GENERAL RAILWAY SIGNAL COMPANY.

1911

BULLETIN No. 115-B

BLOCK SIGNALING

FOR

HIGH SPEED INTERURBAN LINES

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BLOCK SIGNALING
FOR
HIGH SPEED INTERURBAN LINES

A DESCRIPTION OF THE

GENERAL RAILWAY SIGNAL COMPANY'S

INSTALLATION OF

)EL 2A SIGNALS

ON THE LINES OF THE

WASHINGTON WATER POWER COMPANY'S RAILWAYS

BY R. A. WILLSON
GENERAL SUPERINTENDENT OF RAILWAYS
W. W. P. CO.

TO WHICH IS ADDED SOME INTERESTING CORRESPONDENCE AND A STATEMENT REGARDING THE OPERATION OF THE SYSTEM

THE necessity of providing an adequate and reliable system of signaling on high speed electric lines, that is, a system that would insure first, the greatest possible safety and secondly, maximum operating efficiency, was recognized by the officials of the Washington Water Power Company's railways at a very early date, and they have accordingly made a complete installation on about 20 miles of their single track lines extending between Spokane and the towns of Medical Lake and Cheney in the state of Washington.

Before contracting for this work, the writer made a thorough investigation of the several systems in use, in the course of which he visited and inspected numerous installations and several manufacturing establishments in the East.

A careful consideration of the information gathered during this investigation res[illegible] a contract entered into with the General Railway Signal Co[illegible]ny of Rochester, N. Y., for the installation of the 29 automatic block signals shown on the signal location plan, Figure 1.

The system covered by this contract is the same as that used on the electric division of the New York Central Railroad's terminal improvements in and around New York City, by the Long Island R. R., New York, New Haven & Hartford R. R., and other lines, with the addition of automatic train stops which are not used on any of the lines enumerated.

This system is much more expensive, from the standpoint of first cost, than those usually adopted for electric lines, but it was felt that the additional cost was warranted by the increased safety due to the continuous track control of the signals, and the elimination of the trolley contacting and car counting devices ordinarily used (which indicate ingress and exit only) and are incapable of protecting against a car accidentally or maliciously moved from a siding onto or afoul of the main line, and which are subject to annoying disarrangements in operation.

With the system adopted, the presence of one pair of car wheels on or afoul of the main line at any point within the area protected by a given signal or signals is sufficient to set the signals at the "stop" position, and will hold them in that position until the wheels are moved clear of the main line. The same is true if a rail is broken or removed, or if the insulation of a track joint breaks down. The throwing of a switch in any block section sets the signals protecting that section at stop; no train can pass a "Stop" signal until one of the train crew has cleared the "Stop arm" in a manner to be explained later, and any attempt to pass without performing this operation results in the automatic setting of the brakes and prevents their release until a glass tube, broken by the unauthorized movement past the signal, has been replaced.

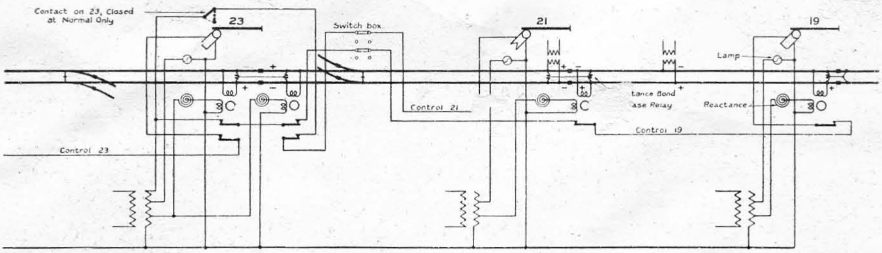

Fig. 2
Typical Circuit Plan.

The system provides, as will be noted from an examination of Figures 1 and 2, an overlap control for all signals, that is, the control of all signals by a train is carried to a point beyond the next opposing signal, an arrangement that renders it impossible for two trains approaching each other to meet without one of them receiving a stop signal at least one block away from the other, and provides two stop signals in the rear for the government of following moves.

Equipment

The signaling equipment consists entirely of the Signal Company's standard apparatus, and includes their Model 2-A spindle type of signal mechanism, polyphase relays, iron core reactance bonds, etc.

