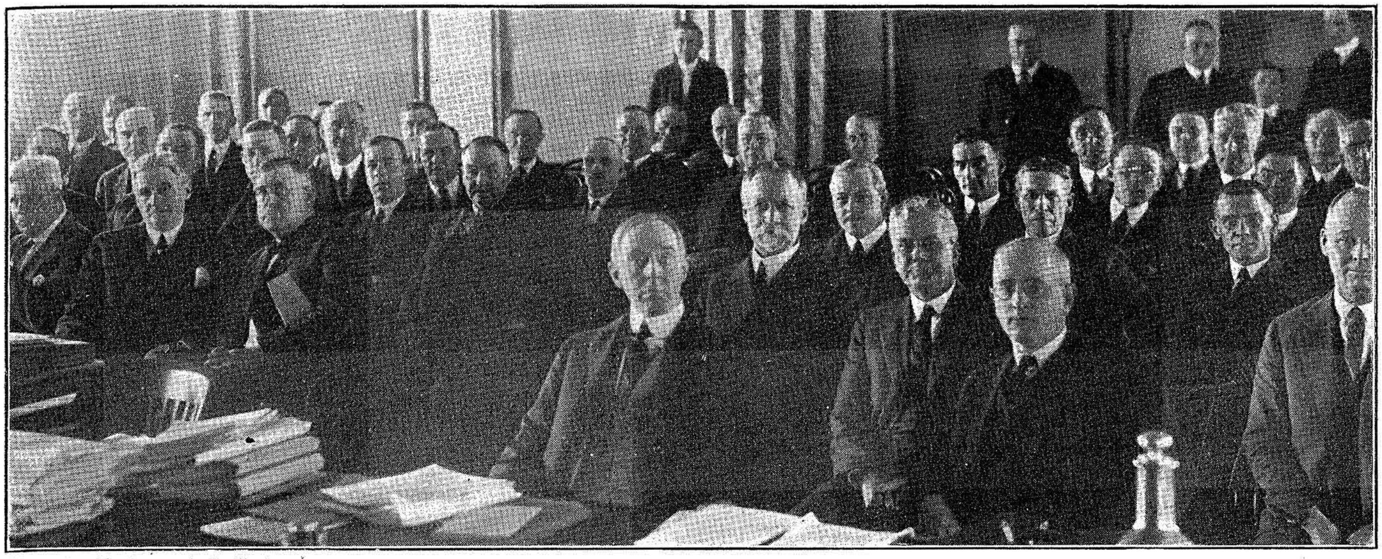


Photo by Underwood & Underwood
Some of the Listeners at the Automatic Train Control Hearings

Automatic Train Control Hearing Is Concluded at Washington

Train Control Proprietors Present Testimony Which Completes Evidence on Which I. C. C. Will Base Decision

IN ORDER that automatic train control companies could present evidence in connection with the proposed order of the Interstate Commerce Commission on automatic train control, the Commission at the close of the testimony of the railroads on March 24 (reported on page 151 of the *Railway Signal Engineer* for April) continued the hearing until April 12.

Before the train control companies were called on, M. C. List, attorney for the Commission, presented for the record a list of acts and documents pertaining to train control showing the government's activity on this subject. Mr. List outlined the reasons which led up to the formation of the Block Signal and Train Control Board in 1907; the amount appropriated and spent by the government in its investigations through the Board and later by the Bureau of Safety. Extracts pertaining to automatic train control were read into the record from the reports of the Board and from the Bureau of Safety's annual reports after the Board was discontinued.

Performance and Accident Records Submitted by Bureau of Safety

The Bureau of Safety prepared and submitted through Mr. List a tabulation of the operating records of the American Automatic Train Control Corporation, the Miller Train Control Corporation and the Regan Safety Devices Company which were based upon the reports of the engineer-examiners and the inspectors of the Joint Committee on Automatic Train Control of the American Railway Association. These tabulations cover the same period as that portion of the report of the subcommittee of the Joint Committee (of the A. R. A.) which relates to the devices in use which was presented by J. A. Peabody at the hearing on March 20, and in connection with the tabulation prepared by the Bureau of Safety a careful check of the Joint Committee's compilation was made. Difference in the classification and record of failures and undesirable stops were shown in the statement accompanying the memorandum. An abstract of the performance records of the three above mentioned train control devices as presented by Mr. List is given below.

Operating Records on American Train Control

The Bureau of Safety submitted a tabulation of the operating records of the automatic train stop device of the American Train Control Corporation as installed on the C. & O. for the period from August 16, 1921, to January 31, 1922, inclusive. During this period an engineer-examiner of the Bureau of Safety and an inspector of the A. R. A. Joint Committee on Automatic Train Control were assigned to this installation for the purpose of observing and maintaining records of the operation of the device. Joint reports were made by these observers, one copy being sent to the Bureau of Safety and one copy to the A. R. A. Joint Committee.

During this period there were a total of 124,446 operations of the train stop device. Each time a locomotive with this device in service passed a ramp location was counted as one operation. Of this total there were 124,316 proper operations, of which 124,035 were clear, 11 were caution, and 270 were stop operations. There were 40 failures of the device in the test zone; these caused 78 stop operations, and 5 were false clear failures. There were 47 undesirable stop operations in the test zone, 9 of which were caused by defects in the engine apparatus of the train control device and 38 were caused by 12 failures of parts of the signal system. Outside the test zone there were 23 stops caused by 19 failures of the engine apparatus of the train control device and 2 undesirable stops from other causes. The total number of safe failures and causes of undesirable stop operations in the test zone was 56, resulting in 125 stops;

outside the test zone, 21 causes resulting in 25 stops; a total of 76 causes and 150 stop operations. As previously noted there were 5 false clear failures of the train control device.

On 42 trips the apparatus was cut out of service and the engines passing 1,413 ramps with the device inoperative.

The total number of equipped engines in service during this period was 3,168, or an average of 18.7 per day. The total mileage of these engines in test zone was 92,786; outside test zone 343,418, or a total of 436,204 miles.

Comparing the total operations with certain classifications in this tabulation, there were 3,888 operations of the train control device for each failure of the engine apparatus of this device; 41,482 operations per failure of the track apparatus; 1,430 operations per safe failure or undesirable stop due to train control apparatus; 3,274 operations per stop due to failure of signal apparatus, and 13,827 operations for each undesirable stop due to the engine apparatus. There were 24,889 operations of the train control device for each false clear failure.

On the basis of engine mileage there were 2,441 engine miles per stop in test zone due to failure of the signal system; 1,066 engine miles per stop in test zone due to failure of the train control device; there were 13,737 engine miles per stop outside of test zone due to train control and on the basis of total mileage and total failures there were 3,894 engine miles per stop due to failure of train control device.

