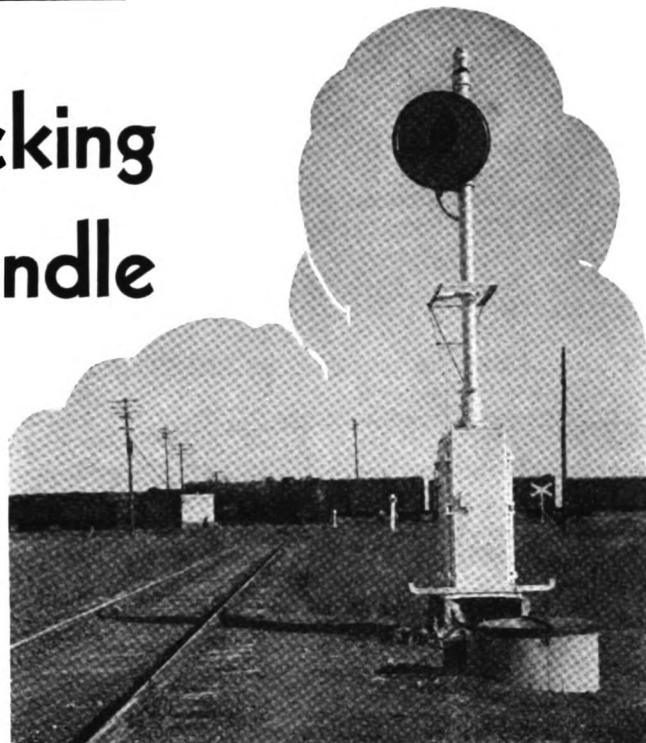


Railway Signaling

Automatic Interlocking in the Texas Panhandle

Plant involving Burlington and Santa Fe lines includes time-recorder and provides for switching operations



Two Denver trains occupying the crossing, viewed from a Santa Fe home signal

AN automatic interlocking plant has been installed at Chillicothe, Tex., at the crossing of the former Orient line of the Panhandle & Santa Fe, part of the Santa Fe system, and the Ft. Worth & Denver City, part of the Burlington system. Several years ago an obsolete mechanical plant was removed from service at this point, for the reason that the expense incurred in its operation and rehabilitation was not warranted by the amount of traffic handled. Nevertheless, some sort of signal protection and a means of reducing train delays at the crossing were highly desirable in view of the numerous switching movements made in the vicinity of the crossing. Under these conditions an automatic interlocking with special plant-releasing equipment was the logical solution of the problem of protecting and expediting train movements.

Traffic Over the Plant

Chillicothe is situated midway between Ft. Worth, Tex., and Amarillo, on the Denver, and 18 mi. south of the Oklahoma-Texas border on the Santa Fe line that extends from Wichita, Kan., to Presidio, Tex. The

Santa Fe traffic consists of two passenger and two local freight trains daily; the Denver operates four passenger trains and six freights daily. As there is considerable interchange between the local freights on the two lines, transfer tracks and sidings are located near the crossing, which is midway between the two passing-siding switches on the Denver. As a further complication to the layout, passenger stations are situated within one of the clearing sections on each road between the approach and the home signals, and a house-track switch on the Santa Fe is within home-signal limits. These conditions, coupled with the fact that there are a total of 16 main-line switches included between the four approach signals of the plant, conspire to make the application of automatic interlocking difficult. Serious train delays would have to be contended with whenever a train stopped at the depot or otherwise utilized the clearing sections of the plant simultaneously with a train on the other railroad, were not some provision made for the safe release of the actual crossing in such cases. The elimination of these possibilities and the degree of safety attained are the principal features of this installation.

Layout of Plant

Reference is made to the diagram of tracks and signals showing details of the interlocker. All main-line home signals are situated 400 ft. from the crossing. The approach signals on the Santa Fe are 2,840 and 3,465 ft. from the crossing, and both of those on the Denver are 4,400 ft. distant. The track circuits extend approximately 2,600 ft. in advance of the approach signals in each case. Thus, the four clearing sections range from 5,180 to 6,640 ft. in length. The speed limit, by bulletin, for all trains is 20 m.p.h. over the crossing.

