Automatic Signals on the Northern Pacific

A Description of the Single-Track Signaling Just Completed between Billings, Mont., and Livingston.

BY ALF. MUNTHE*

To relieve the congested traffic conditions on various parts of its system, the Northern Pacific has recently been making rather extensive installations of automatic block signals. One of the most important of these was placed in operation a short time ago in the State of Montana. This particular installation is 115 miles in length, extending from Billings to Livingston. Of this distance 100 miles, from Livingston to Laurel, is single-track, while only 15 miles, from Laurel to Billings, is double-track.

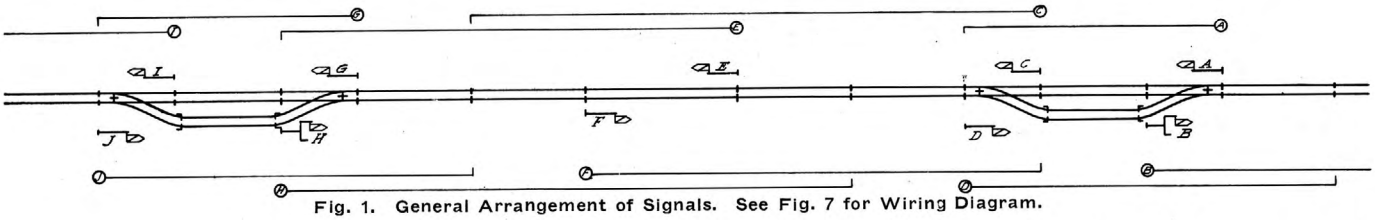

Fig. 1. General Arrangement of Signals. See Fig. 7 for Wiring Diagram.

The line for the whole of this distance runs through the fertile Yellowstone Valley, which, with its great system of irrigation, contains some of the most productive land in the state, adding considerably to the traffic over this territory, which, particularly at certain seasons of the year, is very heavy; so much so that the manual block system under which the traffic was previously handled was found entirely inadequate. The road bed is practically level the whole way, no grade exceeding .20 per cent.

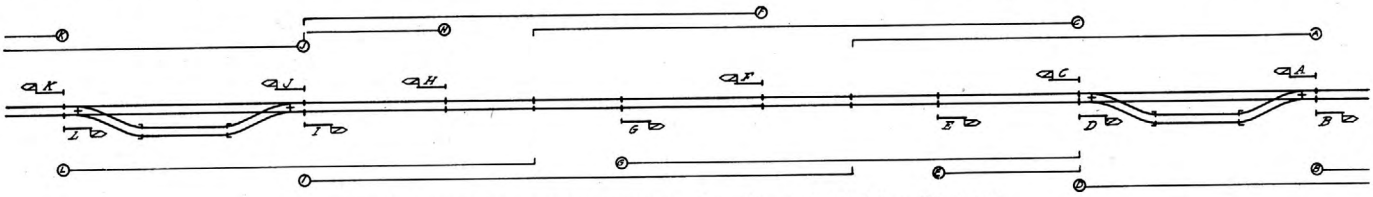

Fig. 2. General Arrangement. See Fig. 9 for Wiring Diagram.

In determining the most suitable signaling arrangement, these local conditions, as well as the traffic requirements received due consideration, and in the system, as finally adopted, a very economical as well as effective result has been obtained. The work was done under the direction of C. A. Christofferson, the signal engineer; the General Railway Signal Company furnishing the labor and the material for the installation, under contract, with the exception of such labor and material as are usually taken care of by the railway company in such cases.

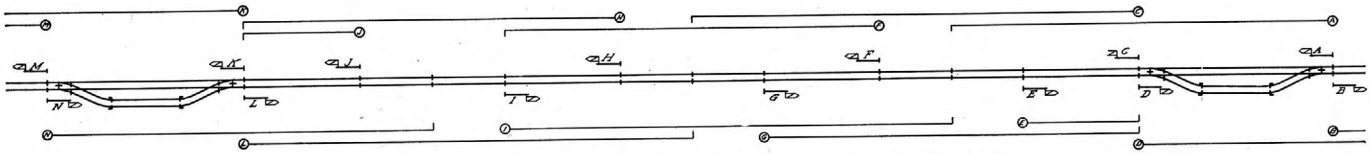

Fig. 3. General Arrangement. See Fig. 10 for Wiring Diagram.

On the double-track territory there are two interlocking plants, one mile apart and located just east of Laurel station. One, a mechanical plant of 19 working levers, takes care of various switches and cross-overs in Laurel Yard, while the other, a General Railway Signal Company's electric machine of 12 working levers takes care of a junction with the Great Northern.