The performance record of the American device for the months of February and March, 1922, according to the Bureau of Safety, was as follows:

Proper Operations:	February	March
Clear	21,223	21,675
Caution:		
No application	13	10
Stop	116	45
Total	21,352	21,730
Engine Failures in Test Zone:		
Shoe	4	
Wiring	1	
Unknown	1	3 causing
Split magneto base	1	
		3 stops
Total	7 causing 14 stops	
Engine Failures Outside Test Zone:		
Broken Pipe to Shoe	0	2
Wiring	2	1
Undesirable stops in test zone	0	2 causing 2 stops
Undesirable stops outside test zone:		
Obstruction	2	1
Undesirable stops due to Failure of Signal System:		
Signals	9	6
Wiring	13	0
Track Circuit	10	1
Unknown	5	2
Total	37 causing 37 stops	9 causing 27 stops
Failure in test zone due to ramp battery	1	2
Wiring total	1	
		6 stops
Total operations	21,404	21,768
Device cut out:		
Trips	5	1
Indication points	130	5
Engines in service	746	675
Engine miles in test zone	15,915	16,498
Engine miles outside test zone	58,908	58,930
Total engine miles	74,823	75,428
Number of operation per failure of engine apparatus	3,057	7,256
Number of operations per failure of track apparatus	21,404	7,256
Number of operations per stop due to train control	1,427	1,979
Number of operations per stop due to signal apparatus	5,784	806
Engine miles per stop in test zone due to failure of signal system	430	611
Engine miles per stop in test zone due to failure of train control	1,061	1,499
Engine miles per stop outside test zone due to train control	11,781	7,366
Engine miles per stop due to train control	3,741	3,969

COST OF MAINTENANCE—CHESAPEAKE & OHIO—LOCOMOTIVES EQUIPPED 37—MILES OF ROAD EQUIPPED 21—MILES OF TRACK EQUIPPED 21—NUMBER OF RAMPS 67

Locomotive Maintenance:	Aug. 1921	Sept. 1921	Oct. 1921	Nov. 1921	Dec. 1921	Jan. 1922
Inspection of Equipment	$190.19	$237.16	$236.39	$235.24	$242.94	$251.79
Repairs:						
Labor	119.12	157.32	208.54	196.13	125.48	106.26
Material	53.54	110.89	72.84	87.11	37.02	45.59
Total for Locomotives	$362.85	$505.37	$517.77	$518.48	$405.44	$403.64
Roadway Maintenance:						
Inspection of Apparatus	$ 46.39	$ 44.36	$ 54.23	$ 41.64	$ 42.99	$ 65.84
Repairs:						
Labor	297.26	185.92	85.89	98.56	67.76	92.80
Material	394.30	96.55	73.31	75.51	361.82	157.09
Total for Roadway	$737.95	$326.83	$213.43	$215.71	$472.57	$315.73
Total for Locomotives & Roadway	1,100.80	832.20	731.20	734.19	878.01	719.37
Av. per Locomotive	$ 9.80	$ 13.65	$ 13.93	$ 14.01	$ 10.96	$ 10.90
Av. per mile of Track	35.14	15.56	10.16	10.27	22.50	15.03
Av. per Ramp	11.01	4.87	3.18	3.22	7.05	4.71

Average cost per month for 6 months for Locomotives and Roadway, $832.63.

Operating Records on Miller Train Control

The Bureau of Safety submitted a tabulation of operating records of the automatic train stop device of the Miller Train Control Corporation, as installed on the Chicago & Eastern Illinois, for the months of May, June and July, 1921; during this period an engineer-examiner of the Bureau of Safety and an inspector of the A. R. A. Joint Committee on Automatic Train Control were assigned to this installation for the purpose of observing and maintaining records of the operation of the device. Joint reports were made by these observers, a copy being sent to the Bureau of Safety and to the A. R. A. Joint Committee.

During this period there were a total of 232,793 operations of the train stop device; each time a locomotive with this device in service passed a ramp location was counted as one operation. Of this total there were 232,492 proper operations, of which 156 were proper stop operations, and 232,336 proper clear operations; there were 71 failures of the device in the test zone; these caused 122 stop operations, and 6 were false clear failures; there were 172 undesirable stop operations in the test zone due to signal failures or causes other than failure of the train control device and 1 due to the train control device. Outside the test zone there were 2 undesirable stop operations. The total number of safe failures and causes of undesirable stop operations in the test zone was 168, resulting in 295 stops, and in addition two outside the test zone; as noted there were 6 false clear failures.

On 8 trips the train control device was not in service and 441 indication points were passed.

The total number of equipped engines in service during this period was 2,300, or an average of 25 per day; the mileage of these engines in test zone totalled 271,651, and outside test zone 151,315, or a total mileage of 422,967.

Comparing the total operations with several classifications in this tabulation, there were 9,700 operations for each failure of the engine apparatus of the train control device, and 5,678 operations for each failure of the track apparatus of the device; there were 1,893 operations for each safe failure or undesirable stop caused by the train control device, while there were only 1,353 operations per undesirable stop due to failure of some part of the block signal apparatus; there were 38,798 operations for each false clear failure of the train control device.

On the basis of engine mileage, there were 1,579 engine miles per stop in the test zone due to failure of the signal system, and 2,208 engine miles per stop in test zone due to failure of the train control device. There were 75,657 engine miles per stop outside the test zone due to the failure of the train control device, and of the total mileage both within and outside the test zone, there were 3,383 engine miles per stop due to failure of the train control device.

It is also worthy of note that during this period of three months the total stops in the test zone caused by failures of the signal system was 172; and that there were 123 stops caused by failures of the train control device in the test zone; that is, there were 49 more stops due to the failures of the signal system than were caused by failures of the train control system.

In February, 1922, observations of this device were resumed and the performance record for that month is as follows:

Proper operations:		
Clear		82,800
Stop		41
Total proper operations		82,841
Failure of engine apparatus in test zone	8	causing 10 stops
Failure of train control track apparatus	4	causing 7 stops
Undesirable stops due to failure of the signal system		46
Total causes		34
Total Stops		63
False clear train control		1
Total operations of train control		82,905
Device cut-out:		
Trips		5
Indication points passed		189
Engines in service		856
Miles in test zone		101,245
Miles outside test zone		46,572
Total mileage of equipped engines		147,817
Number of operations per failure of engine apparatus		10,363
Number of operations per failure of track apparatus		20,726
Number of operations per failure of train control apparatus		6,908
Number of operations per stop due to failure of signal apparatus		1,802
Number of operations per false clear failure of train control device		82,905
Engine miles per stop in test zone due to failure of signal system		2,201
Engine miles per stop in test zone due to train control		5,955
Engine miles per stop due to train control		8,695

It will be noted that the record for the month of February, 1922, compares favorably with the records for the months during the previous observation period.

The performance records with respect to this installation are of particular interest for the reason that the device has been in service for several years on a passenger-engine division, a large percentage of the locomotives operated over the line are equipped, and with respect to both operation and maintenance, it presents practically a typical service installation of an automatic train stop device.

The performance record for the month of March, 1922, according to the Bureau of Safety, was as follows:

Proper operations:		
Clear		90,725
Stop		61
Total		90,786
Engine failures in test zone:		
Valve	1	
Wiring	3	
Total	4	causing 6 stops
Engine failures outside test zone	0	
Undesirable stops in test zone	0	
Undesirable stops outside test zone	0	
Undesirable stops due to failure of signal system:		
Signals	4	
Wiring	1	
Track circuit	7	
Switch boxes	3	
Interlocking plant	1	
Total	16	causing 24 stops
Failures in test zone, track apparatus:		
Wiring	1	
Relay	1	
Unknown	4	
Total	6	causing 8 stops
Total operations		90,824
Device cut-out:		
Trips		8
Indication points		380
Engines in service		945
Engine miles in test zone		110,738
Engine miles outside test zone		51,844
Total engine miles		162,582
Number of operations per failure of engine apparatus		22,706
Number of operations per failure of track apparatus		15,137
Number of operations per stop due to train control		6,487
Number of operations per stop due to signal apparatus		3,784
Engine miles per stop in test zone due to failure of signal system		4,614
Engine miles per stop in test zone due to failure of train control		7,909
Engine miles per stop outside test zone due to train control		No stops
Engine miles per stop due to train control		11,613