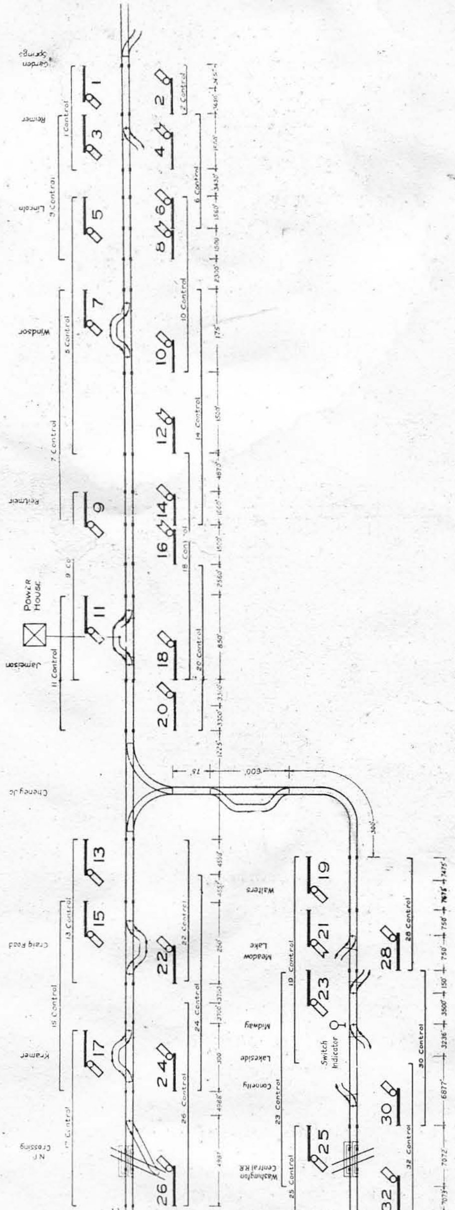

Fig 1.
Signal Location Plan.

Power

The cars are operated by 600 volt direct current, which makes it imperative to use alternating current track control for the signal system, in order to secure immunity from interference and false operation of the latter by the former.

The 600 volt propulsion current is obtained from motor generator sets supplied from a 60,000 volt, 60 cycle line.

Figure 2 is a typical circuit, showing the overlap control of the signals.

Current is available at the Jameison Sub-station in approximately the center of the district to be served, and is delivered to the buss bars of the signal switch board at 2200 volts, whence it is distributed to the signal transmission lines through automatically tripped oil circuit breakers equipped with I. T. E., time limit relays and alarm bells. Measuring instruments are also provided for each line.

The transmission lines are each composed of two No. 10 H. D., T. B., W. P., line wires strung on the same poles, and under the main transmission line. This size gives a carrying capacity such that the maximum drop at the end of any line is less than 10% when starting the entire signal system.

Transformers stepping from 2200 volts to the various voltages required are placed at each signal and track feed location.

High tension lighting arresters are installed at approximate half mile intervals for protection against electrical storms.

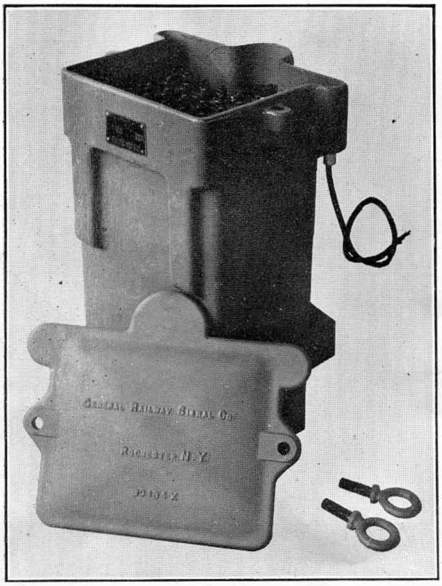

Figure 3. Model H. Transformer.

Transformers

The oil cooled Model H transformers, shown in Figures 3, 4 and 5, are used throughout. The 2200 volt primaries are provided with fuses located in the porcelain containers on the back of the cross arm which supports the transformer.

Independent secondary windings are provided for each track circuit and for the signal operating, lighting, and relay local circuits, the fuses and lightning arresters for which may be seen in the bottom of the relay boxes.

The grid resistances for limiting the current flow to the track when the rails are short circuited are clearly shown in Figure 5.

Fig. 4. Relay Location.

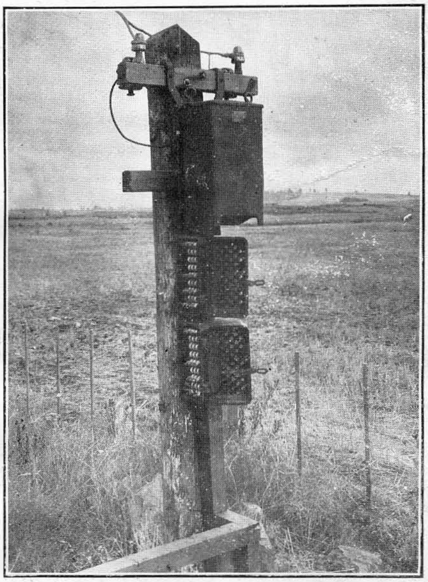

Fig. 5. Track Feed Location.

The track secondary windings are provided with taps ranging from 1.5 to 8 volts for the requirements of varying lengths of track sections; the signal secondaries provide 220 volts for signal operation with taps of 55 volts for signal lighting and of 28 volts for the relay local windings; all of which taps are taken to a terminal board for convenient connection to the external circuits.