Both these plants were installed simultaneously with the block signals and by the same contractor. Provision was made therefore in the plans and specifications for continuous block operation through both the plants; all main-line signals being semi-automatic of the three-position type, so controlled that when a route is set up and the signal lever reversed, the signal arm will assume the proper position subject to the control of the track circuit and the position of the arm of the next signal beyond, in the same manner as the automatic block signals. The signals used on this installation, both the automatic and the semi-automatic, are the Model 2-A type, giving indications in three positions in the upper right-hand quadrant. The normal indication of the block signals is "clear."

The signals which govern movements from single to double track, and vice versa, are controlled by the position of the switch at end of the double track. As this switch is normally set for west-bound movements, the last block signal on the double track, governing west-bound movements into single-track territory, is therefore normally in the "clear" position, while the last signal on the single track governing east-bound movements into double-track territory is normally in the stop position.

There is a total of 202 signals on the whole territory, including 5 semi-automatic home signals at the interlocking plants. 176 of these signals are on the single-track territory, which is the only part of the installation that will be described in this article.

In Figs. 1, 2, 3 and 4 is shown the general arrangement used in the location and control of signals between stations, the particular arrangement used at any point depending on the distance between sidings, as well as on local and traffic conditions. At lap sidings, of which there are six in all, two additional signals are introduced, as shown in Fig. 5, to take care of such operation. Altogether there are four lay-outs as in Fig. 1,

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eleven as in Fig. 2, four as in Fig. 3, and one as in Fig. 4, besides the six lap-siding arrangements just mentioned.

In the illustrations the extent of the track circuit control of each signal, for movements from 0 deg. to 45 deg., is shown by a line with a circle at one end and a hook at the other, the hook indicating the extreme of the track circuit governing the signal opposite which the circle is placed. From a study of these various lay-outs it will be seen that on account of the overlap control system used, two trains running in opposite directions between stations cannot come closer together than 3,000 ft. without encountering a stop signal, and as all signals are of three-position type controlled by the indication of the next signal beyond for movement from 45 deg. to 90 deg., trains will, in practically every instance, have been prepared for such a stop signal by receiving a "caution" indication from the previous signal. In a few instances, where there are long grades, the overlap on the down grade is made one-half block longer than on the up grade, but there are very few instances where this has been found necessary.

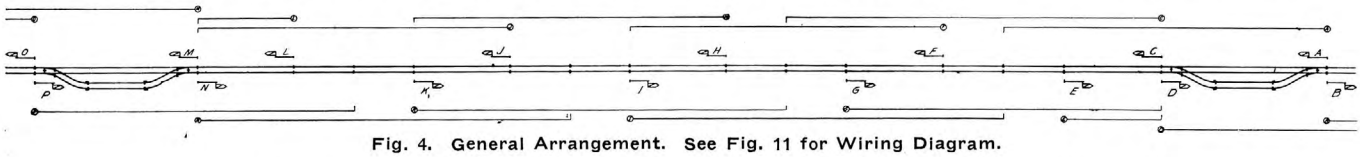

Fig. 4. General Arrangement. See Fig. 11 for Wiring Diagram.

Under the rules governing this block system, a train stopped by a signal in the "danger" position, if a "clear" or "caution" signal is not displayed immediately, may proceed under protection of a flagman, to the next signal, except when the next signal beyond, for the same direction, can be plainly seen to be a "caution" signal or a "clear" signal when the train may proceed under control without sending a flagman ahead, expecting to find the track impassable. Meeting points for all trains are still determined by the dispatcher, who is in position to stop any train at a station for orders by means of the mechanical station signals which, of course, are still in service for such purposes; but in event of two trains meeting between stations, the inferior class train must back up to the next station and take the siding.

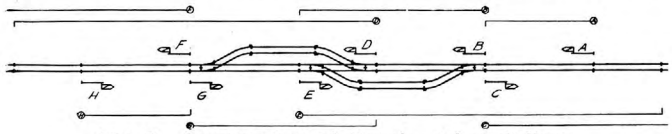

Fig. 5. Arrangement of Signals at Lap Sidings.

In Figs. 7, 9, 10, and 11 are shown typical circuits for the signal arrangements in Figs. 1, 2, 3, and 5 respectively.