COST OF MAINTENANCE—CHICAGO & EASTERN ILLINOIS—LOCOMOTIVES EQUIPPED 85—MILES OF ROAD EQUIPPED 105.4—MILES OF TRACK EQUIPPED 210.8—NUMBER OF RAMPS 175

Inspection of Equipment:	May	June	July
Inspection of Equipment	$502.45	$652.11	$365.72
Repairs:			
Labor	597.32	146.08	183.51
Material	426,36	239.10	205.28
Total, Locomotives	$1,526.13	$1,037.29	$754.51
Roadway Maintenance:			
Inspection of Apparatus	$223.54	$187.41	$183.18
Repairs:			
Labor	210.41	137,57	208.11
Material	124.38	158.05	1.54
Total for Roadway	$558.33	$483.03	$392.83
Total for Locomotives & Roadway	2,084.46	1,520.32	1,147.34
Average per Locomotive	$ 17.95	$ 12.20	$ 8.87
Average per mile of Track	2.65	2.29	1.86
Average per Ramp	3.19	2.76	2.24

Average cost per month for three months for Locomotives and Roadway, $1,584.04.

Operating Records on Regan Train Control

The Bureau of Safety submitted tabulation of the operating records of the automatic train control system of the Regan Safety Devices Company as installed on the Chicago, Rock Island & Pacific for the months of May, 1921, to January, 1922, inclusive. During this period an engineer-examiner of the Bureau of Safety and an inspector of the A. R. A. Joint Committee on Automatic Train Control were assigned to this installation for the purpose of observing and maintaining records of operation of the device. Joint reports were made by these observers, one copy being sent to the Bureau of Safety and one copy to the A. R. A. Joint Committee.

During this period there were a total of 78,663 operations of the train control device; each time a locomotive with this device in service passed a ramp location was counted as one operation. Of this total there were 78,464 proper operations of which 76,373 were proper clear operations, 1,864 were proper caution operations and 227 were proper stop operations. Of the caution operations noted 1,611 resulted in brake applications at caution ramp locations and 253 resulted in no brake applications, the rate of speed being below the prescribed caution rate. There were 75 failures of the train control device in the test zone; these caused 85 stop operations and 3 were false clear failures. There were 15 undesirable stop operations in the test zone due to condition of the engine apparatus and 55 undesirable stop operations in the test zone due to 32 instances of defects of the signal system. Outside the test zone there were 30 stops caused by 28 cases of engine apparatus defective, and 38 undesirable stops, 35 of which were due to striking obstructions. The total number of safe failures and causes of undesirable stop operations in test zone was 117 resulting in 155 stops; outside test zone, 66 resulting in 68 stops, or a total of 183 causes and 223 stops; as noted there were also 3 false clear failures of the train control system.

In addition to the following there were 3 cases of absence of speed control; also several instances of undesirable caution operations due principally to the failure of some part of the signal system and 6 of which were due to a broken wire of the train control device.

During this period the train control device was not in service on 210 trips or parts of trips and 3,802 indication points were passed with the device out of service.

The total number of equipped engines in service during this period was 3,802, an average of approximately 10.1 per day. The mileage of these engines in the test zone totaled 103,452; outside test zone 298,148; a grand total of 401,600.

Comparing the total operations with several classifications in this tabulation, there were 1,140 operations for each failure of engine apparatus of the train control device and 26,221 operations for each failure of the track apparatus of this device. There were 786 operations for each safe failure or undesirable stop caused by the train control device, while there were 1,430 operations per undesirable stop due to failure of some part of the block signal system; there were 5,244 operations for each undesirable stop caused by the engine apparatus. There were 26,221 operations for each false clear failure of the train control system.

On the basis of engine mileage there were 1,881 engine miles per stop in test zone due to failure of the signal system, 1,034 engine miles per stop in test zone due to failure of the train control device, 4,384 engine miles per stop outside of test zone due to train control, and taken as a whole, 2,375 engine miles per failure of undesirable stop due to train control system.

The performance record of this device for the month of February, 1922, according to the records of the Bureau of Safety, was as follows:

Proper operations:	
Clear	6,878
Caution:	
Application	143
No application	12
Total	155
Stop	29
Total	7,062
Engine failures in test zone:	
Absence of speed control	1
Engine failures outside test zone:	
Air pipe to shoe broken	1
Undesirable stops in test zone	0
Undesirable stops outside test zone:	
Obstruction	1
Undesirable stops due to failure of signal system:	
Track circuit	1
Total causes in test zone	2
Total stops in test zone	1
Total causes outside test zone	2
Total stops outside test zone	2
Total causes	4
Total stops	3
Total operations	7,072
Device cut-out:	
Trips	10
Indication points passed	195
Engines in service	301
Engine miles in test zone	9,295
Engine miles outside test zone	26,806
Total engine miles	36,101
Number of operations per failure of engine apparatus	7,072
Number of operations per stop due to failure of signal apparatus	7,072
Engine miles per stop in test zone due to failure of the signal apparatus	9,295
Engine miles per stop outside of test zone due to train control	13,403
Engine miles per stop due to train control	18,050

In connection with the records of observation of this device it should be noted that the installation of 22.4 miles is located between Blue Island and Joliet, 15.7 miles from Chicago, and 140.8 miles from Rock Island, respectively, the division terminals. Repair facilities were available at Chicago only, and necessary repairs were not always made when engines arrived at that terminal; in a number of instances engines were sent out again without opportunity for repairs to the train control equipment to be made. At Joliet inspectors were located to examine the apparatus and cut it out of service westbound and into service on eastbound trains. On trains which did not stop at that point it was customary to leave the apparatus cut in service for the round trip; and in many cases where the apparatus on locomotives had been cut out westbound at Joliet no stop was made at that point eastbound, and the locomotive was operated through the test zone with the device out of service. This accounts for a considerable number of the instances of the device being cut out. In recording the trips with the device cut out, from the point where the device was cut out until the engine reached Chicago where repair facilities were provided, was counted as one trip, and all indication points passed between those points were counted, the results being shown in the tabulation.

These conditions affecting both operation and maintenance, which were less favorable than can reasonably be expected in a typical service installation which may be made, maintained and operated by a railroad company, should be taken fully into account in connection with these records.

COST OF MAINTENANCE—CHICAGO, ROCK ISLAND & PACIFIC—LOCOMOTIVES EQUIPPED 20—MILES OF ROAD EQUIPPED 22.4 —MILES OF TRACK EQUIPPED 44.8—NUMBER OF RAMPS 34