All coils are thoroughly insulated by vacuum impregnation. Sheet copper ground shields, connected to the iron case of the transformer, which is in turn connected to — ground —, are placed between prima and secondary windings to protect the secondary cuits from lightning discharges which might invade the primary windings.

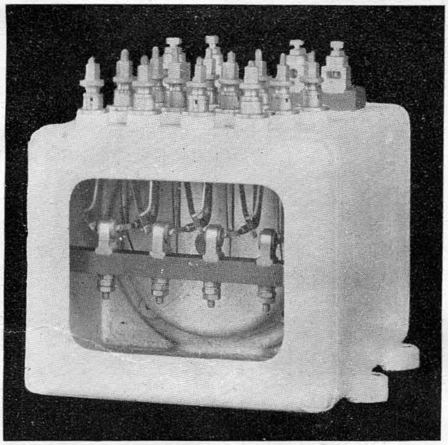

Fig. 6. Polyphase Relay—Contact End.

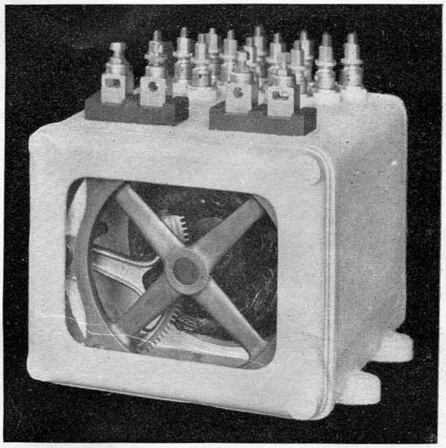

Fig. 7. Polyphase Relay—Rotor End.

Relays

The polyphase relay used is shown in Figures 6 and 7. It is, essentially, a two phase induction motor, one phase of which is energized from a transformer located at the relay, and the other through the track circuit, which is energized by a transformer located at a distance. This arrangement provides for the furnishing of the major portion of the energy for operating the relay from a local source with low losses, and requires that only a very small amount of energy shall be supplied through the track where the losses are high. It is remarkable for high efficiency, simplicity of design, high point of drop away current, and for the large opening and great contacting power of the contact points. The efficiency is most emphatically proved by the fact that, in this installation, they are operating on continuous track sections, that is, track circuits without cut sections, of over fifteen thousand (15,000) feet in length, and in the absence of the best conditions as to ballast and track leakage. This length of continuous track section has *never before been equalled or even approached in the signaling art.*

The relays are provided with 4 front contacts for the control of the signal circuits.

The simplicity of design is clearly shown in the figures, motion is transmitted from the rotor to the contacts by means of a trundle pinion engaging with a segmental gear mounted on a shaft, which latter is connected to the contact bar by a crank. Friction is reduced to a minimum by the use of ball bearings for all rotating parts. The contacts rub through the last 1-16″ of their travel thereby insuring strong self cleaning action.

Track Circuits

Two rail track circuits are used, arranged so that both rails are available for the returning propulsion current. 60 ℔ A. S. C. E., steel is used for the tracks, which are divided into block sections of from 175′ to 15,150′ by means of insulated rail joints and reactance bonds. The joints are for isolating the signal blocks, the bonds for providing a path around the former, while permitting the unobstructed passage of the return propulsion direct current, will *not* permit the passage of the alternating signaling current from one block section to the next.

Reac ce Bonds

The reactance bonds are shown in place in Figure 8. These are oil cooled and consist of an insulated copper conductor of suitable carrying capacity wound around an iron core. The ends of the coil are attached to the track rails on the same side of a pair of insulated joints. A center tap from each coil is attached to the center tap of the bond on the adjacent section. This arrangement provides a return path for the D. C., and at the same time provides a very high reactance between rails for the alternating signal current. Unbalancing, that is, inequality of return propulsion current flow in the two rails of a block section, which would tend to magnetize the core and reduce the reactance, is taken care of by the introduction of an adjustable air gap in the magnetic circuit.

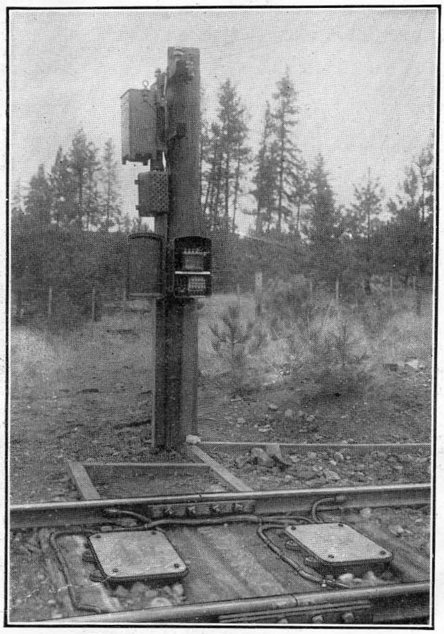

Fig. 8. Track Bonds in place.

