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Automatic Interlockers Are Profitable Investments

Twenty-two plants now in service on the Chicago, Milwaukee, St. Paul & Pacific—Annual savings effected range from 70 to over 100 per cent on the investment

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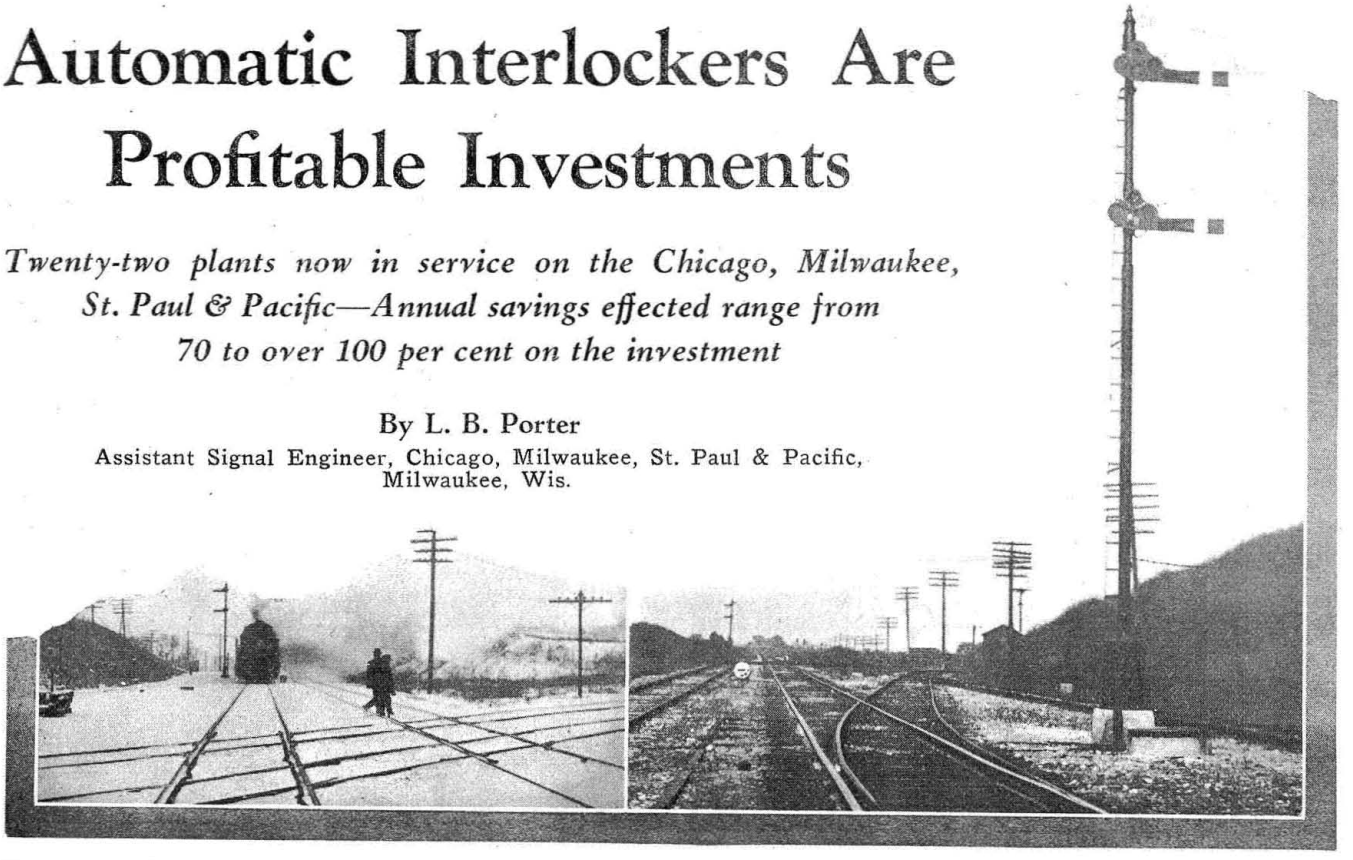


Two views looking west on C. M. St. P. & P. double track, at Delmar Junction, Ia.