	May, 1921	June, 1921	July, 1921	Aug., 1921	Sept., 1921	Oct., 1921	Nov., 1921	Dec., 1921	Jan., 1922
Locomotive Maintenance:									
Inspection of Equipment	$ 453.04	$ 453.04	$ 420.40	$ 420.40	$ 420.40	$ 420.40	$ 420.40	$ 420.40	$ 420.40
Repairs:									
Labor	1,399.73	1,470.18	1,446.74	1,855.21	1,577.09	1,886.99	2,002.50	1,592.05	1,687.73
Material	59.26	105.08	163.34	180.67	124.79	85.00	66.56	196.56	110.85
Total for Locomotive	$1,912.03	$2,028.30	$2,030.48	$2,456.48	$2.122.28	$2,392.39	$2,489.46	$2,209.01	$2,218.85
Roadway Maintenance:									
Inspection of Apparatus	......	......	......	......	......	6.30	......	......	......
Repairs:									
Labor	170.59	186.19	252.33	212.42	141.52	831.27	207.87	260.51	260.41
Material	173.41	50.92	116.63	138.49	203.82	526.81	62.85	......	......
Total for Roadway	$ 344.00	$ 237.11	$ 368.96	$ 350.91	$ 345.34	$1,364.38	$ 270.72	$ 260.51	$ 260.41
Total for Locomotives and Roadway	2,256.03	2,265.41	2,399.44	2,807.39	2,467.62	3,756.77	2,760.18	2,469.52	2,479.39
Average per Locomotive	$ 95.60	$ 101.41	$ 101.52	$ 122.82	$ 106.11	$ 119.62	$ 124.47	$ 110.45	$ 110.94
Average per mile of Track	7.68	5.29	8.24	7.83	7.70	30.46	6.04	5.81	5.81
Average per Ramp	10.11	6.97	10.85	10.32	10.16	40.12	7.96	7.66	7.65

Prorated cost of engine materail at $18.29 for September, October, November, 1921.
Prorated cost of engine material at $101.54 for December, 1921.
Average cost per month for 9 months for Locomotives and Roadway, $2,629.00.

Accident Records

A summary of the accidents which have occurred between 1906 and 1921, inclusive, shows a total of 106,473 which resulted in 6,142 killed, 95,936 injured and a loss of $80,386,694. There were 17,042 rear end collisions resulting in 1,914 being killed, 25,974 injured and a loss of $21,507,894. During this period the number of head end collisions were 9,255 in which 2,412 were killed and 34,708 were injured. This resulted in a loss of $19,461,769.

Collisions investigated by the Commission from July 1, 1911, to March 31, 1922, were as follows:

Kind of collision	Number	Persons Killed	Persons Injured
Head end	255	863	5,462
Rear end	205	773	3,948
Side	43	130	738
Miscellaneous	15	41	139
Totals	518	1,807	10,287

The collision investigated by the Commission which occurred in automatic block signal territory due directly or indirectly to the failure of enginemen to observe or be governed by signal indications from July 1, 1911, to March 31, 1922, numbered 80 which resulted in the death of 416, the injury of 1,837 and a property loss of $1,081,583.35. This loss did not include damage to lading. In addition to the above and among other exhibits presented by Mr. List was one listing the roads cited in the proposed order on train control giving their total automatic block signal mileage; total passenger lines operated; territory designed in the Commission's order of January 10; mileage covered by this territory and the automatic block signal mileage in it with certain explanatory notes.

American Train Control Corporation

C. W. Hendrick, in presenting his brief, stated that "after 14 years, on the part of the Commission, through its safety division, to secure the co-operation of the railroads by getting them to recognize that the present wayside signals are not giving sufficient protection, your Commission, after careful and extensive investigation, and not until two years after the passage of the Transportation Act giving you power, did you take any positive action until the issuance of the present order now under discussion. For this committee (the Carriers' Committee) to come forward at this late date and endeavor to discredit your investigation and order by trying to show that train control is in an undeveloped stage and does not warrant you having issued the order is clearly a desire on their part to secure further delay, which is largely based on prejudice. We are perfectly justified in taking the stand that wayside signals are also in a developing stage * * * after 30 years of development. Knowing that a first impression is difficult to overcome, special efforts have been made to create an unfavorable impression by magnifying small things and belittling important accomplishments of train control, at the same time praising wayside signals."

Mr. Hendrick told how long freights can be handled on mountain grades without danger of losing the air through gradual application. Regarding the service record on the Chesapeake & Ohio, attention was called to the testimony of the signal engineer in which he stated that during two years of service, out of 1,120,000 operations there were only two false clear failures. The objections of the Carriers' Committee was next answered in detail.

In speaking of installation costs, Mr. Hendrick said that he did not want these costs mixed up with the cost of signals and that the costs should be based on three things:

(1) Installation of train control in connection with wayside signals, when wayside signals are provided. (2) Installation of train control when no wayside signals are provided. (3) Apparatus to be supplied for the engine equipment. The approximate cost of this system was given for installations where wayside signals are already in. Engine equipment was listed at $850; each ramp location at $200 and the cost of attaching the equipment to engines is $50 per engine. Maintenance costs were given as $14.03 per engine per month. In concluding his brief, Mr. Hendrick said that "if you (the Commission) defer the issue, you can rest assured the signal companies, who have been advising the railroads through these years of opposition, will not work overtime to aid in developing a system that will eventually cause them a heavy loss by putting the wayside signals in the same class as the horse car is to the electric car." C. C. Paulding, attorney for the railroads, asked Mr. Hendrick on what grounds he based his charge that the railroads were influenced by signal companies and he stated that it was from general observation. Mr. Hendrick was asked if that was basis enough on which to make such grave charges and he could not present any specific instances to substantiate his statement.

B. F. Wooding Presents Brief

Dr. Wooding said: "If all the presidents of railways were to appear before your Honorable Commission and it was put up to them that they must either kill one of their number each year or install all the railroads with the automatic train control, can you guess what their answer would be?" Dr. Wooding gave a description of his device and told of the difficulties experienced in developing it and the trouble he had in arranging for and conducting experiments on the railroads. In touching on the induction type of train control he said that it "is far behind the contact, though having had every advantage with the latter. * * * With the contacts * * * all complications and uncertainties are eliminated which are common to the transference of electrical impulses in comparison with definite mechanical operation. Besides, the maintenance cost for current along the roadway cannot help but be expensive."

The cost for locomotive equipment was placed at $450; track equipment for 100 trains daily, complete, $800; 200 trains daily, $900 and for 300 trains daily, $1,000. Fixed charges for locomotive maintenance, if the battery is charged from the headlight dynamo was placed at from $2 to $5 per month while that for track maintenance was placed at $5 for 100 trains a day; $10 for 200 trains a day and $15 for 300 trains.

Commissioner McChord asked if he thought that enginemen would be less alert with train control than without it and was answered in the negative. Dr. Wooding explained why he felt that an emergency application of the brakes should be made and stated that it would be a mistake for the railroads to make installations of signals without also installing train control. Interlocking construction, in his opinion, could well be delayed until after installations of train control.

F. J. Sprague Takes the Stand

Stating that many of the objections raised to train control were of the "rubber stamp" type, F. J. Sprague said that it was unfortunate that the same committee of the American Railway Association which had been appointed to co-operate with the Commission was the one to handle the case against train control for the carriers. He pointed out that the opposition raised by the railroads to the adoption of Section 26 of the Transportation Act was based largely on a statement made by S. M. Felton, president of the Chicago Great Western, who had ventured in a field of prophecy already disproved by facts. Mr. Sprague felt that the Carriers' Committee could have done much better had it offered constructive criticisms rather than presenting every defect against the devices found in service. The wayside signals, in his estimation, gave only a limited indication of traffic conditions ahead and that if an accident happened every time an engineman passed a red signal the newspapers would be as full of them as they are of automobile accidents. Accident statistics, he stated, were a dry menu for the widows and orphans and as to the victims themselves it was a 100 per cent loss. In giving a general description of his device, Mr. Sprague said that he had adopted certain requirements which he felt should be met and that the application of magnetic induction to other fields such as the telegraph, electric railways, signal systems, etc., proves that it is available for the train control field and that any system, in his opinion, should be a thorough mentor and guide to the engineman to assist him in his work. He stated that the price for his equipment would be furnished those railroads asking for estimates and that estimates given by the railroads were absurd.