The signaling current flowing through the bond when the track is unoccupied creates a difference of potential at the rails, which varies with the length of track section and the impressed voltage. The sections and voltages are always arranged so as to provide an ample margin over and above the 4-10 volts required for the operation of the relays when using a 60 cycle current.

Signals

The Model 2-A signal mechanisms are clamp to the poles and are arranged for 45° travel of arm in the upper left hand quadrant.

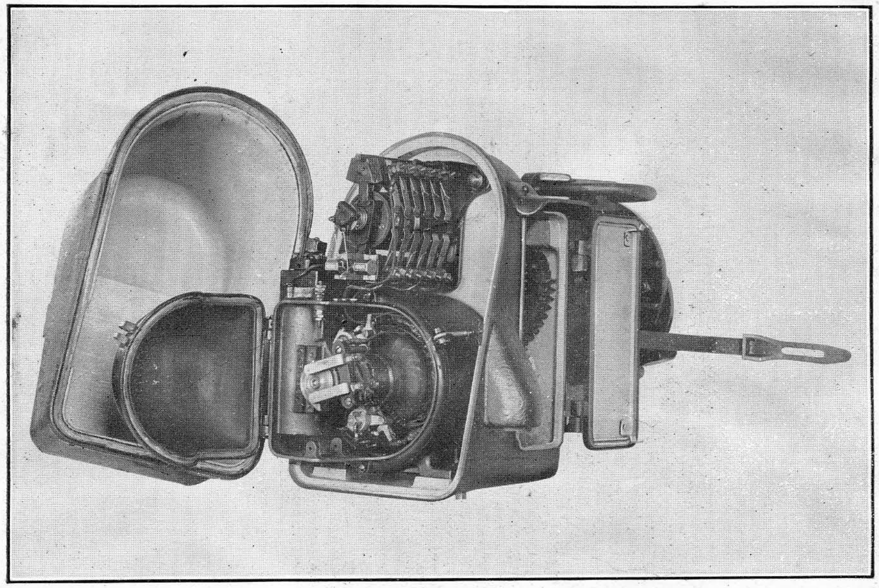

Fig. 9. Model 2A. A. C. Signal Mechanism.

The mechanism is shown in detail in Figure 9. It is operated by a series wound commutating alternating current motor designed so that it gives sparkless operation, and having the usual high starting torque, low starting and operating current and high efficiency characteristic of this type. The low current consumption is indicated by an inspection of Figure 2, where it will be seen that the transformer from which the signal receives its power is located one block in advance; a distance varying from 175′ to over 15,000′, and that the signal is operated directly over this line without the use of a line relay. As a matter of fact, the longest control in the installation under discussion is about 7 miles with No. 10 copper for both control and common wires. That is, the signal is operating successfully through a total line resistance closely approximating 74 ohms.

A centrifugal governor is provided on the end of the armature shaft for controlling the speed of the motor and preventing the signal from over-running its position; the contacts are in series with the motor and are shunted during a portion of the movement, so that the speed control does not become effective until just before the signal arm reaches the proceed position. It is a very simple arrangement resulting in quick and accurate action of the signal arm.

The motor is geared directly to the semaphore operating shaft and holds the signal in the clear position through the medium of a reactance which is cut in series with the motor by the action of the circuit breaker at the end of the clearing movement. The signal returns to the stop position by the action of gravity.

The direct gearing of the motor to the semaphore operating shaft, and the holding of the signal in the clear position by the motor render the use of a slot or dash pot unnecessary, and thereby eliminate these very troublesome features of some types of signals.

The circuit breaker is a complete unit. It is connected directly to the operating shaft by means of segmental gears, and is provided with individually adjustable contacts for the control of 12 circuits including the local control of the signal.

Automatic Stop All of the motor cars of the system are provided with 3 glass tubes, such as are shown in Figure 10 and mounted as shown in Figure 11, connecting with the train air system. Each signal is provided with an auxiliary arm (Figures 12 and 13), which is mechanically connected to and operated in unison with the signal arm, and is so located that when the signal is in the stop position the tube on any car attempting to pass will strike against and be broken by the arm. The breaking of the tube results in a semi-service application of the brakes, which cannot be released until the broken tube is replaced; a limited supply of and strict

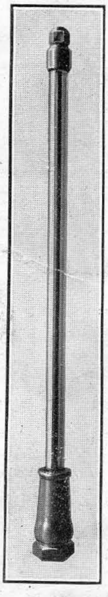

Fig. 10.
Automatic Stop
Tube.

Fig. 11. Car Showing Automatic Stop Tube.

accounting for tubes forms a most effective check on the observance of signals.