SINCE 1921, and particularly within the last three years, a number of installations of automatically-controlled signals for governing train movements over railroad grade crossings have been made. This new facility is now found at crossings not previously protected and at others in replacement of manually-controlled interlocking plants. Protection of this nature, which is now generally termed "automatic interlocking," was first described in an article in the April, 1921, issue of *Railway Signal Engineer*.

Probably a hundred or more automatic interlockings are now in operation in the United States. Inquiry develops that four western roads alone have 55 such installations in service, 24 of which have replaced manually-operated plants. Twenty-two automatic interlockings are now in service on the Chicago, Milwaukee, St. Paul & Pacific; five have been authorized or are under construction, and several additional installations are contemplated. Eight mechanical plants have been replaced by the new type, making it possible to take off a number of levermen, thereby effecting marked economies.

Advantages of Automatic Interlocking

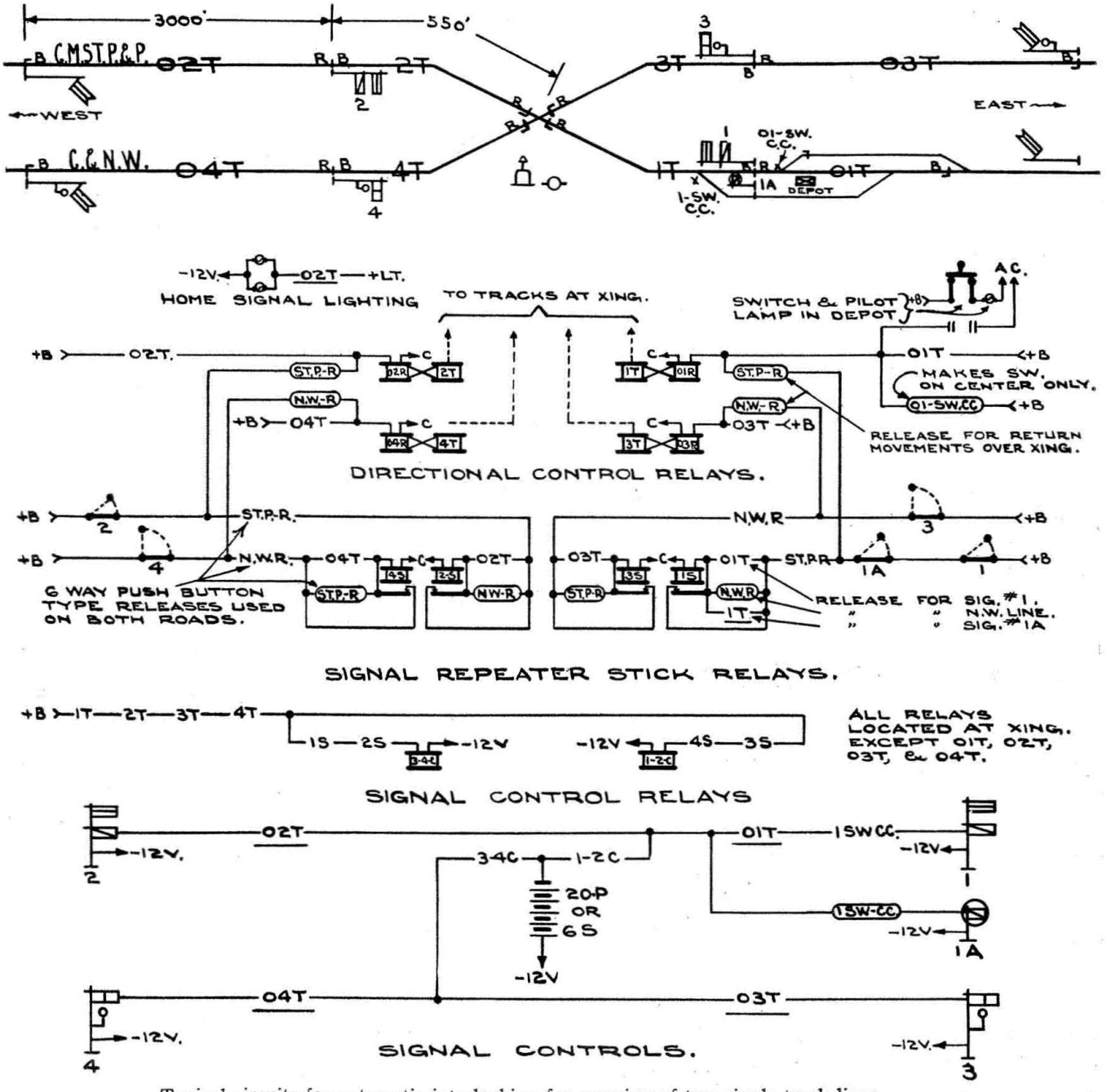
The use of automatic interlocking provides an economical means of eliminating the statutory stops for non-interlocked grade-crossings. This results in faster schedules and in substantial savings in train hours, fuel consumption, and wear and tear to equipment. In many cases where crossings are located on or near grades or at points where train starting conditions are unfavorable, the elimination of the stops may permit the handling of additional tonnage. Frequently the avoidance of crossing delays may mean that freight trains can make longer runs without stopping for coal or water. Also it is possible for dispatchers to make closer meets on single track, and it is easier for trains to make up lost time. Train operation generally is improved.