The Miller Train Control Brief

W. B. Murray, chief engineer of the Miller Train Control Corporation, told of the action taken to remedy the faults cited by the Carriers' Committee and said that his company was working in closest accord with the Joint Committee on Automatic Train Control of the American Railway Association; the representatives of the Interstate Commerce Commission and the officers of the Chicago & Eastern Illinois. Regarding the possibility of a ramp being removed or displaced, Mr. Murray said that it was of such a design and substantial construction that the chances of its accidental removal are extremely remote as has been demonstrated during eight years of regular service on the Chicago & Eastern Illinois. As to the operation of the device under all weather conditions which permit train movement, the Carriers' Committee stated that no dependable records were available prior to May 1, 1921. In answer to this it was pointed out that daily reports, similar to those made of the automatic signals, are made of the operation of the train control by the railroad and that during the past eight years practically all kinds of weather has been experienced, including many storms of snow, sleet and ice, which has conclusively proved the control's operation under all weather conditions which permit train movement. Unusually severe weather conditions prevail at times in the territory between Chicago and Danville, Ill. In February, 1914, it was pointed out that it was necessary to plow snow drifts from tracks, and ramps covered with snow and ice caused no interruption. The winter of 1918-1919 was the most severe experienced in many years and the control operated satisfactorily on all classes of trains.

Another question raised by the Carriers' Committee was the effect on operation, as it was pointed out that in moving trains against traffic, there being an average of six such movements a day on the Chicago & Eastern Illinois, no protection is afforded by the train control device. In this connection it was pointed out that since the train control operates with the automatic block signals, it provides only partial protection in the case of movement against the current of traffic on double track, in the same manner as do automatic block signals themselves, but that full protection could be readily obtained by arranging the automatic block signals and ramp locations for single track operation.

Mr. Murray said that the device had been in service on 107.2 miles of double track for the past 8 years and that 85 engines were equipped, while there were 175 ramp locations. Mr. Murray then traced the development work carried on since 1908, and its installation and operation. The first track installations for actual service were as follows:

Location	Distance Miles	Completed
Danville to Hoopeston	24	Dec. 9, 1913
Hoopeston to Watseka	22.7	July 14, 1914
Watseka to Momence	27.5	Aug. 15, 1914
Momence to Chicago Heights	23.3	Oct. 9, 1914
Chicago Heights to Dolton	9.7	Nov. 1, 1914
Total number	107.2	double track

The class and character of locomotives equipped with the device are as follows:

Passenger Locomotives		Number Equipped
Atlantic Type	4-4-2	24
Pacific Type	4-6-2	18
Consolidated Type	4-6-0	5
Total number passenger locomotives		47
Freight Locomotives		**Number Equipped**
Mikado Type	2-8-2	25
U. S. Type	2-8-2	13
Total number freight locomotives		38
Total number locomotives equipped		85

The low cost of maintenance and operation is based on actual figures of the railroad company for a five-year period as follows:

Year	Engines	Ramps
1917	$ 7,052.24	$ 4,965.70
1918	7,286.65	5,841.19
1919	7,715.62	9,118.27
1920	10,275.94	11,009.56
1921	9,324.48	9,869.28
Total for 5 years	$41,654.93	$40,804.00

Average Operation and Maintenance for One Year:
Engines $8,330.99, Ramps $8,160.84. Total $16,491.83.
Average yearly cost per engine......$98.01 or $8.17 per month
Average yearly cost per ramp........ 46.64 or 3.89 per month

These figures include the usual 10 per cent added for supervision and use of tools on cost of labor, and 15 per cent for freight and handling on cost of materials. The interest on investment is not included. The price of installation of apparatus such as is now used on one engine division of the C. & E. I., 107.2 miles, double track, is 85 engines complete at $500 each, $42,500; 175 ramps complete at $300 each, $52,500, or a total of $85,000.

Mr. Murray said that his company could deliver 50 of the engine devices a day. All material except ramp stands, control instrument and shoe is of standard manufacture, which can be obtained anywhere. Arrangements have been made with large foundries and machine shops which have patterns of their material and are acquainted with their work.

Statement of H. H. Orr

Mr. Orr, signal engineer of the C. & E. I., has been connected with the signal department in various capacities throughout these introductory years. Replying to Attorney Lyon, he said that in the main he concurred in the report of the Miller Train Control Corporation as read.

Mr. Lyon: Has the stop as installed and operated on your line a permissive feature?

Mr. Orr: Yes.

Mr. Lyon: Why do you install and operate it in that way?

Mr. Orr: In order that the engineman may retain control of the train if he is alert. The engineman would have to release it wilfully to prevent a stop.

Commissioner McChord: Why wilfully? Might it not be thoughtlessly?

Mr. Orr: In my opinion it would have to be wilfully.

Replying to further questions, Mr. Orr said he had never heard of an engineman releasing brakes thoughtlessly after an automatic application.

After the conclusion of the testimony the carriers' attorney waived cross-examination, this being the only train control company with an extensive installation which was not cross-examined.

Clifford Automatic Train Control & Signal Corporation

Stating that "it is safe to say that 80 per cent of railroad collisions of the last 10 years could have been avoided had automatic train controls been installed," P. J. Clifford touched on the development of train control during the last 50 years. He called attention to the action taken by the Railway Signal Association at its Louisville, Ky., meeting, saying that "the signal engineers over the country began to ransack their brains for conditions that train controls would have to meet. They not only put down a list of requisites but added to that list a list of accessories, and the next year at their convention they boiled down the list of requisites, supplying in its place a list of fundamentals." Mr. Clifford felt that train control is a public utility; that public opinion demands that the railroads make their tracks safer to travel upon; that they provide means to that end. Automatic train control, he said, has been generally advocated in the public press for a good many years, and especially after each collision involving serious injury and loss of life occurring on tracks protected by block signals, where the human element has failed.

In Mr. Clifford's opinion, "the bed rock causes of the incapacity or insufficiency of roadside signaling in their truest aspects, are the failure of enginemen to see or understand signals, and this may be due to fog, smoke, snow, absence of night signal indications, complexity in the scheme of indication, unfamiliarity of the engineman with the route over which his train is running, or the diversion of his attention by the improper functioning of some of the mechanical devices on the engine, or his physical capacity." The New York subways were pointed out as demonstrating a method of safeguarding and facilitating traffic and attention was called to expenditures saved, because by the use of train control an additional running track did not have to be built.

Mr. Clifford next quoted from the paper on train control, read by W. G. Bierd, president of the Chicago & Alton, at a meeting of the Western Society of Engineers at Chicago on October 21, 1920, after which he gave a general discussion of his device and then took up the standard requirements in detail, telling how the Clifford devices conform to those requirements. He said that he might go further and make the requirements 14 points instead of 12, the thirteenth one being "that the Clifford device can be made inoperative by the engineman simply pushing a button when the locomotive is working in yard tracks or other dead territory outside of electric circuits, but will automatically return to its functioning by its returning to live territory, and the engineman cannot prevent this action. The fourteenth point or requirement is the supplying of a continuous signal indication and continuous control regardless of where the train may be located on the rails. There is no intermittent feature connected with the functioning of the Clifford devices when a train is in live territory, and its operation cannot be prevented by manipulation of the engineman." While no prices are given, Mr. Clifford states that the apparatus can be constructed and installed for a price that is absolutely within the financial limitation of any railroad in the United States.

