face being only 19.4 deg. F. The minimum air temperature for the month was —43 deg.; also between the minimum of 33.8 deg. at 4 ft. in depth and the soil surface there was only a 14-deg. gradient.

The range of temperatures encountered in the subsoil at Bozeman is illustrated by Fig. 1 for February, 1936, and as a general proposition in Fig. 2. The accompanying table illustrates the measurements made on February 8 and 9, 1933, at various depths.

Temperature Measurements at Bozeman, 1933

	Feb. 8 Deg. F.	Feb. 9 Deg. F.
Air temperature 6 in.	—11.7	—19.5
Snow level 4 in.	— 0.4	— 9.2
" " 3 in.	+ 5.2	— 2.8
" " 2 in.	10.6	+ 5.0
" " 1 in.	19.0	15.6
Soil surface	20.8	17.7
1 in. below surface	21.4	19.0
2 in. " "	22.3	19.4
3 in. " "	22.7	19.7
4 in. " "	23.1	20.2
5 in. " "	23.6	20.8
6 in. " "	24.0	21.1
8 in. " "	24.9	22.5
10 in. " "	26.2	23.6
12 in. " "	26.5	25.0
14 in. " "	27.0	25.6
16 in. " "	27.8	26.6
18 in. " "	28.4	27.4
20 in. " "	29.2	28.0
22 in. " "	29.7	28.3
24 in. " "	30.3	29.0
3 ft. " "	33.6	32.7
4 ft. " "	36.0	35.0
5 ft. " "	37.8	37.6
6 ft. " "	40.0	39.6

In measuring these temperatures, it was necessary to arrange a series of thermo-couples in the soil at the various levels without disturbing the original state of the earth. This was done by burying a vertical wooden shaft or casing, from which the thermo-couples protrude into the earth. Electrical connections were run from this shaft to the measuring instruments in the laboratory building. The inside apparatus consisted of a sensitive galvanometer, a potentiometer of the General Electric Type PJ-1B, together with terminals, a switchboard, etc.

The connection from the terminal box to the buried part of the system consists of a lead-covered telephone cable of 52 paper insulated 22-gage copper wires. The buried portion of the system is 30 ft. from the building in a grass lawn. The cable lies in a wooden casing constructed of 1-in. soft pine which, like all the wooden construction, has been treated with two coats of hot creosote. The buried couples are constructed of 32-gage copper and constantan enameled and single silk insulated wires. All the wiring has been done on a piece of hard wood 1 in. by 4 in. by 6 ft., the thermo-couples projecting 6 in. through 3/16-in. holes bored at the required depths. In order to hold the couples out horizontally from the board and to maintain their relative distance from each other, as well as to protect them from corrosion, 3/16-in. copper tubes 7 in. long, sealed at one end and threaded at the other, were slipped over them and screwed into the wood. The wiring being completed and the protecting copper tubes placed in position, the wires were soldered to those of the cable from the recording instruments. One end of the casing being plugged, hot insulating compound, such as is used in transformers, was poured into the other end, thus making the system watertight.

Each foot of earth removed was kept in a separate pile so that it could be returned in the same order in which it was removed. Holes just large enough to receive the copper tubes were bored in the undisturbed face of the excavation. The wired casing was then placed in position and the hole filled.

Location of Home Signals at Automatic Interlockings

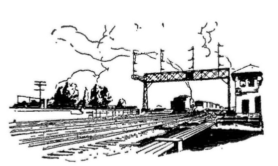
"When installing an automatic interlocking at the crossing of two single-track main lines, how far from the crossing should the home signals be located? Are there any special factors leading to a decision that they should be as close as 100 ft. or less?"

Proper Distance 400 to 500 Ft.

R. A. Sheets
Signal Engineer, Chicago & North Western, Chicago

It seems to have been established, over the many years that grade crossings between railroads have existed, that stop boards, where required, should be installed approximately 400 ft. from the actual crossing. Nearly all state laws have limited the location of the stop boards somewhere between 800 ft. maximum and 400 ft. minimum. Established practice for the location of home signals at interlocking plants has likewise, throughout many years, been based upon a 500-ft. distance from the crossing. As a general proposition our experience with automatic interlocking plants has indicated that this distance of 400 or 500 ft. is practical, and has neither been too close to the crossing nor too far away.

Such distance will not cause undue delay to trains in the event that it is necessary for a trainman to proceed to the crossing to change a route when there is a conflicting movement, or to give flag protection for a train movement in the event of failure of the automatic devices. Although enginemen operating trains on signal indications are very reliable and proficient in the matter of controlling the speed of trains so that they are almost always able to stop at a home signal indicating "stop," it has always seemed to be good practice to allow some margin of safety for those extreme cases where the judgment may be poor or where conditions are such that a home signal at "stop" might be overrun. Therefore, the distance of 400 or 500 ft. certainly seems to be warranted as a safety factor.



Some conditions and locations, however, make it necessary for the home signals to be closer to the crossing, such as the proximity of stations or connections from a yard to a main track adjacent to the crossing, where there would be an actual disadvantage in locating the home signal 500 ft. from the crossing. Nevertheless, only where the speed of operation is naturally restricted by other conditions and circumstances, and only where the view of signal and crossing is unobstructed, should the distance be reduced to a minimum of 250 to 300 ft. Any distance less than this is reducing the safety factor too much.

