crossings are as follows: Iowa, 43 crossings; Illinois, 36; Minnesota, 25; Wisconsin, 22; California, 17; Kansas, 16; Nebraska, 14; South Dakota, 13; Missouri, 12; and Texas, 10. The total for all states in the Union is 293 such grade crossings and 26 such gauntlets.

The total length of road on which visual cab signals are in operation—3,855 miles—is 50 miles more than

Aggregate Length of Lines and Parts of Lines and Number of Locomotives Equipped with Automatic Train-Stop or Train-Control Devices on January 1, 1932. (I. C. C. Table No. 6)

Name of railroad	Miles of road equipped	Miles of track equipped	Number of locomotives equipped	Number of motor cars equipped
Alton	113.3	203.5	68	
Atchison, Topeka & Santa Fe	175.6	356.2	87	3
Atlantic Coast Line	[1] 293.9	582.1	137	
Baltimore & Ohio	127.1	258.6	204	1
Boston & Albany	208.1	507.9	236	
Boston & Maine	104.6	213.2	161	
Carolina & Northwestern			11	
Central Railroad of New Jersey	120.3	180.4	133	
Chesapeake & Ohio	125.0	125.0	110	
Chicago & Eastern Illinois	141.5	283.0	187	
Chicago & North Western	511.0	1,050.0	346	3
Chicago, Burlington & Quincy	161.0	242.0	91	7
Chicago, Indianapolis & Louisville	161.0	161.0	50	
Chicago, Milwaukee, St. Paul & Pacific	212.5	425.0	94	
Chicago, Rock Island & Pacific	342.5	573.4	165	4
Cleveland, Cincinnati, Chicago & St. Louis	235.1	384.4	287	4
Cleveland Union Terminal			22	
Delaware & Hudson	198.2	279.3	150	
Delaware, Lackawanna & Western	256.5	546.5	211	
Elgin, Joliet & Eastern			30	
Erie	242.4	484.4	170	
Great Northern	229.5	255.9	79	3
Illinois Central	219.6	343.2	153	
Lehigh Valley	280.2	661.8	332	17
Long Island	48.4	88.0	48	295
Louisville & Nashville	297.9	302.1	95	
Michigan Central	315.5	631.0	[2] 314	
Missouri-Kansas-Texas			3	
Missouri Pacific	50.0	53.0	42	
Mobile & Ohio			6	
New York Central	1,013.8	3,389.3	1,287	3
New York, Chicago & St. Louis	139.7	157.5	61	
New York, New Haven & Hartford	162.8	346.9	207	
New Orleans-Great Northern			15	3
Norfolk & Western	238.7	241.2	80	
Northern Pacific	215.6	215.6	82	
Pennsylvania System [3]	[4] 650.8	1,600.3	[5] 1,151	1
Pere Marquette	135.4	148.6	104	
Pittsburgh & Lake Erie	64.2	232.5	115	
Reading	101.1	204.5	145	[6]
Richmond, Fredericksburg & Potomac	109.7	219.4	62	2
St. Louis-San Francisco	106.1	115.4	101	
Southern System	2,718.6	3,491.0	952	
Southern Pacific	232.4	294.5	303	3
Texas & New Orleans	170.1	170.1	61	
Union Pacific System	309.0	536.5	173	
Total	11,544.7	20,554.0	8,891	349

[1] Includes 2.8 miles of road and 5.6 miles of track on the Richmond, Fredericksburg & Potomac, equipped for operation of Atlantic Coast Line locomotives.

[2] Includes locomotives operating over 489.8 additional miles of equipped track in Canada.

[3] In addition to the mileage shown there are 335.5 miles of road and 1,219.5 miles of track equipped for cab signal operation over which train control equipped locomotives are operated.

[4] Includes 32.3 miles of road and 83.8 miles of track on the Baltimore & Ohio, equipped by the Pennsylvania for operation of its equipped locomotives.

[5] In addition to the train control equipped locomotives listed there are 798 steam locomotives, 9 electric locomotives, 200 multiple-unit cars and one gas-electric car equipped with cab signals only, without train control which may be operated interchangeably over all equipped tracks.