The Richards-Ford Device

H. W. Richards said that he had been engaged in development work for about 7 years. In his study of train control he began to work with the intermittent electric contact type, but because of his trouble in obtaining a good contact between engine and roadside apparatus he then developed a mechanical and magnetic device which he later laid aside to work on an inductive system of train control. Mr. Richards spoke of the advantages of the overlap for wayside signals in connection with train control and stated that any train control must be within the means of the railroads to finance. He said his device would give three indications from the inert track element, thus repeating the indication of the roadside signals. Mr. Richards then gave a description of his device, stating that speed control can be furnished, but that he considered this as an adjunct to an automatic stop. Regarding the cost of the device, he stated that approximate figures only could be given. The cost of engine equipment would not exceed $1,000 and for the track element per mile, $400. His device brings the train to a stop with a service application. Commissioner McChord asked whether his device had ever been tested out on a railroad and Mr. Richards stated that it had not, but that he expected to be ready for a road test in about three weeks' time.

Warthen Automatic Train Control Corporation

A. S. Dulin, special representative, in presenting the brief for this company, said that up to the time of Mr. Warthen's death in 1919 he had kept in close touch with train control development and with the Bureau of Safety. Mr. Dulin set forth his claims regarding patents, cost and adaptability. He said that during Mr. Warthen's life efforts had been made to make a test installation on railroads, but the inventor received no encouragement. The signal engineers, he said, were wedded to block signals; they know nothing about automatic train control and that had they advocated it they would have lost their positions. In Mr. Dulin's estimation the hearings have developed too fast, because, first, the intermittent electric contact type has proved its case and, second, the inductive theory has not had the opportunity to prove what it can accomplish. The Bureau of Safety is fairly familiar with the ramp types and it has a fund of knowledge regarding them. Mr. Dulin stated that the carriers at the hearing in March stated that the inductive type was the preferable one and wanted time for this to be developed. He felt that the railroads have had time to try out all of these devices and that the unnumbered millions of the traveling public demand this protection which was crystallized in the Transportation Act. Continuing, he said that it is unfair to the inventors and to those with money invested in automatic train control devices to postpone such installations when automatic train control has already proved itself.

W. A. Brown, electrical engineer for this company, was next called to the stand and in presenting an itemized statement of cost said that the estimated cost of wayside apparatus was $585.95 and locomotive apparatus $497.50, or a total of $1,053.45 for one location of wayside apparatus and one locomotive. Mr. Brown stated that certain reductions might be made from the above prices, provided the electric headlight generator was used, the reduced totals averaging between $933.45 and $958.45. The estimated maintenance costs were $120 a year, divided $60 a year per locomotive, $60 per year per wayside apparatus.

E. B. Katte of the New York Central questioned Mr. Brown on the use of the ramp in third rail territory with reference to clearances to be met and asked where a ramp could be located if the third rail takes up all available space. Mr. Brown stated that in that case a ramp could not be used in electrified territory. Mr. Katte stated that that was the point he wished to make and supports what the Carriers' Committee said with reference to the desire to wait for the development of the induction type.

Nevens-Wallace Train Control Company

Louis R. Wallace, in presenting the brief for this company, stated that its device was of the mechanical ground trip type, electrically controlled and consists of three pieces known as the track equipment, the engine box and the permissive valve. The track equipment is located at a braking distance in advance of the entrance of the block and is so constructed that its trip arm stands normally locked in the danger position and controlled by the track circuit. The engine box containing the various valves, contact arm and speed control features is located beneath and to the rear of the breast beam, at either end, and at a point which allows the contact arm to travel within the zone of contact of the track equipment. The permissive valve, which forms a part of the speed control feature, is conveniently located on the side of and within the cab. The engineman may prevent a stop by the use of the permissive valve, providing he is proceeding at a rate less than that prescribed when passing the track equipment or when, through brake application, his speed has been reduced to that rate.

Abstract of Remarks by G. P. Finnigan

George P. Finnegan presented a written statement in which the railroads were criticized for their attitude on the whole train control question. He has worked on this subject for over 20 years developing and patenting trips, ramp rails, electric and mechanical contacts on engine, continuous a.c. control with a plurality of frequencies and, finally, intermittent induction. The avoidable losses due to wrecks and the absence of train control would finance the installation of train control on the principal railways of America.

"Railroads are so positive that trains will make prompt arrivals that they sell insurance, guaranteeing that the passenger will be delivered on time; and the whole responsibility rests on the engineer, and he depends on the wayside signals to guide him in his flight. Although signals have been in a state of development for the past 50 years under the supervision of the most able engineers in the world, they still fail to function perfectly and they have the physical defects of being unreadable under various conditions, such as snow storms, fogs or a blanket of smoke. Therefore, aside from the ability of the track circuit to report a defect in the rail, what does the most up-to-date form of signals add to railroad safety? They simply accelerate traffic over the rails, admittedly at the cost of safety. However, the higher railroad officials naturally do not want to spend money for new things and they wonder why the signal companies have not up to the present time shown any determined interest in train control. There are hundreds of engineers employed by railroads in the maintenance of signal systems, and the majority of these engineers are pupils of the signal concerns, many of them having worked for these corporations. The stock of goods that are put in their hands to work with are mostly manufactured by and purchased from the signal companies, and so naturally these engineers prefer to deal with those who have an able force of engineers to help them install and maintain; so the signal companies have been sitting back in their traces with respect to train control. The signal makers know that reliable cab signals are more desirable than the junk that they deliver to the railroad companies today, therefore, why not wait; in fact, why not retard, if possible, any movement towards automatic train control and cab signals? But at the eleventh hour we see them rushing about trying to bite a mouthful from some poor inventor's dream and go out after the business that seems forthcoming.

"The Interboro Rapid Transit Company of New York, the Pennsylvania and the Baltimore & Ohio afforded us every courtesy in assisting to develop the principles of train control. There are also other railroads which have granted permission to inventors whereby they might develop their devices, such as the Erie (18 years ago).

"The Lackawanna has permitted the installation of several devices, including those of the Union Switch & Signal Co., within the past 15 years, and, strange as it may seem, they are still determined to find an efficient system of speed control. We are glad to inform this commission, and some of the old guard of signal engineers who 20 years ago thought Finnigan's train control ideas were loony, that the Lackawanna has entered into an agreement to install 15 to 30 miles of the Finnigan induction traffic speed control with a view of equipping the whole system. The installation will be made on the main line between Hoboken, N. J., and Scranton, Pa., work to begin at once. Who's loony now? Yes, boys, 'the world do move.'

"Many signal engineers for a long time have been in favor of train control and have endeavored to keep themselves posted; but there are many dyed-in-the-wool anti-control signal engineers who have not missed a single chance to submerge train control when the opportunity was offered. These men are on record at every official meeting within the past 12 years as train control knockers. . . .

"In 1910 and 1911 on the Interboro line, in New York, our system of train control was commended by J. M. Waldron, signal engineer of the Interboro. With this induction apparatus we developed a remarkably simple form of speed control. The engine apparatus designed on a closed circuit had no contacts or moving parts, and if it failed it failed safe.

"Some of the parties who inspected this system at that time were J. P. Coleman and F. L. Howard (U. S. & S. Co.), Oler and Allen (P. R. R.); also Charles Stephens (C. & O.), who since that time has done more to develop and operate automatic train control on steam railroads than any man in America. The device was also inspected by the famous 'we-don't-want-to-find-train-control' committee of the New York Central, composed of Elliott, Mock, Balliet, Rose and Denney. These men saw the device under all conditions of flexibility that could be required by any railroad and it functioned 100 per cent.