All home signals have red and green aspects, excepting

Automatic interlocking began with simple outlying grade crossings. Recently, complex situations have been successfully signaled without sacrifice of necessary flexibility or safety. This article describes an automatic layout that embraces most of the ramifications yet attempted.

the dwarfs on the Denver passing siding, which present either red or yellow aspects. The approach signals on the Denver are normally yellow, changing to green upon the approach of a train, if the home signal is also clear. However, these signals do not provide automatic-signal protection, as they apply to the crossing alone. Conversely, the Santa Fe approach signals are three-position normally-yellow signals which change to green upon the approach of a train and, in addition, show the red aspect if any switch or track circuit in the approach to the home signal, excepting the preliminary track circuit, is not normal, thus affording the equivalent of automatic-signal protection. The home signals are, of course, normally red. All of the signals are the Union Switch & Signal Company Style H-2 searchlight type designed for 8-volt operation.

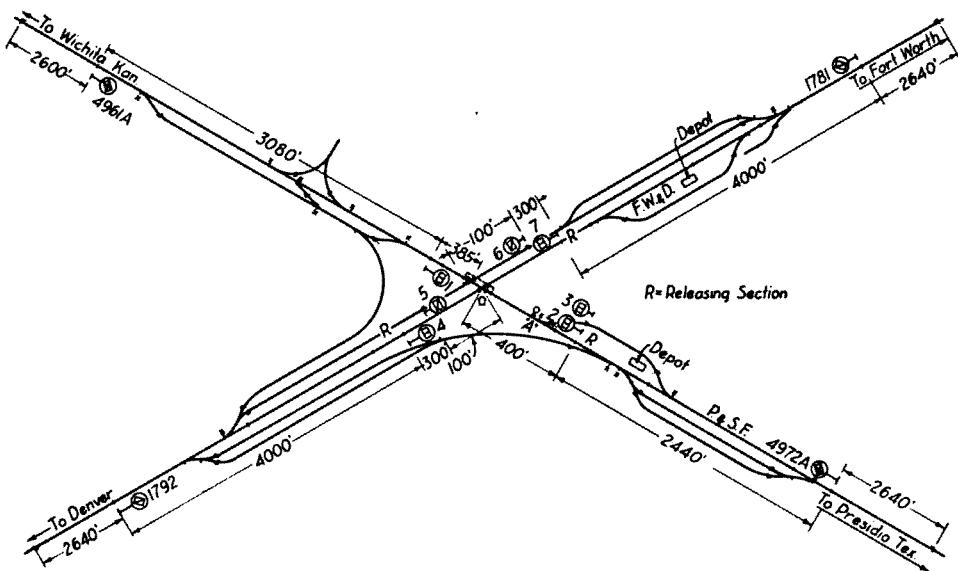
Automatic Releases Provide Flexibility

Referring again to the track diagram, it will be noted that there is a short track section immediately in the approach of signals 2, 4 and 7 respectively. The pur-

Preference is given to the first train occupying a releasing circuit.

Under normal operating conditions, a train moving across the plant will not obtain a green back-up signal to again use the crossing unless it first clears the releasing section, where such sections are provided (both main-line approaches on the Denver and the northward approach on the Santa Fe, signals 2, 4 and 7). If a train passes the releasing section and then re-occupies it, a "proceed" signal will immediately authorize the back-up move, provided a train on the other road has not obtained a clear signal before the releasing section was re-occupied for the back-up move. Thus a monopoly of the use of the crossing by either road is prevented.

Where releasing sections are not employed, a back-up signal can be cleared by a member of the train crew operating a switch-key circuit controller which is located at the home signal. In the case of signal 7 on the Denver, there are occasions when, in switching cars into the mill and cotton-gin tracks after the plant has been crossed, it is impossible to get the engine or cars entirely clear of the releasing section in order to authorize a



Plan of the Chillicothe interlocking, showing the track and signal arrangement and the principle dimensions

pose of these 100-ft. sections is to allow a train to re-establish the signal indication, authorizing use of the crossing, after it has been deprived of the initial clearing of the signal on account of not having accepted it within a prescribed time interval. Specifically, the circuits are so designed that a train entering the clearing section on any approach, which includes all track circuits up to the home signal, causes the required signals to operate, provided the plant is unoccupied; all conflicting moves are thereby prohibited by all opposing signals. However, a DT-10 time-element relay set for 4 to 6 min. also begins to operate at the same time, and, after its operation is completed, the home signal returns to the red aspect if it has not been accepted in the meantime. This arrangement prevents trains on the opposing road being detained on account of switching or train stops which may be in progress on the first road. When the train is ready to use the crossing, after having completed a station stop or switching move, it occupies the 100-ft. releasing track section immediately in the approach of its home signal. If all other approaches to the plant are unoccupied, the signal will clear immediately. However, in the event another train is approaching the crossing or otherwise occupying the plant, a 4-min. interval is imposed before the signal will operate after going to "stop."

