committee was held in Chicago, at which time it was agreed to use two electric flashing lanterns in a horizontal line with the lights flashing alternately. The first one of these was installed on the Pennsylvania at New Bethlehem, Pa., on June 27, 1923.

Because the New Haven had already adopted the Morrison light signal as a standard, it did not install any of the signals recommended by the Signal Section, until August 8, 1924. After the installation of these signals, it was found that highway vehicles could pass the signal and approach the railroad and thereby lose the indication of the light. Therefore, various schemes were suggested to give a side view of the signal, but without a great deal of success.

An early type of flashing-light highway-crossing signal, known as the "Morrison" signal

The New Haven in November, 1928, installed duplicate signals on each signal mast; that is, the signal on the far side of the railroad tracks gave the same indication as that given by the signal on the near side. This, I believe, was one of the first, if not the first, case of each signal shining both ways.

Due to highway travelers misinterpreting the double flashing light as a railroad grade-crossing signal, various types of signs were attached to the signal, such as the word, "Stop," in vertical line, giving an indication during the approach of a train. Others gave the word, "Stop," by a revolving disk. Both of these schemes consumed electric energy and required additional apparatus. The New Haven developed a "Stop on Red Signal" sign made up of reflecting lenses, such as is illustrated on page 739 of the November 14 issue of Railway Age. This type of sign was recommended to the special committee of the American Railway Association on highway grade-crossing protection, was approved by them, and later approved by the Signal Section, as well as by numerous railroads. The first sign of this kind was installed on the New Haven in April, 1930.

This information should convey an idea of the development of the electric flashing highway-crossing signal up to the present type of signal as recommended at the last meeting of the Signal Section.

Recommendation Presented in 1922

By A. H. McKeen

Signal Engineer, Union Pacific System, Salt Lake City, Utah

The Signal Section Committee on Highway Crossing Protection, which was appointed in 1921, discussed for two years the matter of standardizing on one type of device. During the period prior to 1923 there were many different types of crossing signals in use, comprising wig wags, disk signals, Brach flashers, etc., but outside of the single flashing light on the N. Y., N. H. & H. and the Penna., no flashing lights were installed until 1923, when the first double flashing-light installation was made on the Pennsylvania.

The matter of standardizing seemed to be a forlorn hope until the latter part of 1922, when, at a meeting of the Committee in Chicago, the suggestion was made and the following recommendation presented, as appearing in Vol. XX of the 1922 proceedings, page 35.

> "It is the opinion of the committee that only one aspect should be recommended as a standard signal to indicate the approach of a train, and the members of the committee present agreed to experiment with a signal consisting of two lights in a horizontal plant, alternately flashing red."

Subsequent thereto and prior to the annual meeting in 1923, the committee designed and examined a signal consisting of two horizontal alternately-flashing lights, which, it was found, presented the appearance of a single swinging light, and unanimously passed a resolution as the recommendation of the committee which was presented at the 1923 annual meeting and appearing in Vol. XX, page 214, reading as follows:

> "Resolved that an electrically or mechanically operated signal used for the protection of highway traffic at railroad crossings, shall present toward the highway when indicating the approach of a train, the appearance of a horizontally swinging red light and/or disk."

Thus was born the present A. R. A. standard crossing signal, which was first publicly exhibited in the vacant lot across from the Drake hotel, Chicago, during the annual meeting in March, 1923. Therefore, it would appear that the installation of two alternately-flashing horizontal lights, made on the Penna., in June, 1923, was the earliest installation.

W. J. Eck, assistant to vice-president, Southern, states that the earliest installation of signals of this type on the Southern was made at a public road crossing at Aiken, S. C., and that these signals were placed in service on March 10, 1923.

C. E. Hartvig, assistant signal engineer, Chicago, Rock Island & Pacific, replies that "A flashing-light signal answering the description given in the inquiry was placed in operation on the Rock Island at Pennsylvania avenue, St. Louis, September 5, 1922, and is still in service as originally installed. This signal is a center-of-street installation, including the use of a storage battery with a mechanical rectifier, and a power-off relay for normal operation of the lights."

Polarized Track Circuits

"Under what conditions can polarized a-c. or d-c. track circuits be used with safety? What is to be gained by the use of such track circuits?"

Safer and More Economical

By E. Winans

Signal Engineer, Atchison, Topeka & Santa Fe, Los Angeles, Cal.

There is 685 miles of double-track three-position straight a-c. signaling on the Santa Fe Coast Lines, all of which is controlled through polarized track circuits. The advantage of this circuit is that no secondary line circuits are required for the control of the signals themselves.

Several states require the grounding of the neutral point of all line transformers as a matter of safety. With a common return in an a-c. installation, or without a common return if the neutral points of all line transformers are grounded, a line cross may result in bypassing some relay contacts. The use of a polarized track circuit eliminates line control and if there is no line control there is no line wire to cross and, therefore, the a-c. polarized track circuit control is both safer and more economical.

W. J. Eck, assistant to vice-president, Southern, says, "We use this type of circuit whenever the circuits can be simplified by its use. It saves line wire, the circuits are simpler, and, we believe, safe."

Shooting Track-Circuit Trouble

"What inspection methods and what equipment are most efficient for the purpose of locating track-circuit defects such as partial or complete short-circuits in bridge decking, hidden non-insulated gage rods, defective rail-joint insulation, defective tie-plate and throw-rod insulation, intermittent breaks in concealed bond wires, defective fouling, etc?"

Voltmeter Test Usually Sufficient

By Otto M. Jensen

Office Engineer, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.

To the experienced maintainer, a check with a voltmeter will quickly indicate the nature of trouble on a track circuit, that is, whether the trouble is an open circuit or a short circuit, and therefore a voltmeter is most commonly used in "hunting down" track-circuit trouble.

Various other novel methods are successfully employed in detecting trouble on track circuits. On a-c. track circuits it is practical to connect a six-volt lamp to the motor car wheels in such a manner that the lamp will indicate the point of trouble in the track circuit, when traveling over the track with the motor car. Another method of locating trouble on a-c. track circuits consists of employing a "detector" made of a triangular piece of wood containing about 600 turns of No. 36 magnet wire on each leg of the angles, and connecting a 2,000-ohm telephone receiver to the magnet wires terminating at one of the angles. This triangle, when carried parallel to and directly above one of the rails,