The automatic type of plant is much more flexible than the old standard interlocking at points where there are switches in close proximity to the crossing. With the automatic plant these switches are arranged for hand operation, whereas with the latter, they would have to be connected up and handled from the tower. In many cases, the interlocked switch retards the setting out or picking up of cars and creates an awkward switching arrangement. It, of course, is an advantage to have certain switches interlocked and this can in some cases be taken care of by remote control for those individual units, with automatic operation for the balance of the layout. The Great Northern has some electrically-operated switches that are lined up automatically by the approach of a train, or by trainmen operating a simple control device

located at some convenient point where a station stop is made.

At points where crossings are located near stations where operators are on duty all or a part of the time, it is often desirable to introduce an element of manual control into the automatic scheme. In this way it is possible to select train movements in accordance with their importance; to release the crossing when switching movements are made; and to avoid unnecessary delay when trains have station work. By the use of call-on signals where there is a joint depot at the crossing, the transferring of passengers and baggage from connecting trains can be facilitated and a great deal of delay avoided. Under an arrangement of this kind, two trains can be moved up to the station at the same time, whereas, under the old type of plant equipped with derails, this would be impossible without involving considerable complication.

The quickness of operation of the automatic plant appeals to enginemen. It takes very little time to clear a route and this is particularly noticeable when two trains are approaching the crossing simultaneously. As soon as the rear end of the train which has obtained the route has passed out of the home signal limits, the other train receives its signal without any delay for the throwing of levers, as in the manually-operated plant. The elimination of the derail removes a hazard from the track as well as a piece of apparatus that is expensive to maintain. The installation of automatic interlocking at "stop" crossings promotes safety, as it is safer to govern trains by positive signal indications, which give information as to actual track conditions, than to depend on the observance of rule only, as is the case at the non-protected crossings.



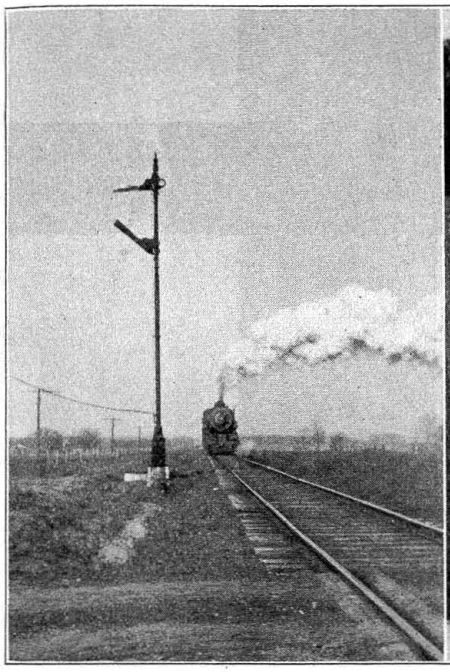
Typical circuits for automatic interlocking for crossing of two single track lines