Means are provided on each signal pole whereby in the event of any disarrangement of the signal system the auxiliary stop arm may be raised by hand for the passage of a car; this can be accomplished only by the insertion of a key in a lock provided for the purpose, which key cannot be removed until the arm has been restored to the normal position.

A letter from Mr. W. P. Borland, secretary of the Board of Train Control, Interstate Commerce Commission, and the reply thereto by Mr. A. L. Wright, of the contracting engineers who placed the order for signals, are printed on the following pages, as showing the interest taken in, and the purchasers' opinion of the installation in question.

Views along the line are appended, and include some of the distant signals which are provided where an adequate view of the home signal cannot be obtained on account of curves.

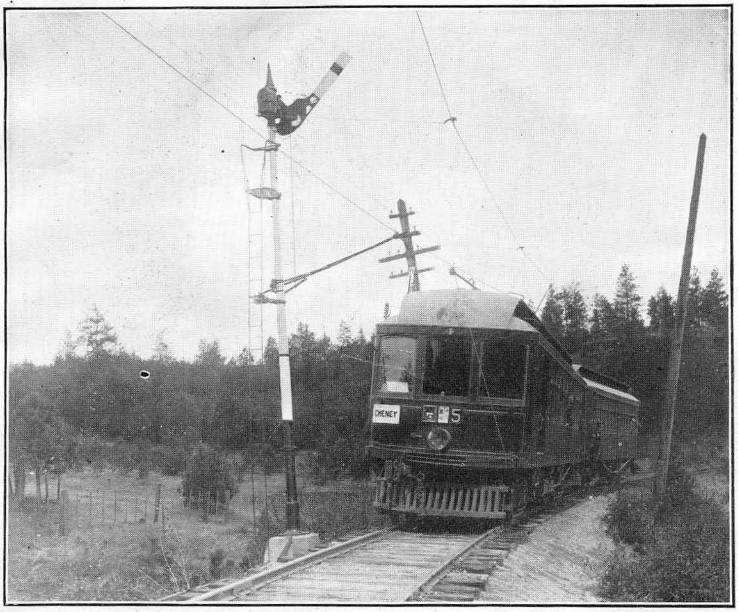

Fig. 12. Signal Location Arm at Proceed.

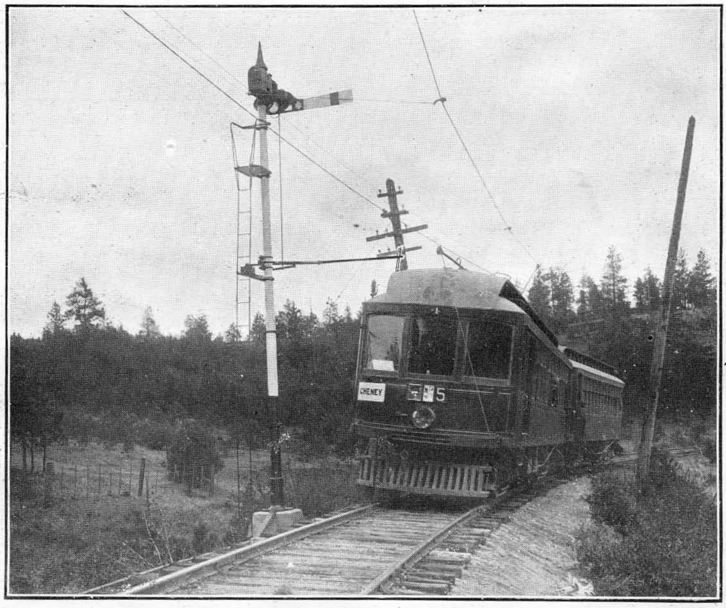

Fig. 13. Signal Location Arm at Stop.

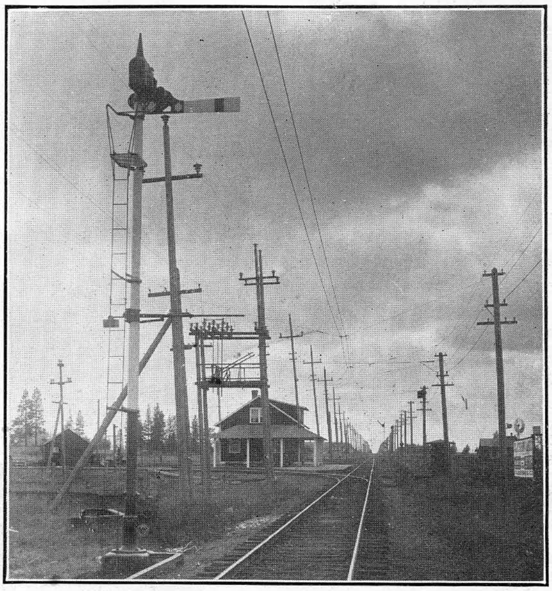

Fig. 14. Station Yard Limits, Cheney Jc.