[6] There are 70 multiple-unit cars, equipped with cab signals only, which operate over 13.3 miles of road in train-control territory.

the figure given in the 1931 report. This 50 miles consists of 39 miles on the Chicago & North Western and 11 on the Pennsylvania.

Centralized traffic control is now in operation on 893 miles of road as compared with 554 miles on January 1, 1931; number of passing sidings, 177, as compared with 111; switches, 725, as compared with 344. Of the 27 roads appearing in this table, 12 have more than one section each. The Boston & Maine has 11 sections; C. B. & Q., 6; Missouri Pacific, 4.

The table showing remotely operated switches gives a total of 396 control points, a small increase.

The telephone is now in use for the transmission of train orders on 154,462 miles of road, a slight increase over January, 1931. As in former reports, it appears that a considerable number of roads report the use of both telegraph and telephone for train dispatching on the same section. On 18 roads of considerable length—from 200 miles each to 1,500 or more—the train dispatchers still use the telegraph exclusively.

Rock Island Improves Lightning Protection

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used, in line circuits at each break, the ordinary choke-coil arrester with one gap, and an artificial ground. Also, a jump-spark arrester was used across the coil terminals of both track relays and line relays.

The facts listed above indicated that the lightning coming in on line circuits was "breaking away" via track relays through which it passed to the rails. Therefore, we started using the three-gap arrester, attaching an artificial ground to one gap post and one each of

Table Showing Reduction of Lightning Trouble on Rock Island

Signal Interruptions Due to Lightning		*Relays Damaged by Lightning*		
Year	*Cases*	*Track*	*Line*	*Total*
1926	127	140	69	209
1927	59	94	54	148
1928	24	87	57	144
1929	32	70	53	123
1930	26	54	31	85
1931	26	44	31	75

the rails to the other two gap posts. Our results were so satisfactory that, in addition to buying this type of arrester for all new work, we decided to arrange the single-gap arresters to provide a path to each rail as well as to an artificial ground. This re-arrangement has been carried out in connection with rail relay work, etc., which required rewiring of relay housings.

The reduction of the number of interruptions caused by lightning, and of the number of damaged relays, notwithstanding a large increase in equipment, indicate, in my opinion, the advantages of our present practice.

A Detector Bar Fails

ON March 2, 1932, there was a derailment of a passenger train of the Chicago, Indianapolis & Louisville, at Indianapolis, Ind. An abstract of the report of the Bureau of Safety on this accident follows:

This accident occurred within limits of an interlocking plant at the junction of three railroads, the Big Four, the Nickel Plate, and the Monon. The route traversed by northbound Monon passenger trains, commencing at the Union Station, is over the Indianapolis Union Railway tracks for a distance of 4,200 ft., then on the eastbound main track of the Big Four for 5,000 ft. to home signal 40, where keeping to the left they enter upon the track of the Nickel Plate, which track is traversed a distance of 650 ft. to the point where the Monon property rights commence. The accident occurred at the beginning of the Monon line, at the south switch of a crossover connecting that track with the Nickel Plate track on the east.

The interlocking plant is operated and controlled by a 40-lever electric machine having 32 working levers. The switch involved, switch 14, is directly controlled by

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sired. In hot weather we sometimes have trouble getting new end-posts in between the two rails; with the aid of an expanding jack the two rails are pushed apart far enough to take the end post out and put in the new one, but, of course, if the rail is cold, it is necessary to take the angle bars off of the rail at the first joint away from the insulated joint and put the expanding jack on the rail there and push the rail together at the insulated joint and then put the new fibers and insulated joint together and bolt it up tight. The spikes in the joints on one side of the insulated joint and on the other side of the expanding jack must be pulled. Then the rail can be pulled together with the jack, and the joints can be spiked to hold the rail while the jack is being taken off of the rail to put the angle bars on.

A. G. Turner, signal maintainer, Oregon Short Line, suggests the use of the following device for an oil or water can on which the small wire handle causes an unnecessary inconvenience by reason of the fact that it is sometimes difficult to grasp it quickly when one's hands are cold and numb, or when one is wearing gloves: If a small quantity of tape is rolled around one end of the handle, the tape will hold the handle up slightly and permit the fingers to slip under easily. If oil prevents the tape from holding, the roll can be made of No. 10 copper wire, slightly flattened, and rolled on the handle with the pliers.