New System Has Limitations

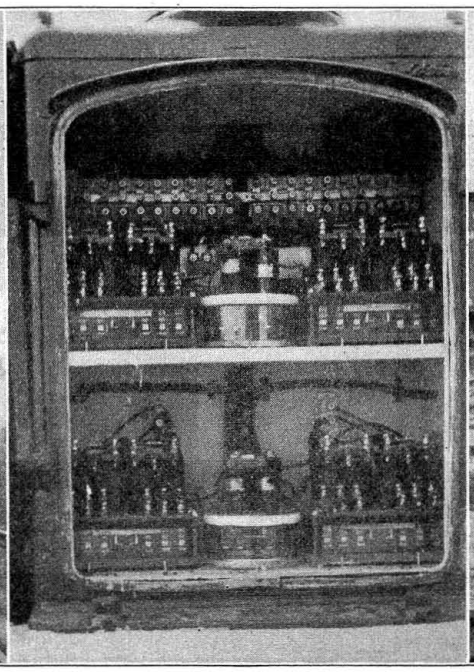
Automatic interlocking has limitations, and, of course, can not be used where operators are required

for train orders, blocking, or to handle switches. It is best adapted to simple crossing layouts, or to locations where traffic on one road is light. It is not practical on heavy traffic lines where superior trains of one road would be subject to frequent delays by inferior trains of the other road; or where an occasional delay, due to the necessity of flagging over the crossing in case the home signal failed to clear, could not be tolerated. Nor would this type of protection be practical where a reduction of speed approaching the crossing would be objectionable.

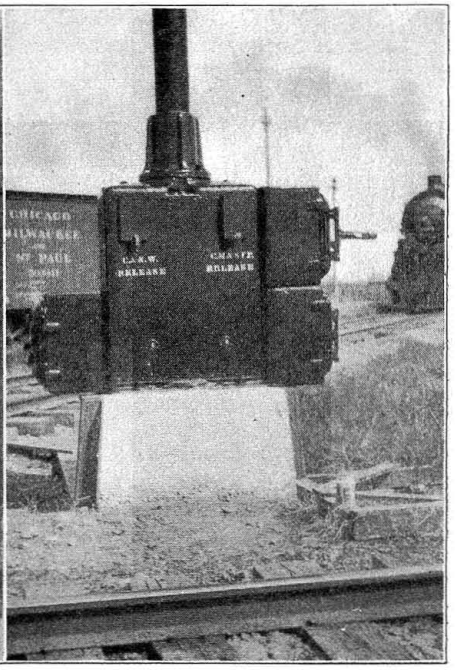
So far, due to the absence of derails and manual attendance, it has usually been considered necessary to impose a speed restriction where this type of interlocking is used. This varies from 10 to 25 miles per hour in the different states. In order to have the signal indications consistent with the speed restriction, fixed distant signals are usually provided. Some roads use a home signal that displays a slow-speed indication also. In the future, after more experience has been gained, it may be considered safe to raise the speed limit, in which case an operative distant signal would be more appropriate. If the development reaches that stage the value and utility of the new system of interlocking will be greatly increased.



Home signal at an automatic plant



Interior of typical relay case



Release boxes at crossing for each road

Low Maintenance Costs and Attractive Savings

The cost of installing an automatic interlocking at a single track crossing amounts to about $6,000, which means low fixed charges for interest and depreciation. No levermen are required and consequently the cost of operation is low. The maintenance expense is also low and, due to the fewer number of units and the greater simplicity, the cost is considerably less than for the old type of plant. There is no expense for tower heating and supplies. The total cost of maintenance and operation plus the fixed charges will amount to about $1,400 per year. Assuming that this expense is divided equally between the two interested roads, each company's proportion will amount to $700 per year, or less than $2 per day.

The cost of stopping trains at a non-interlocked crossing varies widely, due to different conditions, but figuring it at $1 per stop, which would be considered a conservative average for both passenger and freight trains, it would then only be necessary to eliminate two stops per day for a proposition of this kind to carry itself. A movement of eight trains per day would, after making allowance for a certain percentage of delays that would still occur, result in a net saving of about $2,100 per year which would be equal to a return of 70 per cent on the investment.