"For a practical device for mixed railroad traffic we are confronted with cold, hard facts, and these facts have been laid down in commandments issued by your commission. There is nothing in these requisites but what should be conformed to. The conditions are reasonable. . . . The engine apparatus should be of few parts, as it is almost impossible to maintain electrical contacts or moving parts on an engine, due to impact and vibration.

"We have recently heard much discussion of automatic train control on the engine subject to manual control. Is not the object of automatic control to eliminate the human element, and does not this feature reintroduce it? Why is train control desirable or worthy of consideration if the human element still exists in operating trains? Are all these years of toil and millions of dollars that have been consumed by hundreds of inventors trying to eliminate the human element to be annulled and the conditions made more hazardous by introducing, instead of one engineer, two 'piano players' on each locomotive, whereby the cardinal principle is submerged? Has not an engineer running at 75 miles an hour with signals appearing every 50 seconds, enough responsibility, with the care of his engine, without adding to his burden the task of synchronizing himself with the other piano player in letting themselves past the signals and creating a condition more hazardous than the present signal system?

"Anyone aware of the responsibility of an engineer or fireman running a high speed train, will agree that these men have no time to play tag around the boiler of a fast moving train.

"If we are to have automatic train control, let it be automatic. Do not install any device that will produce any degree of degradation on the engineer nor inconvenience his control while he elects to run safe. When a device is shown in operation to conform to these conditions, the railroads may be expected to be glad to accept it as a financial and humanitarian adjunct to their system. . . ."

Automatic Train Control Company

Edward Stegelmeyer, secretary, in speaking of his device, stated that it was of the electrically controlled, mechanical trip type, in which a throttle-closing cylinder is used, which he believes will give a more uniform braking application for all trains. Automatic train control, he said, consists of three units: (1) Automatic signals; (2) automatic control; (3) automatic air brakes, and each unit should be made so that the failure of any one should be a safe one. He said that his device had been tested on the Cleveland, Cincinnati, Chicago & St. Louis in 1909, about 18 or 20 tests being run one afternoon. When asked by Commissioner McChord as to why these tests were not continued, he said that he did not know, but that in trying again to obtain permission for conducting further tests on the Big Four the general manager told him he was wrong as the railroads did not want to decrease the enginemen's responsibility, but rather wanted to increase it. The general manager was told that by increasing the responsibilities a limit would be reached which would finally result in disaster. Regarding his attempt to make a test installation on the Chicago, Indianapolis & Louisville, Mr. Stegelmeyer said that the president had promised co-operation after the end of federal control, but that up to the present he had been unable to obtain the president's consent for making this installation. The cost of the device was given as approximately $500 for engine equipment and about $300 for wayside equipment. When asked by W. P. Borland of the Bureau of Safety as to what facilities he had for making extensive installations, Mr. Stegelmeyer stated that his company was prepared to handle their first order on a job-lot basis and would arrange for manufacturing facilities for future contracts.

The Simmen System

Stating that the ramp type of train control is entirely suitable for more than 85 per cent of the American railroad mileage, P. J. Simmen, of the Simmen Automatic Railway Signal Company then outlined his years of development work and told of the installations made in sections of the country having an even temperature and those where extreme cold winter conditions prevail. He said the efforts of his company were divided into three distinct groups: First, an automatic block system in which cab signals are substituted for wayside signals; second, speed control devices for the purpose of enforcing cab signal indications, and third, a remote control dispatching and recording system which is intended to take the place of the present dispatching system used on American railroads and combine with this an automatic block and speed control system whereby all signals are given through cab signals instead of wayside fixed signals.

Mr. Simmen outlined the efforts made by his company to arrange for the installation of the dispatching, recording and cab signal system on various railways, which, because of the war, resulted in nothing being accomplished. He then told of the agreement with the General Railway Signal Company whereby it was licensed to use his speed control device. In view of what had been accomplished by the General Railway Signal Company working in conjunction with Mr. Simmen, it was his feeling that train control is not in the experimental stage. Mr. Simmen then proceeded to describe his speed control and train dispatching system as installed on the Indianapolis & Cincinnati Traction Company. It was his belief that no provision should be made to enable an engineman to prevent the automatic application of the brakes under any consideration, except by properly reducing the speed of the trains; he was further in favor of recording every time the engineman permitted the air brakes to be applied automatically and to discipline him every time he permits such an automatic application as severely as he is now disciplined when he passes an automatic signal at danger and is caught at it. It was his belief that under such operating rules the air brakes would be automatically applied very seldom and that much of the argument as to the effect of automatic air application on long trains would be eliminated. He believed that by the use of the maximum speed feature, millions of dollars could be saved to the American railways in less maintenance costs on locomotives because they would not have to run at an excessive speed and that other millions could be saved in the maintenance of track. In speaking of the train control art as being new and the objection of the railroads to the fact that were installations to be made now they would have to be scrapped within a few years, it was his belief that this would not be so, in support of which he called attention to the number of the miles protected by various forms of automatic block signals, such as the exposed disc, enclosed disc, electro-pneumatic semaphores, electric motor semaphores, etc.

C. C. Paulding, attorney for the Carriers' Committee, asked Mr. Simmen if the display of cab signals is continuous and as to whether he knew that cab signals have been used by many railroads. Mr. Simmen stated that the display is continuous and that he believed the cab signals were as old as the fixed signals. It was his belief, further, that because fixed signals were less costly at first than cab signals that this accounted for the adoption of the fixed signal, but that now the fixed signal installations are much more expensive than the cab signals.

Bourdette-Brookins Train Control System

A. J. Brookins, supplementing his statement at the March hearing, said that he has made a study of train control for the past 10 years and has kept in close touch with the Bureau of Safety and with signal engineers familiar with train operation. It was his belief that a train control system is not necessarily an automatic engineman and that such a system should be designed to facilitate traffic. He believes that wayside signals as at present installed have two opportunities for false clear failures classified as mechanical failures and man failures. Mr. Brookins said that the first need not be discussed, but under the second that a man failure is nothing but a false clear signal failure, if a man sees a signal and fails to act. He classified the man failures under three heads:

First, an engineman may see a signal, but the indication does not impress itself on his mind; second, adverse weather conditions make it impossible for the engineman to read the signals and he takes a chance on their being clear, and third, deliberate disobedience of signals. Mr. Brookins believed that man failures under the first two heads constitute at least 90 per cent and that very few enginemen will deliberately run signals. If the railroads wish to make a mechanical engineman out of a train control device, Mr. Brookins stated that his was flexible enough to allow for such a development, but in his opinion he did not believe it necessary. His device is designed on the principle of position signaling. This enables one to have audible or visual signals or both in the cab which give a true indication of the track ahead. Continuing, he said that dependability is the primary function of any device, because if the engineman and wayside signals fail the device is the only thing standing between the train and disaster. The train control device should be made to function as often as every signal operates and because the ramp type possesses this feature he said that he had made no effort to develop any other type of train control. It was his belief that no delicate apparatus will operate for any length of time on a locomotive with any success. He then gave a brief discussion of his device and stated that he used one ramp to pick uo the indication for operation in either direction.