As will be seen from these illustrations the flow of current from the signal battery to the motor is controlled by a polarized line relay in every instance. The 45 deg. control is taken through the neutral contacts only, while the 90 deg. control is taken through both the neutral and the polarized contacts. The energy for this line relay is, in every case, taken from the battery of the signal next ahead through a contact on a pole changer operated with the mechanism of that signal, and so arranged that the positive side of the battery is connected to the line when the signal is in the 90 deg. position, and to common when it is in the 45 deg. position. The current, either before or after passing through the coils of the line relay, depending on the position of the pole changer, is carried over the line wire through front contact on all track relays, and through normally-closed contacts of all switches within the scope of the signal controlled by the relay. Thus all signals are controlled by track circuits for movements from the horizontal ("stop") position to the 45 deg. ("caution") position, and by the indication of the next signal beyond for movements from the 45 deg. ("caution") position to the 90 deg. ("clear") position. In all instances where it is required that the track control of one signal shall overlap that of the signal beyond to its extreme end, as, for instance, is the case with signal F in Figs. 2 and 7, such signal will virtually become a two-position signal giving only the "stop" and the "clear" indications. Taking signal F in Figs. 2 and 7 as an example: the general arrangement requires this signal to be in the stop position whenever signal H is in the

Fig. 6. Signal Location Showing Trunking Arrangement.

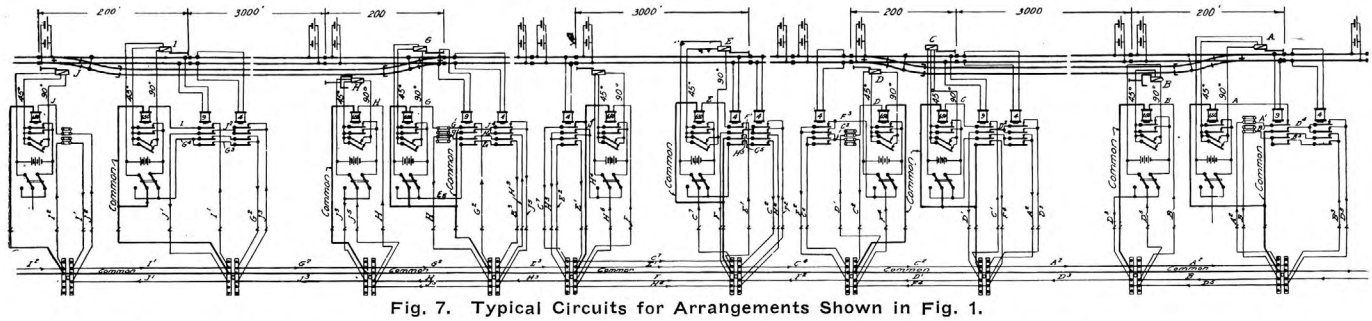

Fig. 7. Typical Circuits for Arrangements Shown in Fig. 1.

stop position, while with signal H in the "caution" position, signal F should naturally assume the "clear" position.

To secure this operation, the method used in all such cases is simply to connect the 45 deg. and the 90 deg. controls in multiple, taking both through the polarized as well as through the neutral contact of the line relay.

As will be seen, the lengths of the various track circuits vary considerably. While the short circuits between the in-bound and out-bound signals at end of passing tracks in arrangement Fig. 1, average somewhat over 200 ft., the general average is about one-half mile. Many circuits, however, exceed 3,500 ft., and a few are over 4,000 ft. in length. The longest track circuit on the whole installation is 4,880 ft.

The energy for each track circuit is furnished by two cells of Columbia track battery connected in multiple, except through