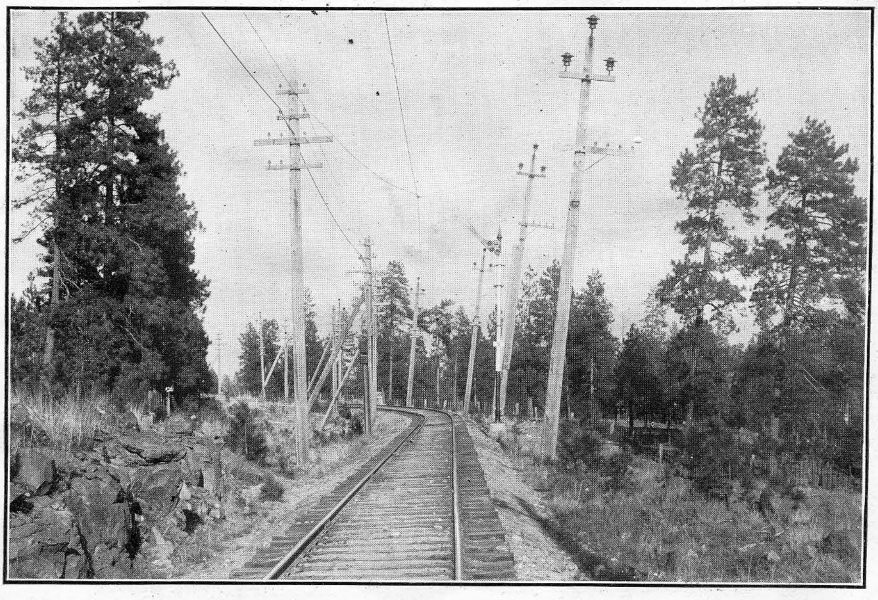

Fig. 15. Caution Signal, East of Washington Park.

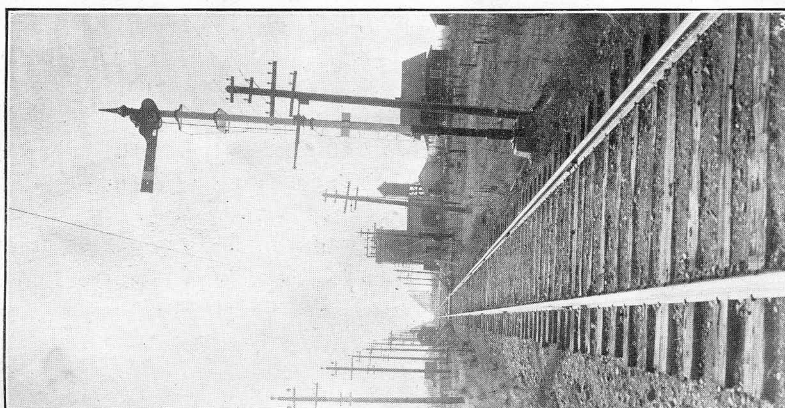

Fig. 16. Jameison Sub-station.

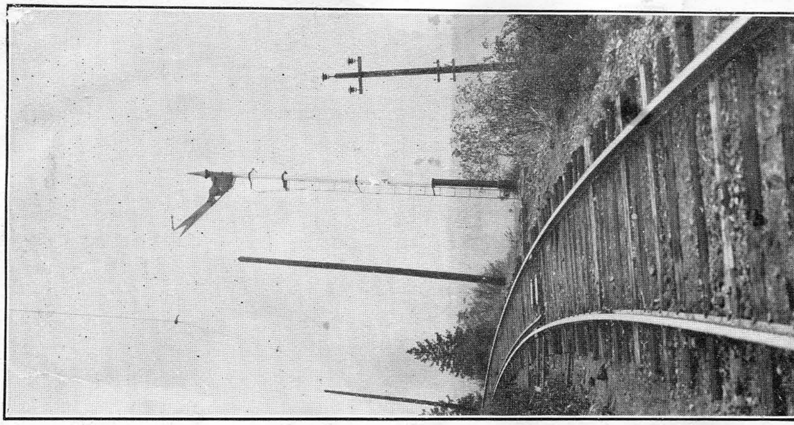

Fig. 17. Caution Signal on 2% Down Grade.