The savings from replacement of a manually-operated plant with an automatic interlocking are also very attractive. Again taking the case of a single track crossing protected by a mechanical plant, requiring continuous service of levermen, the expense being equally divided between two roads, each company's proportion of the maintenance, operation, and fixed charges, on a valuation of $10,000, would amount to from $3,500 to $4,000 per year. Taking the smaller figure, the difference in favor of the automatic interlocking would amount to $2,800 per year, or equal to 90 per cent on the investment. This figure does not take into account the credits from retirement of the mechanical plant, and does not make any allowance for increased costs, if any, of train operation due to the speed restriction and the possibility of there being a few more delays under the automatic arrangement than with the mechanical plant.

On the basis of the foregoing figures, it would take a minimum of about 20 movements per day, or 10 on each road, for the old style plant to be a paying proposition as compared with a minimum of 2 on each road for the automatic type of plant.

Six Crossings Protected on Single Track Subdivision

There are six grade crossings on the C. M. St. P. & P. line between Aberdeen, S. D., and Mitchell—four with the Chicago & North Western and two with the Minneapolis & St. Louis. Although trains

were required to stop for all of these crossings it was never believed that there was enough traffic to justify the heavy expense incident to the old type of manually-controlled interlocking. During the last two years, however, automatic interlockings have been installed at three of the C. & N. W. crossings, the fourth one is to be taken care of soon and gates have been provided at the two M. & St. L. crossings, so that trains can now move over these crossings without stopping.

This subdivision is 128.6 miles in length, and forms one of the connecting links between the Pacific Coast extension and the Chicago-Omaha line. Connections are also made with two other St. Paul lines extending east and west across Iowa and Minnesota. It runs through an open prairie country and most of the way the line is straight, there being one 33-mile stretch of tangent track. While the line is fairly level, there are a number of grades, the maximum being 1 per cent. The track is laid with 75 and 85-lb. rail. Traffic consists of four regular passenger and four regular freight movements. Extra trains are operated occasionally, especially during the season when grain is being moved. The freight is of a varied character and consists principally of merchandise, lumber, coal, oil, grain, stock, machinery and farm implements.