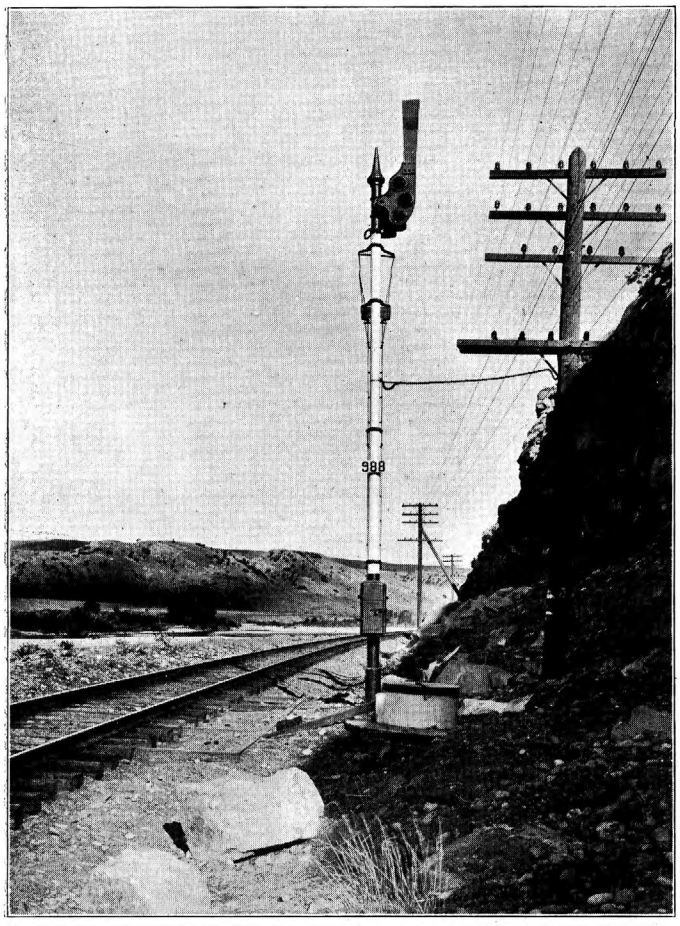

Fig. 8. Showing Method of Running a Cable from the Telegraph Pole to the Signal.

station grounds where gravity battery is substituted. Owing to the extremely low temperature which may be found in this part of Montana in the winter time, the chutes provided for the track batteries are exceptionally well made. They are all of a type specially designed by Mr. Christofferson for use in very cold climates. They are 9 ft. deep, made of cast-iron, and are equipped with double-metal frost covers, which are fitted with gaskets of heavy rubber tubing. Entrance for the wires is made under the lower frost cover through loricated piping, which is screwed into the wall of the chute, and which is extended upward into the trunking. Not more than two cells of battery are placed in one chute, and in no case are relay posts bolted to the chutes, but are placed on separate concrete foundations.

Signal batteries are of the BSCO type, 16 cells connected in series being employed for each signal. The jars for all batteries both for track and signal are of heat resisting glass made by the Corning Glass Manufacturing Company. This is a great improvement over the usual porcelain jars, as it permits the

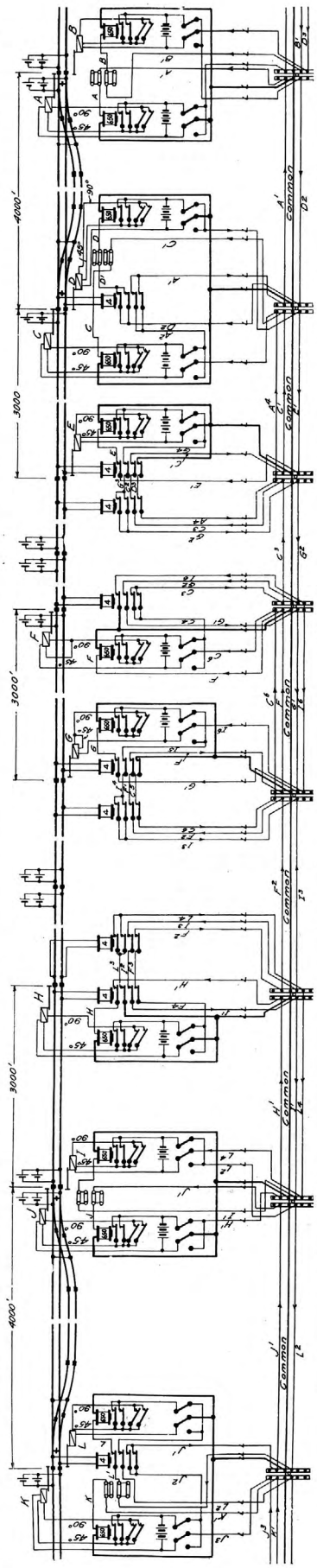

Fig. 9. Typical Circuits for Fig. 2.