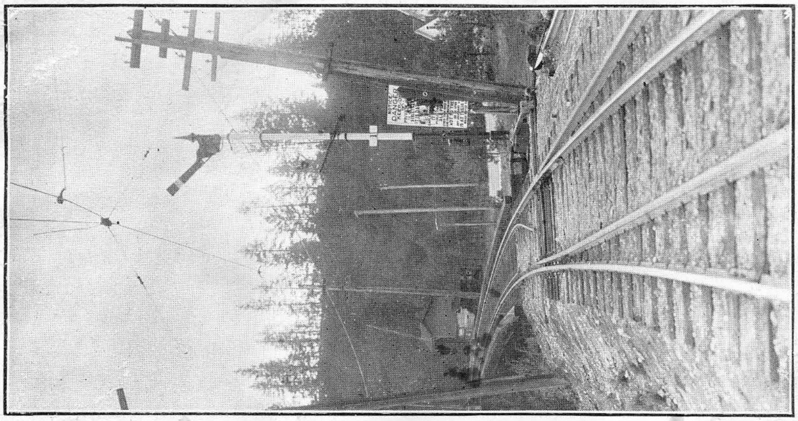

Fig 18. Garden Springs
End of Double Track, City Lines.

Washington Water Power Company,
Spokane, Washington.

Gentlemen:—

An article has appeared in the press recently regarding a system of electric block signals and automatic stops installed on your electric lines between Spokane and Cheney and Medical Lake, Washington.

This board is very much interested in devices of this character, and I would be very glad if you would furnish me details of this installation, including number, type and method of operating signals and stops, and the name of the company installing same. If you could furnish descriptions and drawings or prints of the devices, particularly the automatic stop, or a layout of the road showing the location of signals and stops, this matter would be very much appreciated.

Very respectfully,
W. P. BORLAND,
Secretary of the Board.

Spokane, Wash., November 15, 1910.

Mr. W. P. Borland,
Sec. Block Signal & Train Control Board,
Interstate Commerce Commission,
Washington, D. C.

Dear Sir:—

Your letter of the fifth instant to the Washington Water Power Company of this city asking for information regarding a system of electric block signals with automatic stops just installed on their interurban line between Spokane, Cheney and Medical Lake, has been referred to the writer as this contract was placed through us and the writer has been in charge of the work here.

We are enclosing you herewith a map of the line with a number of photographs showing the signals. We have marked the map, showing the locations of the block signals and the distance signals, giving the distances. This installation is on twenty-nine miles of a single track interurban line. Signal No. 1, in the photograph, being located at the end of the double track lines of the city cars and where the interurban line commences. These signals are operated by alternating current, which is supplied from the sub-station situated about half way between Garden Springs and Medical Lake. Here the current is taken at 2300 volts and distributed to the transformers located at different points along the line and at the signals. These transformers step the current down to 240 volts for the signal motors, 58 volts for the lighting circuit and 28 volts or multiples for the track circuit.

The signals in use are a little different from those used by the steam lines, i. e., they are left hand instead of right hand boards. In this way the semaphore board extends out over the track and gives the motorman a clear view of the signal and of the board. This could not be done very well with right hand signals on account of trolley poles, wires, etc.

There are two classes of signals used on the line—distance and home signals. All of the home signals are equipped with automatic st[illegible] device, whereas the distance signals are not, and are simply used as indications of the home signals.

You will note, from the photographs, that the danger position is when the board is in a horizontal position with [illegible] track and the clear position, when the board stands [illegible] of forty-five degrees. These signals are not taken to the nin[illegible] account of the automatic stop breaker mechanism. [illegible]anism is connected to the same shaft as the spectacle blades of the semaphore, and the breaker arm is raised and lowered as the semaphore is cleared or goes to danger. The breaker mechanism is balanced so that very little power is required to raise and lower it. This mechanism is made of pipe. The breaker arm, being a piece of one inch pipe, which slips into a larger pipe and is bolted in so that it cannot be taken out without the use of a wrench. In case of the current being shut off, all signals go to danger, or if anything is wrong with the mechanism, in order that trains can be gotten through, there is a locking arrangement on the semaphore pole whereby the motorman or conductor can lock through by raising the arm so that it will clear the glass bottle on top of the car. This arm must be put back to the danger position before the men can release the key from the lock. Conductors are not allowed to lock through without orders from Train Dispatcher, and all keys are numbered and are charged to the men. At each signal the company are installing a telephone Jack, and, as each of the motor cars are equipped with a telephone, train crews can get into communication with the dispatcher from the train, in case they find a signal against them and get orders to proceed or to wait, as the case may be.

You will note, from the blue print, that the first portion of this line is constructed around side hills and is a comparatively heavy grade. On this hill the signals are arranged close together. The distance signals are used on this portion of the track to protect the curves and to give the motorman plenty of time to stop in case home signal is against him. On the balance of the track are some long tangents and here the signals are spaced at much greater intervals. These signals are all arranged with over laps so that there is absolutely no chance of two trains coming together. The automatic train stop on the car consists of a glass tube extending about sixteen inches above the roof of the motor car. This tube is connected into the air brake system through a separate set of pipe and cannot in any way be tampered with or put out of commission. With a train running through a signal set at danger, this glass tube is broken by the breaker arm and the air is set automatically. The pressure used on this automatic stop is about thirty-five or forty pounds, which gives the train a quick service stop.