M. T. Northman, signal maintainer, sends us the following: "Frequently ice will form on the bell of a highway crossing signal, causing the bell to produce only a muffled sound. This may be remedied by applying oil or grease to the bell. The grease causes the rain water to run off the bell before it freezes."

Detector Bar Fails

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lever 14, and the movement of lever 14 is protected by the mechanical locking of the machine so that it can be operated only in a prescribed sequence. Protection against the movement of the points of switch 14 is provided by a detector bar of the motion-plate type, operated by the switch mechanism in the usual manner. Similar protection on the Big Four tracks is afforded by detector circuits.

Towerman Hendricks, of the Big Four, who was on duty at the interlocking plant, stated that when he saw train No. 30 clear signal 40 he restored that lever to normal, with the intention of allowing a Nickel Plate engine to pass through the plant as soon as the Monon train cleared it. Towerman Hendricks had been in the employ of the Big Four since 1901, and during the last 13 years he had been stationed at this interlocking. Signal Maintainer Taylor, of the Big Four stated that he arrived at the scene of the accident about 5:35 p. m., or 27 min. after it happened, and on going to the tower he found all the levers in proper position, with none of them reversed.

Supervisor of Signals Kelley, of the Big Four, stated that on the morning following the accident he conducted tests to determine the condition of the detector bar at switch 14 and by placing a device on the track to simulate a wheel it was found that there were 10 or 12 points at which the detector bar permitted the switch to be moved. Supervisor Kelly further stated that he made a test to ascertain whether or not it would be possible for the switch to move under a train without any operation or effort on the part of any one and it was found that it could not be done, the lever on the machine had to be operated before the switch could be moved, for the reason that polarized relays are used to prevent a movement of the switch in the position opposite to that of the lever.

Signal Engineer Stoltz, of the Big Four, in explaining how switch 14 could be operated while a train was passing over it, stated that the detector bar is applied to two sections of rail where the track of the Nickel Plate joins the track of the Monon. The detector bar clips on the Nickel Plate rail, which is an 80-lb. rail, require the bar to rise to a higher elevation above the top of the rail than in the case of the 90-lb. rail north of the joint; the latter rail, being 7/64 in. higher in the head, allowed the bar to lie that much more below the top of the head than on the 80-lb. rail. In addition to this, loose ties in the vicinity of the switch machine to which the T-crank is attached, permitted a movement of about ½ in. when an attempt was made to operate the bar with a test device to simulate a wheel on it. The lost motion between the machine and the bar, together with the fact that the bar was normally approximately ¼ in. lower than it should have been, permitted the movement of the bar and switch machine with the test device on the detector bar.

Signal Engineer Stoltz further stated that in 1930 detector circuits were installed on the Big Four tracks and in 1931 further improvements were made on the Big Four, including complete approach and detector locking. The Big Four changed from detector bars to detector locking because the locking provided more adequate protection and also because the 105-lb. rail laid by the Big Four in 1930 had a wider head and increased the possibility of a detector bar failing to engage the wheels of a passing train and thus permitting a switch to be opened under a train. Mr. Stoltz said that in correspondence with the other roads, started in 1927, the Big Four endeavored to have complete detector locking installed; he said the reason given by the other roads for not adopting detector locking was because of expense. Mr. Stoltz thought the accident here under investigation would not have occurred had switch 14 been protected by detector locking.

Upon being further questioned subsequent to these tests, Towerman Hendricks admitted that he had inadvertently or unintentionally operated the lever controlling switch 14 before the Monon train cleared it, resulting in the switch being thrown under the train.

Conclusions

The rules of the Big Four provide that signals must be restored so as to display their most restrictive indication as soon as the train or engine for which they were cleared has passed and is clear of the fouling points of its route. Towerman Hendricks should not have restored signal 40 until train No. 30 had cleared the interlocking plant, in which event the unintentional operation of switch 14 could not have occurred.

The condition of the detector bar and its application to the rail was such that it was not reliable to prevent the very kind of an accident for which it was installed. This condition was one which adequate inspection and maintenance should have corrected. At other switches in this plant detector bars had been replaced by detector circuits, because of the greater reliability of such circuits as a means of protection against accidents of this character. It is believed that consideration should be given to the need for detector locking at all switches in this plant which are not now so equipped.