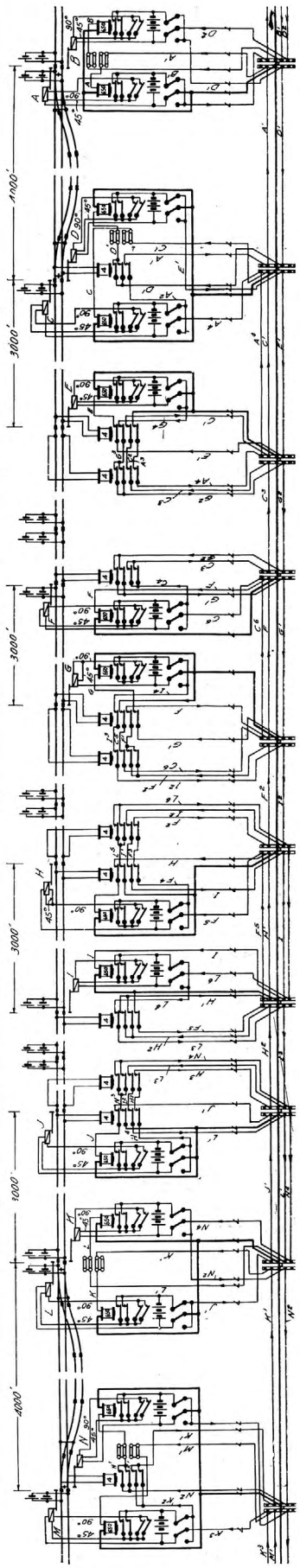

Fig. 10. Typical Circuits for Fig. 3.

maintainer to inspect the condition of the elements at all times without removing them from the solution, and with this kind of glass the breakage is, if anything, less than with the porcelain.

The reinforced concrete wells for signal batteries are made in accordance with the railway company's standard plan, and are known as C. F. Massey Co's. type A Special and Potter-Winslow Co's. type 72. They are of ample capacity, being 8 ft. 10 in. deep and 4 ft. 10 in. in inside diameter, with the opening in the neck 3 ft. in diameter. This gives easy access to the interior and a good large space for the maintainer to work in. The frost covers, of which there are two, are fitted with felt gaskets, and the lower one is divided through the middle in two equal sections with overlapping joint making a perfectly air-tight fit. From the trunking down to the shelving the wires are carried through three-inch fibre tubing provided for that purpose. It has been found in actual experience that even in the coldest weather the temperature in wells of this type will not go below 40 deg. Fahr. Thus high efficiency of the batteries is always secured.

For the very short track circuits of 200 to 300 ft. in length, 9-ohm relays are used, otherwise the usual resistance of 4 ohms is employed for track relays.

All line relays have a resistance of 650 ohms, which is also the resistance used for the switch indicators, of which, however, there are only four on the whole territory, all located at branch line connections; otherwise no switch indicators are used on this single track.

The coils of all relays, as well as the switch indicators, are form-wound, and those of the latter are interchangeable with the coils of the line relays.

All rubber covered wire is of "Okonite" manufacture with 5/64 in. rubber wall, taped and braided, except the flexible wire which has two braids only. It is all manufactured in accordance with the railway company's specifications for rubber covered wire, which are a combination of the Railway Signal Association's specifications and those of the U. S. Navy Department except that a considerably higher insulation resistance is required than in either of these. All the rubber covered wire

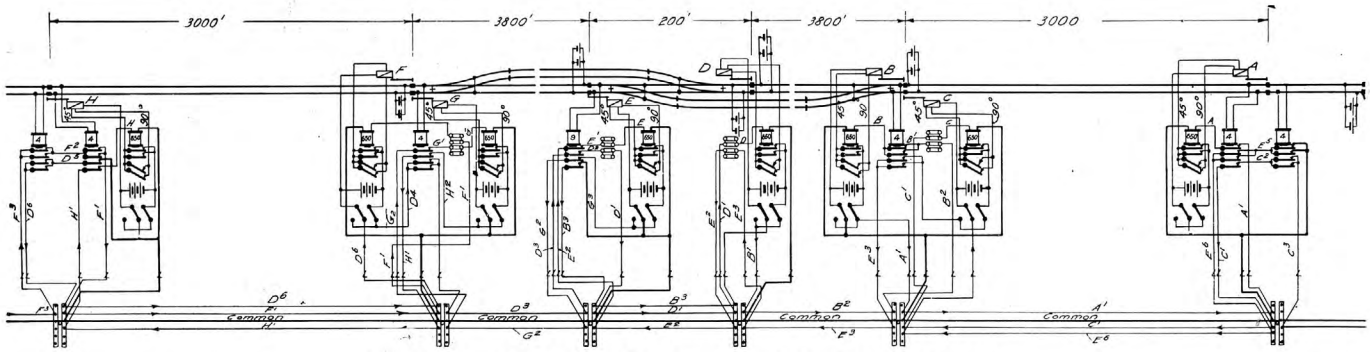

Fig. 11. Typical Circuits for Wiring Diagram Shown in Fig. 4.

Fig. 12. Oneida West Passing Track Switch. Signal Arrangement as Shown in Fig. 2.

Fig. 13. Showing Relay Boxes and Fastenings.

was tested by the Wire Inspection Bureau before shipment, the chemical test being made by James P. Millwood.