These signals are furnished and installed by the General Railway Signal Company of Rochester, New York, who furnished and worked out the breaker mechanism, as shown in the photographs. The automatic stop, consisting of a [illegible] been developed and worked out by Mr. R. A. Willson [illegible] ident of Washington Water Power lines here.

On a test made last week with a train consisting of two cars, motor and trailer, we ran this through one of the signals set at danger, with a speed of approximately forty miles per hour. The glass tube was broken and the train brought to a stop in a little over 300 feet. As this test was made on a long stretch of level track, you will readily see that this system is very satisfactory. There has been a considerable amount of experimental work done by the company in getting this automatic stop worked out so that trains could be stopped without being jammed and wheels slid. This has all been overcome and the service is now in a first class condition.

All of the side tracks and spurs on the lines are arranged so that if a car is left where it will not clear the main line, the signals will stay at danger, and, if a car should be left in the clear and worked out or should be pushed out between the insulated joints, signals would go to danger so as to protect opposing trains. With the blue prints, we have attached a list giving distances between the blocks, and also a sheet showing what signals are set by a train going over the line—both against opposing trains and following sections.

We understand that the General Railway Company are getting out a bulletin covering this installation and we have written them, asking them to send you a technical description covering this installation. We trust they will do so within a very short time.

With the system installed here, we feel that the Washington Water Power Company, on a small line, have gone to a great deal of expense to perfect something which should be installed on every interurban system in the United States, where they are handling as many people as are being handled by these lines. With this system, we have no doubt but what there will be a great saving of life and property, which will more than offset the expense of installation.

[illegible] information we can give you in regard to this [illegible] ed to do so, and, if you, or any members of the Board should come to Spokane, we will be very pleased to take you out over the line so that you can see the system in actual operation.

[illegible] aphs, that the danger position [illegible] tion with the track [illegible] f fort [illegible]

Extract from the December 17th issue of the Electric Railway Journal.

The signals have been in operation only a short time, but they have proved very satisfactory. R. A. Willson, general superintendent of railways, states that it has not been found that the train men are any less careful in obeying the written orders of the train dispatchers since the block signals were put in use. If anything, the men are more careful, for the rules require that if a train crew find a signal set against them they must report immediately to the train dispatcher and receive an order before they are allowed to pass the signal. All train dispatching on the interurban lines of the Washington Water Power Company is done by telephone.

During the first week in December considerable trouble was experinced with the telephone line, but the train crews were able to maintain schedules and operate with perfect safety, using the block signals as their only guide.

All interurban trainmen are picked from among the oldest in the employ of the company. None of the men on this division were familiar with block signaling and considerable time and effort was spent in instructing them in the operation of trains with signal protection. They have all been thoroughly examined on the rules relating to the signals.

The Cheney-Medical Lake line is now being operated on a winter schedule, but it has not been found necessary to change the time card which was in effect last winter before the signals were installed. During the winter months it is seldom necessary to operate trains in more than one section, but when extra trains have been put out on the line no difficulty has been experienced in handling them. The lengths of the blocks at the ends of the line are such that it requires about five minutes for a car to run through them, and this makes it necessary for a second section always to run from five to six minutes behind the first section. The first section thereafter does not delay or interfere with the secon[illegible] llowing.

The regular meeting points are at [illegible] ding and Cheney Junction. The home signals at these [illegible] erlapped on one end for a distance varying between 750 ft. and 3000 ft. At the
[illegible] signals ar[illegible] bound train in passing signal 5 at Lincoln
Signal Company of Rochester, [illegible] t the west end of Windsor siding
[illegible] ker mechanism, as sh [illegible] signal 12, which is 1710 ft. west
[illegible] ss [illegible]
of Windsor [illegible] eastbound [illegible] ound distant
signal 12 at "caution" he [illegible] and k[illegible] t the westbound train which he was to meet had passed signal 5 at Lincoln. He would then proceed to home signal 10, prepared to stop and if he reached the siding ahead of the westbound train he would lock through the home signal, run in on the siding thereby clearing up signal 7, which had been set from the block in the rear of Windsor. This would permit the westbound train to proceed through on the main line. The meeting points are arranged so that the first train to arrive takes the siding. This arrangement has proved very satisfactory. The train crews which have these regular meets help one another in getting through and practically no time is lost. Up to the present time the train dispatchers have had no trouble in handling trains and they have not had to change any of the regular meeting places.

Telephone jack boxes are located at each home signal so that the train crews can get into communication with the dispatcher immediately on arriving at a signal which is set against them and obtain orders to proceed or wait, as may be necessary. The company feels that the system which has been installed provides every possible protection against collisions, and it does not anticipate any trouble in the operation of trains during the busy season in the summer.

GENERAL RAILWAY SIGNAL COMPANY.

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