back-up move. This situation is relieved by the operation of a key controller, which has the same effect as clearing and re-occupying the releasing section. The same condition applies to signal 2 on the Santa Fe. This explains the necessity for both the key controller and the releasing sections at these points.

Key Controllers on Siding Dwarf Signals

Dwarf signals are used at the crossing on the Denver passing track and on the Santa Fe house track. These are not equipped with approach sections, since to so equip them would reduce the capacity of these tracks. In lieu of clearing track circuits, both of the dwarf signals on the Denver include key controllers. These can be operated by a member of the train crew by inserting a switch key and turning it to the right, after which the key can be removed from the controller. This action sets up an influence which will immediately operate the dwarf signal, if conditions on the opposing road permit. If the opposing road is occupied, this influence is stored until conditions are adjusted to permit the operation of the signal. Once the dwarf signal is operated, it will remain clear until a three-minute time interval has elapsed, or until the train accepts the indication and pro-

ceeds over the crossing. After the prescribed time interval has expired, the dwarf will return to its restrictive aspect.

The dwarf signal on the P. & S. F. does not have a key controller, as this signal controls movements that converge into the main line, requiring the operation of hand-throw switch A. This switch is equipped with an indicator that repeats the approach of trains on the Santa Fe, the circuit being controlled by the normal repeaters of signals 1 and 2, as well as by the crossing track sections of the Santa Fe. The reversal of switch A in turn operates dwarf signal 3, by means of a switch circuit controller, unless conditions on the other road do not permit; or it will operate the signal as soon as conditions do permit.

Traffic Circuits for All Outbound Movements

Obviously it is not necessary that trains should operate the home signals as they trail off the interlocking plant. Such unnecessary obstruction of the crossing is avoided by the use of traffic-direction circuits which are incorporated in the signal clearing combination.

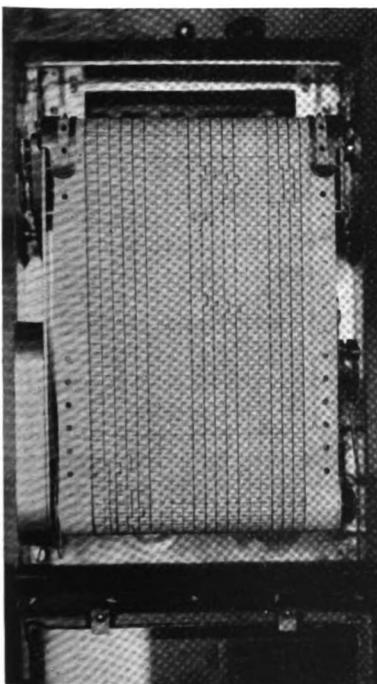
In addition, it has been found undesirable to allow trains which are leaving sidings and proceeding away from the plant to operate home signals, for under such conditions, these operations would undoubtedly cause serious delays to trains on the opposing road. To preclude this unwarranted operation of the home signals at each end of the F. W. & D. C. siding and at the south end of the P. & S. F. siding, special traffic-direction circuits, governed by the position of the siding switch, have been installed. These have the function of reducing the effective length of the clearing section. The holding of the plant signal, which it will not use, in such a situation is thus avoided. If such a siding switch is reversed before the train occupies that fouling section, the home signal will not be influenced at all. However, if the turnout track circuit is first occupied, the signal will ordinarily show green until the siding switch is reversed. The reversal of this switch causes the signal to go to "stop" and to remain so unless the train returns

toward the crossing, in which event normal operation obtains as soon as the switch is passed.