No. 10 B. & S. gauge wire is used for all track connections, while No. 14 B. & S. gauge is used for connections to line, except where signals are located some distance from the battery, such as at lap-sidings and at the end of a passing track in arrangement Fig. 1, in which case No. 4 B. & S. gauge copper wire is run the whole distance from the well to the signal.

The line wire is all No. 9 B. & S. gauge Copper Clad manufactured by the Duplex Metals Company, with weatherproof insulation made by the Chicago Insulated Wire & Mfg. Company in accordance with the railway company's specifications for signal wire.

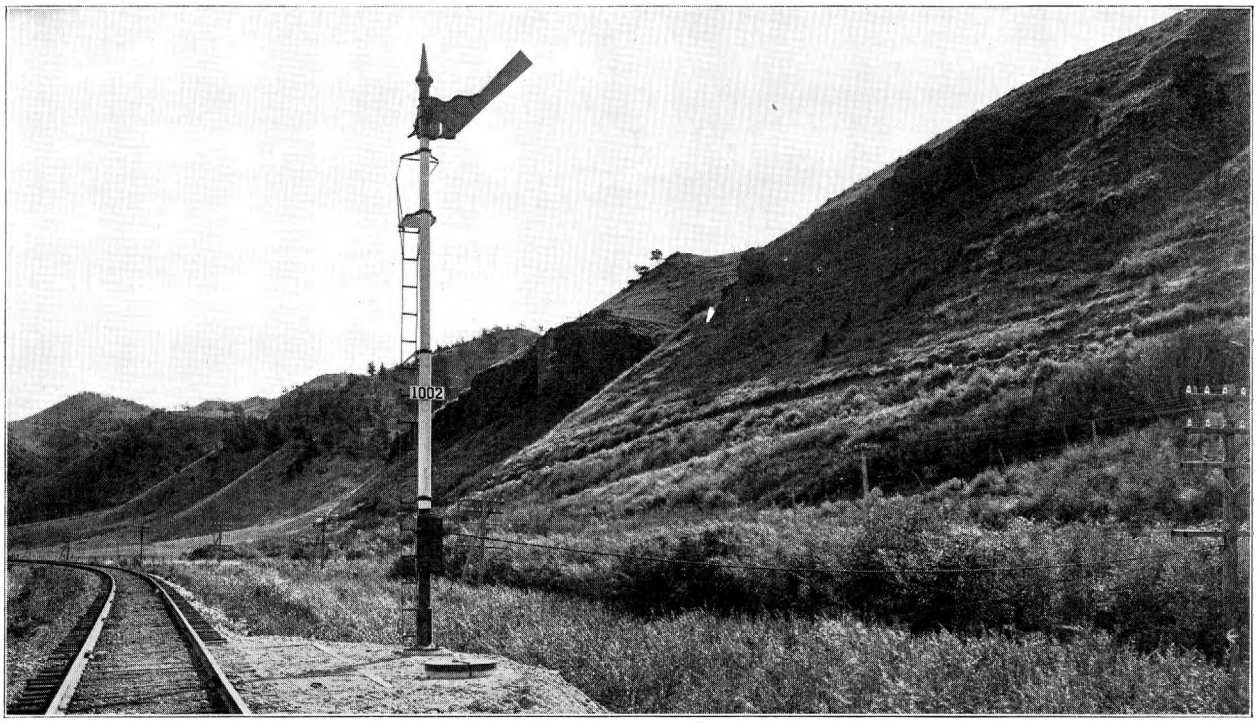

Fig. 14. Signal and Battery Well Located on a Fill.