New Protection Pays Good Returns

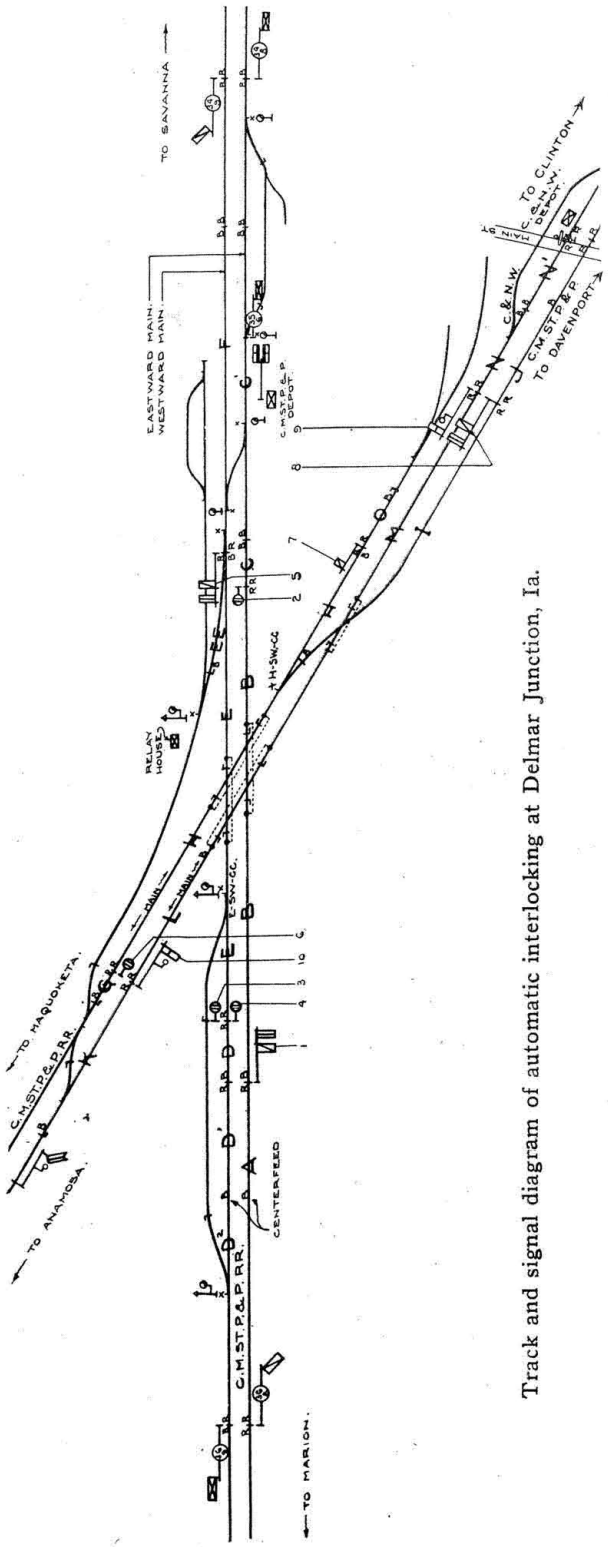
Since the new protection has been installed and the crossing stops eliminated, the average freight train running time over the division has been reduced by 1 hr., 17 min., or an average saving of 14.6 per cent in train hours per trip. The average freight train speed has increased from 14.7 m.p.h. to 17.1 m.p.h., or an increase of 16 per cent. While passenger schedules have not as yet been increased it is now much easier to make up lost time. Freight train loadings have increased an average of about 170 tons per train with no change in the kind of power that is used. This increased train load is being handled in less time without the same amount of fuel as formerly, which, of course, is a substantial saving. In the passenger service the saving in fuel averages about 1,500 lb. per trip.

The protection at the three crossings represents an investment of about $7,200 to the C. M. St. P. & P. The expense of maintenance and operation runs about $1,400 per year and adding 10 per cent for interest and depreciation, this makes a total of $2,120 per annum. Figuring train stops on the basis of $1 each the net saving amounts to $8,000 per year, which makes a return of over 100 per cent on the investment.