With the present tendency towards the use of operative distant signals as a part of automatic interlockings with the particular purpose of permitting increased speed of train operation, it appears of greater importance that the home signals should not be located too close to the crossing. In my opinion, as a general proposi-

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tion the location of home signals between 400 and 500 ft. from a crossing is neither too close nor too far from the crossing.

No Objection to Short Distance

L. S. Werthmuller
Assistant Engineer, Missouri Pacific, St. Louis, Mo.

It has been the general practice for state authorities to require that at non-interlocked crossings, trains be brought to a stop 200 ft. to 800 ft. from the crossing before the movement is completed. As a result, it was the general practice to locate the stop board 200 ft. from the crossing. The leeway afforded by the 200-ft. to 800-ft. requirement, of course, was allowed as, in the early days, it was practically impossible for an engineman to bring his train to a stop within a short space.

However, with the advent of interlocking and the use of derails to provide protection against overrunning the stop signal, it was necessary to move the signals out to provide the necessary distance for a train to stop clear of the crossing, should an engineman fail to make the stop. As a result of this, the derails were generally located 500 ft. from the crossing and the signal 55 ft. to 100 ft. ahead of the derail.

With the increased use of signals for operation of trains and the great improvement in train braking, the use of derails is being gradually eliminated, and with it the necessity of locating the signals so far away from the crossing. It is my recommendation that the home signals be located not more than 200 ft. from the crossing and where, due to special track conditions, it would be better to locate signals 100 ft. from the crossing, I see no objection to this location.

Stranded Bare Cable for Switch Circuit Controller Connections

"What are the advantages and disadvantages of using stranded bare cable stapled to the side of a tie, for connections between switch circuit controllers and rails?"

Reliability Reduced at Terminals

W. N. Hartman
Assistant Signal Engineer, Chesapeake & Ohio, Richmond, Va.

I think the greatest disadvantage in the use of stranded bare cable is that it cannot be satisfactorily terminated on the binding posts in the switch circuit controller, thereby requiring additional connectors which materially reduce the reliability of the shunt circuit. The type of construction described below, aside from being economical to install and maintain, has the decided advantage of being more reliable in that duplicate independent shunt circuits are provided and without intermediate connectors.

The type of switch shunt construction on the Chesapeake & Ohio consists of using two No. 9 AWG flexible insulated signal wires between the switch circuit controller and each rail. Each of the four shunt wires is terminated on a binding post in the switch circuit controller by means of a No. 9 wire eyelet and two independent connections to each rail are accomplished by means of rail terminals in the web of the rail, one of which is on the gage side and the other on the outside, thus providing duplicate shunt circuits so as to insure proper track shunting if one of the rail terminals were to be broken off by dragging equipment. The wires between the switch circuit controller and the rails are enclosed in No. 4 trunking which is secured to the tie on which the switch circuit controller is mounted by means of 16-gage galvanized sheet iron straps 1½ in. wide fastened with 1-in. galvanized roofing nails, and each of the four track wires is brought out to the rail terminal through a snug hole in the top of the capping, sufficient slack wire being left in the trunking to allow for rail creepage and for re-terminating the wire at the rail terminal when necessary. The wire inlet to the switch circuit controller is through a notch in the side of the trunking to a groove in the top of the tie under the circuit controller.

Sees Difficulty in Terminating

A. Hunot
Chief Signal Draftsman, Missouri Pacific, St. Louis, Mo.

An arrangement of this kind would require some sort of junction or terminal box as cables themselves could hardly be run into the controller and connected to the binding posts. In stapling to a tie the wires would be subject to interference or damage through track forces, especially should the tie in question be removed.

The Missouri Pacific standard is two bare stranded cables between each rail and a pot-head located in the center of the track. In the pot-head these stranded cables are connected to two twin-conductor, No. 6 parkway cables which are then soldered in a second pot-head, located near the switch circuit controller, to No. 9 flexible rubber-covered wires which are taken through flexible conduit from the second pot-head into the switch circuit controller and connected to binding posts. This arrangement furnishes very low resistance shunts and is not interfered with by track forces.

Suggests Use of Bootleg Riser

Maurice Peacock, Jr.
Philadelphia, Pa.

In my mind the stranded bare cable stapled to the side of the ties, for connections between switch circuit controllers and rails has many various disadvantages. First of all the stranded bare cable takes the eye of the maliciously inclined, causing them to rip it from the ties and destroy it. Another point is that a trackman might be working on the rail at the particular point and accidentally his maul or wrench might hit the cable or get caught in it and perhaps destroy it or mangle it badly, causing a signal failure. Also, every time the ties that the cable is stapled to have to be renewed, the cable must be taken off and again there is a chance of the cable being damaged.

If bootleg risers were used in place of these cables, I am sure quite a lot of maintenance would be saved. The bootleg riser does not take the attention as greatly as the bare cable, and it does not interfere with tie renewals and trackmen working on the rails and ties.

CORRECTION: The article which appeared in the October issue, entitled New Automatic Signaling on the Missouri Pacific, mentioned at the bottom of column 1, page 522, that the parkway cables were manufactured by the Habirshaw division of the Okonite Company. The parkway cable for this installation was manufactured by the Hazard Insulated Wire Works division of the Okonite Company. The Okonite Company has no connection with the Habirshaw Company.

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