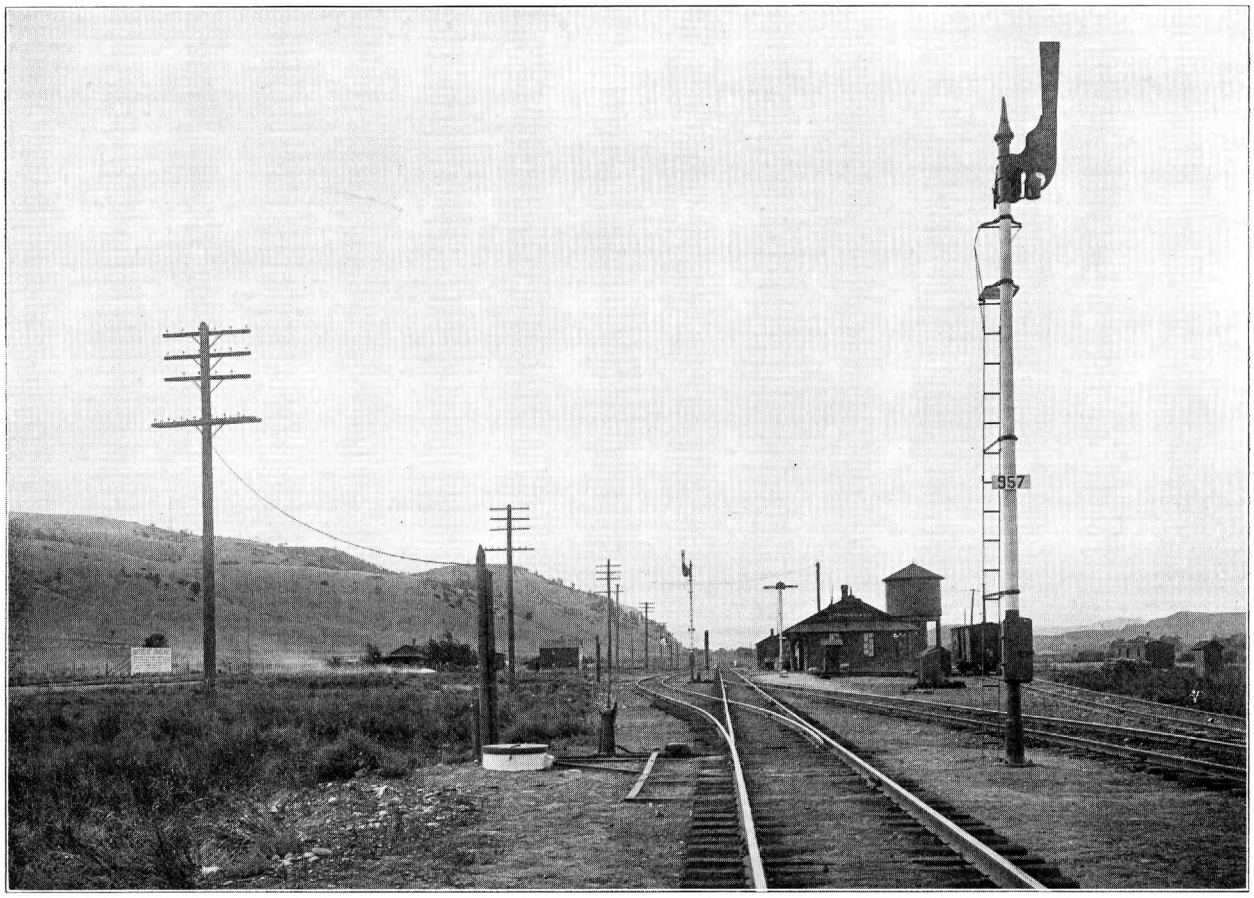

Fig. 15. Springdale Lap Siding Arrangement as Shown in Fig. 5.

All wiring between the overhead line and the instrument is made with single conductors taped together and supported by a galvanized stranded messenger wire 3/8 in. in diameter, to

which they are fastened by means of tarred marlin put on with a spinning jenny.

Where signals are located on the same side of the track as the pole line the wires are run direct from the telegraph poles to the signal, as is plainly illustrated in the view Fig. 8. Similarly in case of relay boxes or indicators on the pole side of the track, these are placed on iron cable-posts and the wires are run directly to these posts. In such cases the lightning arresters are located in a separate compartment provided in the lower part of the relay box. The method followed in cases where the instruments are located across the track from the pole line is clearly illustrated in Fig. 15. The small wooden box, which may be seen at about the middle of the stub pole, contains the lightning arresters, which also serve as terminals. From the lightning arresters the wires are carried in trunking under the track to the instruments.

All lightning arresters used on this installation are the Midget No. 1 type manufactured by Wm. McClintock, St. Paul, Minn. This is a carborundum arrester so arranged that it may be used as a terminal.

In the various illustrations, but especially in Fig. 13, may be seen the method of fastening relay boxes to signal poles. As only two-way relay boxes are used, it is necessary to install two boxes wherever more than two relays are required. Such an application of two boxes may be seen in Fig. 12. Fig. 14 illustrates a signal and a well placed on a fill. In such places sufficient filling is done around them to prevent their settling, and to keep frost from affecting the batteries, and sufficient extra space is allowed to enable the maintainer to place his motor car clear of passing trains.

The various views of the signals also give a good illustration of the number plates which, on the Northern Pacific, are used on all automatic block signals. These plates, which have enameled black letters, six inches high with one-inch bars, on white ground, are made of sheet steel, braced and clamped to the poles.