Description of New Plants

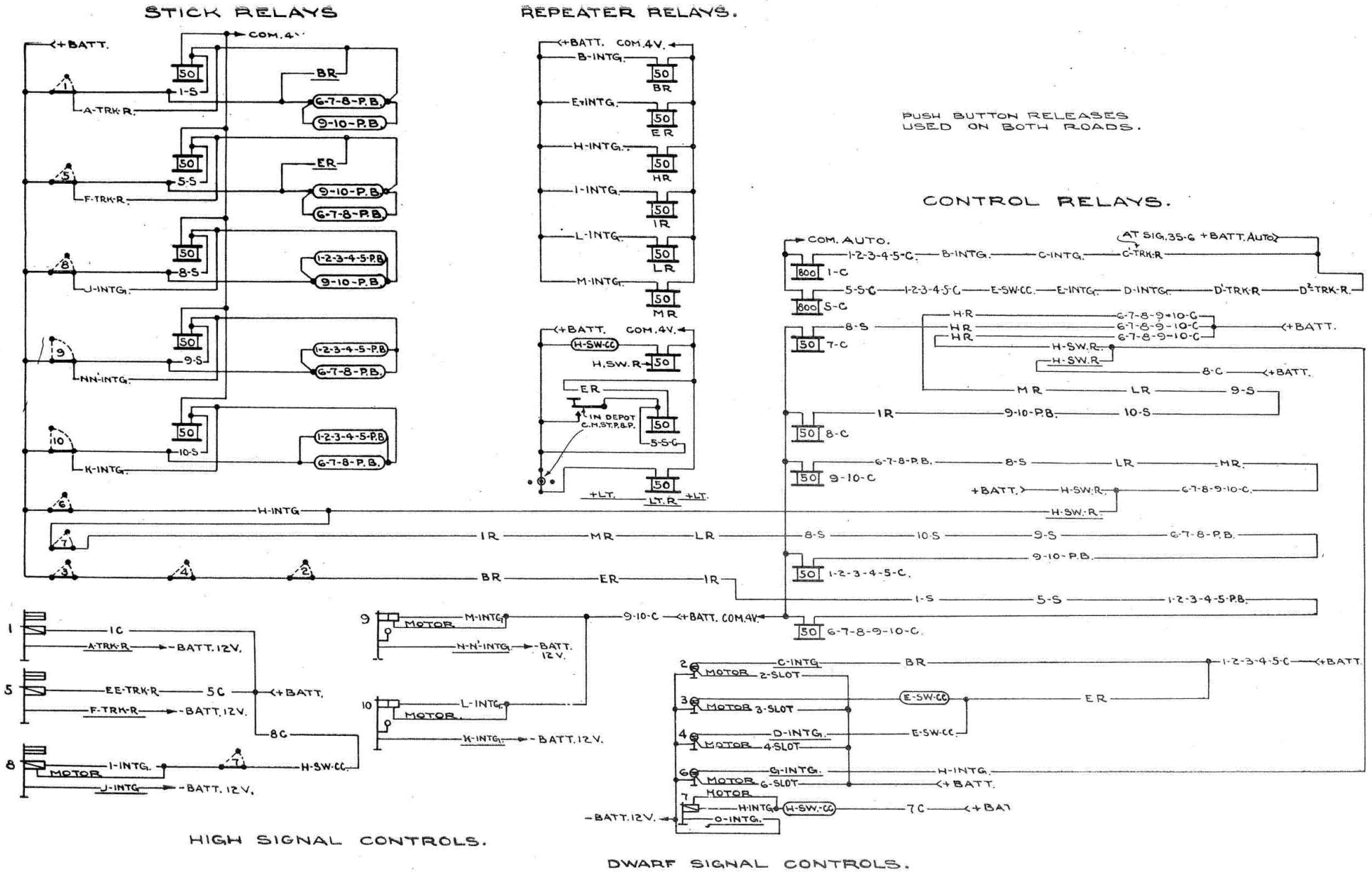
The automatic interlockings are located at Aberdeen, Redfield and Wolsey. The same general scheme was followed out in all of these installations, although there were necessarily some variations due to local conditions. The protection consists of home signals on each side of the crossing and usually located about 550 ft. from it. The C. M. St. P. & P. uses a two-arm, upper-quadrant, semaphore type signal with the top arm fixed and the bottom arm operating in two positions from 0 to 45 deg. This is a slow-speed signal and the restrictive indication is in keeping with the 20 mile restriction that is imposed by special time card rule. Fixed distant signals are provided at distances of 2,600 to 3,000 ft. from the home signals. The general arrangement, aspect, and location of signals is as indicated in the accompanying diagram.

The home signals are electrically-interlocked, and so arranged as to clear up automatically on the approach of a train provided no conflicting signals are in the proceed position and the track circuits on



Track and signal diagram of automatic interlocking at Delmar Junction, Ia.

both roads over the crossing are unoccupied. Clearing circuits usually start at the distant signals, although in several instances they were shortened up on account of sidings, station grounds, or other special conditions. Electric stick locking is provided to guard against the immediate clearing of a signal on one road should a signal that had previously cleared



Circuit diagram for automatic interlocking at Delmar Junction, Ia.

on the approach of a train on the other road go back to stop for any cause before the movement had been completed. This electric locking releases automatically when the approach circuits are clear, and manual, push button type releases are provided at the crossing to be operated by trainmen in case it is necessary to take the route away from one road and clear the signal on the other. This is accomplished by dropping one set of stick relays and picking up the other. As will be noted from the typical circuit plan, the stick relay circuit also affords the cross checking of conflicting signals and gives the electric interlocking feature. The checking of opposing signals on the same road against each other is not considered necessary.