Trainmen are instructed to avoid occupying the releasing sections until they are ready to use the crossing, thereby reducing to a minimum the delays suffered by the opposite road in waiting for the safety time interval to elapse. Trainmen on the Denver are also prohibited from leaving cars on the siding between dwarf signals, thereby obstructing movements on the Santa Fe. In the event of a failure of the plant, the trainmen of both roads are required to protect all train movements over the crossing by flagging in each direction on the opposing road, in accordance with the operating rules.

As previously mentioned, one of the features of this automatic interlocking is the degree of safety attained. One essential premise is the introduction of a time interval between a clear home signal on one road returning to "stop" and a home signal on the opposing road clearing. An exception to this rule lies in the case of a through move, in which the home signal is accepted and two crossing-section track circuits are occupied, the train either completing the movement across the plant, or returning past the home-signal limits. In this case a train on the opposing road will receive a clear indication immediately. In a sense, this is analogous to the well-known principle of approach locking with the delayed release of a line-up as applied to an ordinary interlocking system. The effect of all track circuits within home-signal limits being absolute in the control of all home signals, is likewise analogous to detector locking in the case of interlocked switches.

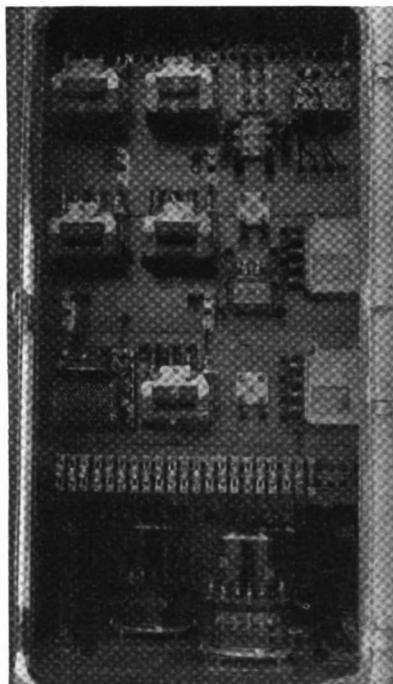
It will be noted by the track diagram that there is a 33-ft. dead section on the Santa Fe over the two Denver tracks. The hazard entailed in this unavoidable circumstance is aggravated by the fact that the Santa Fe house-track switch lies within home-signal limits. However, the possibility of the dead-section being occupied without all signal controls being interrupted is highly remote, owing to the design of the trap circuit. A normally-energized trap-circuit relay breaks the signal combination whenever a train passes over the crossing. The stick circuit of this relay is broken whenever the track circuit



Closeup of time-recorder



Interior of relay house

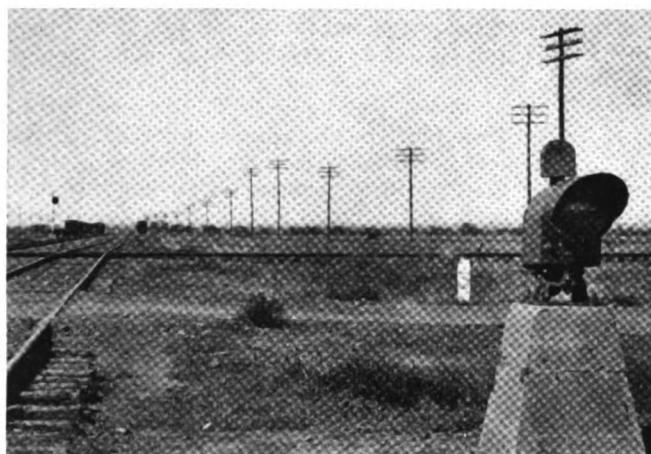


Instruments at signal 2

adjacent the crossing is occupied. Furthermore, the relay cannot be re-energized unless the train either continues over, or returns from the crossing to either one of the short absolute track sections which adjoin the center absolute section. This explains the necessity for the three track circuits between home signal limits on the Santa Fe. Thus, it is impossible for a short light-engine, a stray box car, or a light rail-motor car to stand on the crossing frogs without breaking all signal controls either through the agency of the trap circuit, a track shunt, or both.

Example of Plant Operation

Suppose a train on road No. 1 occupies a clearing section. It operates its home signal, accepts this signal and passes over the crossing onto the receding clearing section, but stops before leaving the track circuits, say, at the station. A train on road No. 2 now enters its clearing section. The second train will instantly receive



Dwarf signal on the Denver passing siding—The key circuit controller is mounted above the signal case

a "proceed" indication, because the first train has completed its use of the crossing and, owing to the design of the circuits, has not influenced the home signal on its road for a back-up move. Since it does not have this back-up authority from the signal, there is no hazard in permitting the signal for the train on road No. 2 to indicate "proceed" immediately.