The arm castings used are of the Loree-Patenall type, with openings for 8⅜-in. roundels. The color indications used are red for "stop", yellow for "caution", and green for "clear". The blades are painted yellow with a black stripe. The signals are all equipped with two Veeder counters, one registering movements from horizontal to 45 deg., and the other registering from 45 deg. to 90 deg., in order that an intelligent record may be had at all times of the performance of each individual signal, as well as of the signal batteries.

The signal lamps are of the Adams & Westlake Company's manufacture, of the "Universal" type designed by Mr. Christofferson. These lamps are provided with openings for two lenses similar to the Adams & Westlake No. 10 lamp for station signals, and are equipped with a shield and glass reflector for one opening and a 5⅜ in. white lens for the other. By simply transposing the lens, shield, and glass reflector, according to requirements, the lamp may be used with the same style of lamp bracket for either upper or lower-quadrant signals, as may be desired. It is fitted with a large-size oil cup and long time socket burner, the chimney for which is made of Corning heat resisting glass.

For maintenance purposes the territory is divided into four maintainer's districts, averaging 25 miles with 44 signals each.

The maintainers are also required to take care of all the signal lamps on their territory, and are furnished with a motor car, and have also a first-class helper to assist them in their work, which arrangement has proved very satisfactory.

During the progress of the work very close inspection was maintained, no piece of apparatus or material being allowed to go in which did not conform to specification requirements. The result is that the installation, both in regard to material and workmanship, is first-class in every respect, and has been borne out by the fact that since these signals were placed in operation practically no failures have occurred, aside from such as are unavoidable on any system.

TRAIN DISPATCHING ON INTERURBAN RAILWAYS

BY C. E. LEWIS.*

The safety of passengers and trains is of the first importance in railroad operation. To accomplish this on single-track, interurban railroads where first-class trains are operated at high speed on frequent schedules, it becomes necessary to have a first-class dispatching system and a book of rules which are plain, brief and cover all points of train movement in such form as to eliminate all chance of doubt as to their interpretation.

Train dispatching covers a wide difference of opinion, and as the American Railway Standard Code is the result of many years of study of experienced and efficient railroad men, it seems to me to be the only one to follow.

Two forms of orders are used on the Rochester interurban lines of the New York State Railways: the train clearance order and the "31" telephone order. Order offices are situated along these lines about 10 miles apart and are positive block stations. Trains cannot pass or leave these stations without obtaining one of these forms of orders. In the absence of other order the train clearance order is used to allow a train to pass a positive block station. It is issued by the dispatcher under a distinct order number and is recorded in the dispatcher's order book with the train number, motor number, time O. K.'d, station receiving and operator's name. The operator, after repeating this order to the dispatcher and receiving the O. K., will hand it to the conductor, who will repeat it to the operator, the operator giving the "complete." Copies are supplied for both conductor and motorman and one is retained by the operator for his record.

When it becomes necessary to make train movements not provided for by the time table the "31" telephone train order is used and is issued in the following manner: The operator at the station where the order is to be placed for the superior train is called and is instructed to copy three or as many as are required. Then the operator at the station where the order is to be placed for the inferior train is called and is given the same instructions. The dispatcher then gives the order number and the addresses of the trains in the order of their superiority. The order is then transmitted and is written in full without abbreviation by the operator. After the dispatcher has transmitted the order and the superintendent's initials, the operator will read it back to the dispatcher without abbreviation. The dispatcher will then O. K. the order if correct and the operator will give his name and order number. The operator will hand the order to the conductor of the train addressed. The conductor will then repeat the order to the dispatcher without abbreviation and when he has finished he will give his name and train number. The dispatcher will complete the order if correct, giving the time and his initials. The order is then in full force and effect, and a copy is given to the motorman by the conductor. The motorman must read his order aloud and without abbreviation to the conductor, the conductor watching closely to see that the motorman repeats it correctly. After the order is fully understood by the conductor and motorman they may proceed.

The requirements where orders are delivered at sidings are the same as the foregoing except that the motorman becomes the operator and receives the order and O. K. from the dispatchers, the conductor getting the "complete" in the usual manner. If, for any reason, the conductor or the motorman does not understand the order, the dispatcher will be notified at once. The responsibility for its correct interpretation must not be assumed and the decision of one must not influence the other.

Twelve different forms with numerous examples and ex-

*Chief Train Dispatcher, New York State Railways, Rochester, N. Y. Paper presented at a meeting called by Public Service Commission, Second District, New York, Syracuse, N. Y., Jan. 19.