All Relays Located at the Crossing

The circuit arrangement is simple. Directional control, to prevent clearing of signals for movements away from the crossing, is obtained by the use of standard interlocking relays. All interlocking, signal control, and stick relays are located at the crossing. The signals are operated from one central battery, which is also located at the crossing. Where there is a-c. power, a 6-cell storage battery on a-c. floating charge is furnished, but where current is not available a 20-cell primary battery is used. A separate 4-cell primary battery is installed at each home signal for controlling the line relays. Primary batteries are used on the track circuits. The home signals are approach lighted, 12-volt lamps being used. Distant signals are equipped with 30-day oil lamps which are maintained by the individual railroad's section men.

The hold-clear and operating circuits for the two home signals on each road are carried through a master relay and then selected through back contacts on the approach sides of the interlocking relays. The master relays in turn are controlled through the four short track circuits inside the home signals, the two repeater stick relays checking the signals on the conflicting road, the release for that road, and through any switches or side track derails in or leading into the route. Switches or derails are not arranged to shunt the track circuits for the reason that the throwing of them by trackmen or others might cause objectionable interference in the signal operation on the other road. Signals are not overlapped beyond the opposing signal, as in some cases where passing track switches are located inside the clearing section, this might cause unnecessary delays in the case of meets.

Special Circuit Features

At some points a special circuit is used so that the throwing of the passing track switch picks up the approach side of the interlocking relay momentarily, thus restoring the relay from its interlocked condition. This permits the signal to clear for the train that may have entered the clearing circuit while another train was pulling in on the siding. Without this feature the directional control would prevent the signal from clearing for the second train. The circuits are also arranged so that the release at the crossing takes care of a return movement over the crossing after the directional control has been set up. When manual control is introduced, a switch is provided at the depot or other convenient point to pick up the approach circuit. This prevents the home signal from clearing, thereby permitting the signals on the other road to clear. Pilot lamps are provided to indicate when these switches have been operated so that they may not be left in the wrong position. All of these special features have been indicated in the circuit plan.

Installation on Heavy Traffic Double-Track Division

An automatic interlocking has been installed at Delmar, Iowa, where the C. M. St. P. & P. double-track main line between Chicago and Omaha, Nebr., crosses one of its branches and a branch line of the C. & N. W. These latter two branches also cross each other at that point and there are a number of switches and other tracks in the vicinity of the crossing. This crossing had previously been unprotected and while interlocking had been considered it had never been installed on account of the heavy expense and due to the complications created by the switches and station grounds it would have been detrimental in some respects. In the past the crossing stops had not been so burdensome as freight trains took water here and a number of passenger trains had branch line connections, but due to the curtailment of branch line service, the use of heavier power, faster schedules, and other changes it became more desirable to "run the crossing." For that reason this was one of the first places where automatic protection was installed.

Traffic on the main line is heavy and there are from 16 to 20 movements a day over the crossing on the two branch line tracks. The automatic interlocking has now been in service almost two years and the results obtained have been very satisfactory. Experience has shown that an installation of this kind is practical on a heavy traffic line where speed is not of first importance and that it makes a flexible arrangement for handling switching movements. Substantial savings have been effected, as there is a 0.5 per cent grade on the main line approaching the crossing from the west and the elimination of the stop has made it possible to handle considerable additional tonnage in eastward trains. The fuel consumption has been reduced, train movements have been expedited and operation on both main and branch lines has been benefited.

The signaling arrangement is similar to that described for the single-track plants with the addition of dwarf signals to govern movements out of sidings and against the current of traffic on the double track. The clearing circuits for the back-up movements were made short and signals on side tracks are arranged to clear up when the switch is thrown. Directional control is provided for all signals except the two main line signals governing in the normal direction of traffic. Manual control from each company's depot is provided for certain signals. The main line is equipped with an automatic block signal system and the crossing signals are connected into it through the track circuits. The distant signals are semi-automatic and operate in two positions only, the same as the home signals.

Other Forms of Modified Protection

The use of gates is now becoming quite general at crossings where traffic on one road is unimportant and there is no objection to the additional delay required for the handling of the gates by trainmen. In some cases electric signals have been provided to operate in conjunction with the gates. The C. M. St. P. & P. now has some 20 crossings protected in this way where trains on one road are permitted to proceed without stopping when the gates are properly lined.