Again, suppose the train which is approaching on road No. 2 does not accept its signal but instead, stops for station work, allowing the signal to return to "stop." Meanwhile, a second train following the first train on road No. 1 occupies the clearing section influencing the operation of the home signal. It does not receive a clear signal because the train on road No. 2 is still occupying its clearing section. After the expiration of the time interval, which provides that an approaching train must accept its signal in a prescribed time or forfeit that signal until the releasing section is occupied, it becomes necessary to introduce an interval of time before the home signal on road No. 1 can be changed to "proceed." This second time interval insures that the train on road No. 2 has had ample time to come to a safe stop behind its home signal or to foul the crossing, which would prevent the operation of any other signal. In substance, the time interval is effective in any situation in which conditions are such that, without the time interval, a signal on one road returning to "stop" from "proceed" would permit a signal on the other road to immediately indicate "proceed."

In order to comply with regulations of the Texas Railroad Commission, a 20-pen Esterline-Angus recorder has been installed. The record tape of this device moves at the rate of three inches per hour, being actuated by a 110-volt 60-cycle synchronous motor. The 15 active pens are actuated by 8-volt d-c. magnets which, in turn, are controlled in much the same manner as illuminated-diagram and indicator lights are controlled at an ordinary electric interlocking. The moving tape provides a continuous chronological record of the operation of the principal functions of the plant, including the seven home signals, the four approach clearing sections and four detector track sections. Of course, with a knowledge of the actual length of track circuits and the record tape, the average speed of a train over any approach to the plant can be estimated. Also, the operation of the various time functions can be observed, the smallest time division on this tape representing two minutes.

Equipment and Power Supply

The line relays include 500-ohm DN-11 and 250-ohm Model-13 types, some of which are necessarily slow-release in order to provide for the proper functioning of the numerous stick-circuits. The various time circuits employ eight DT-10 time-element relays. Continuity of power supply to the signal lights is assured by the use of 11 ANL-20 power-off relays at strategic points, the stand-by battery being of the Exide DMGO-5 or -9 type. The four outlying preliminary track circuits are supplied by eight-cell Edison 500-a.h. primary batteries, the multiple connection assuring an extra long interval between renewals. Keystone plug-type bond wires are used, the bonds being placed on the outside of the track and above the rail-joint bolts. Track connections and short cable runs are made up of 2-in. and 3-in. creosoted trunking, the wires being surrounded with asphaltum pitch. Numbers 6, 9 or 14 A.W.G. wire is used according to the requirements of the circuits. The cable-drops are made up of No. 14 weather-proof wire. However, a 37-conductor manufactured aerial cable is utilized at the concrete relay house at the crossing. Line controls are on open pole-line, and a 110-volt 60-cycle charging line is employed to supply the outlying signal locations. Number 6 weather-proof wire, with porcelain insulators, is utilized for this circuit. The a-c. energy is purchased from a public utility company. Union RT-10 copper-oxide rectifiers are used for battery charging.

All main-line signals are continuously lighted on alternating-current from the NL-25 transformers. However, approach lighting is effective if the a-c. supply fails, which greatly extends the stand-by capacity of the storage batteries. The dwarf signals, having no approach circuit, are continuously lighted on a-c. with a d-c. stand-by. All of the signals are illuminated by 13.5 plus 3.5-watt double-filament lamps.

The concrete relay house at the crossing is fitted with 2-in. by 12-in. finished pine shelving and 1-in. by 8-in. terminal boards which are supported by a 2-in. by 3/16-in. angle-iron framework. The angle-irons for these racks were cut and drilled in the railroad shop according to a standard plan; it was necessary only to assemble the parts in the field. All underground wiring is terminated on the lower level of the instrument house near the battery shelves, and the aerial cable is terminated on arresters on the top terminal board. All local circuits at this substation are carried by No. 14 stranded copper wires which are fitted with Bee-wire terminals soldered to each end.

This interlocking plant was designed and installed by the signal forces of the Atchison, Topeka & Santa Fe.