Automatic Switch Protection

Mr. Hurst, representing the Hurst Automatic Switch Company, presented a brief dealing with the protection of trains against main line switches being open or displaced. W. P. Borland, chief of the Bureau of Safety, stated that this system should be called automatic switch control and Commissioner McChord asked Mr. Hurst wherein his device fell under the subject of automatic train control, and whether the information pertaining to his device has been filed with the Bureau of Safety.

Simplex Train Control

M. E. Miller, attorney for the Simplex Train Control Company, presented a short brief and asked that the Commission's order be modified so that those railroads desiring to use types which have not as yet been developed could have opportunity to do so. Commissioner McChord stated that no modification of the order was needed to do that; but Mr. Miller thought that if the order was issued as now drawn, there would be a rush of the railroads for the ramp type; an extension of time should be allowed.

Regan Safety Devices Company

This company presented a number of exhibits. The first was an analysis of the report of the carriers' committee on inspections. In another exhibit exception was taken to the request of the A. R. A. committee for the re-insertion in the proposed order of paragraph *b*, Section 1, under automatic stops, reading "Under control of enginemen, who may, if alert, forestall automatic brake application." The Regan Company "does not agree with the committee that a forestalling feature with the automatic stop only should be permitted. If one is permitted, then the engineman may cancel at will the automatic stop, when imposed or when about to be imposed; then it is a question of the engineman's judgment as to whether his train shall be brought to a stop, or whether he shall cancel the stop himself, expecting to control the train when it proceeds in accordance with conditions ahead as he sees them."

The exhibits presented were: Exhibit A: A reply to carriers' sub-committee; defects pointed out. Exhibit B: A detail record of the performance of the Regan device on the Chicago, Rock Island & Pacific from February 12, 1920, to date. Exhibit C: A cost analysis of the testimony of railroad witnesses. Exhibit D: A map of the United States showing location of collisions which have occurred in automatic block signal territory from September 4, 1911, to May 17, 1921. Exhibit E: A series of photographs showing the condition of the storage battery used on the locomotive and pictures showing that ramps do not interfere with men getting on or off trains, and that other obstructions such as switch stands, switch movements for electric interlocking, lamps, etc., offer greater obstructions than do ramps. Exhibit F: Analysis of the committee report on specification. Exhibit G: A series of descriptive circulars showing installations of Regan apparatus in the United States, France and Great Britain.

A. G. Shaver, chief engineer of Regan Safety Devices Company, was the first witness for that company. He gave a description of the device and cited records of engine movements, both passenger and freight, over the equipped territory. Concerning induction apparatus, C. E. Denney interrupted to ask if this type was being developed by the Regan company; and whether it had been brought to the attention of the railroads' committee; also whether the Bureau of Safety had passed on it. Mr. Shaver replied in the negative. Regarding installations in France and Great Britain, where the ramp rail was placed between the running rails, Mr. Denney asked Mr. Shaver if that was a good thing and whether it could be used in this country. Mr. Shaver believed that in some cases it could be done.

Mr. Shaver next discussed the objections cited by the carriers' sub-committee. Certain changes in engine circuits have recently been made, and when questioned about this by Mr. Peabody, Mr. Shaver said that the changes would provide for more economical operation. Mr. Shaver stated with reference to the speed control apparatus that it will run about 100,000 miles before needing attention.

Mr. Peabody wished to know what the introduction of speed control would do on heavy mountain grades, particularly with reference to the losing of the air by repeated applications by the speed control apparatus. Mr. Shaver said there were no heavy grades in Illinois in the territory equipped. He said that enginemen must conform to the caution signal indication. A penalty should be imposed if the signal is not observed. To support the committee's contention that speed control as applied on the Rock Island sometimes stopped instead of reduced the speed of trains, Mr. Denney asked if a speed control application was liable to produce this result if the engineman fails to take action. Mr. Shaver admitted this, but said that it was in the province of the engineman to reduce speed so that the speed control does not take effect.

Mr. Denney asked what an engineman must do, and, continuing, said: "You maintain that the speed control will in some cases reduce the speed of the train and in others stop the train. The device does not do what it is designed to do. It is recognized that there is more difficulty and greater hazard in managing the speed of freight trains than of passenger trains, and the sub-committee wishes to bring out its desire to have apparatus developed so that no hazard exists to the trains themselves or to adjacent tracks through accidents, and for that reason any device developed should function at all times as it was destined to function."

C. A. Lyon next took the stand and was cross-examined by the carriers' representatives; an abstract follows:

C. E. Denney: "It is necessary for an engineman to know something of what he has behind him to operate his brakes properly. It can't be done automatically. Speed control cannot go further than to start the operation of releasing the brakes. The conditions vary at different points because of the different speeds of trains, the cars in a train, etc., and an engineman knows shortly after leaving his terminal the conditions existing. Speed control cannot take this into account."

Mr. Lyon: "The purpose of speed control is to enforce obedience to the indication of the caution signal."

Mr. Denney: "It is the purpose of the device to reduce the speed at the caution signal if the engineman does not reduce speed?"

Mr. Lyon: "Yes."

Mr. Denney: "Will the apparatus handle the trains with the usual brake equipment as intended?"

Mr. Lyon: "The sub-committee tests were conducted under abnormal conditions."

C. C. Paulding: "If the engineman observes all conditions and the rules, etc., then such a device is not needed."

Mr. Lyon: "Yes."

Mr. Paulding: "Why do you object to tests being made under abnormal conditions when the device, to act, would be functioning under an abnormal condition, otherwise it would not come into service."

J. A. Peabody: "What are the length of blocks on the Rock Island?"

Mr. Lyon: "An average of from one to one and a quarter miles."

Mr. Peabody: "What is the average braking distance on a freight train of 40 cars, at 40 mi. an hr., level grade, with 20 lb. reduction?"

Mr. Lyon: "Would say about a train length."

Mr. Peabody: "Then less than 2,000 feet. Under the operating rules, when a man passes a signal in a caution position must he not keep this in mind so that he can stop at the next signal?"

Mr. Lyon: "But he is expected to stop at the home signal."

Mr. Peabody: "Under the rules of the road, an engineman might pass the caution signal at 40 mi. an hr., which would not be an abnormal movement, and the speed control would then take effect. In mountainous countries where signals cannot be seen except for short distance, how would an engineman know before he was close to that signal that it was in the caution position? If he had to slow down on approaching such signals, particularly in mountainous country, we could not get the trains over the road."

J. Beaumont, vice-president and sales manager for the Regan company, was called to the stand next. Mr. Beaumont explained the purpose of speed control and its application to railway service. The system is designed on the stop, caution and clear principle and obviously before trains must stop they must be slowed down. The speed control would apply the brakes and slow a train down when conditions require, if the engineman is asleep, etc. Track capacity, Mr. Beaumont said, isn't reduced, as it is obvious that the device, working in conjunction with the three-position signal system, is not going to affect capacity, whether the blocks are 1,000 ft. or 5 miles in length. Mr. Beaumont then commented on some of the "petty and insignificant defects" brought up by the carriers' sub-committee, and considerable discussion took place, which resulted in a clash between the opposing attorneys as to the manner in which Mr. Beaumont was answering questions. Mr. Beaumont said that the entire proposition reminded him of the man who was sick and whose friend came in to condole with him, making him worse and finally the priest and relatives also came in. At this point Mr. Paulding said that "you are not impuning to us the desire to assist in the demise of the Regan device, are you?"

Regarding the entering of the order, Mr. Beaumont said that the Commission would be justified in ordering in train control, because the ramp type is developed and that the railroads have never taken steps to force the development of other types until the Commission had issued its proposed order. Mr. Denney then asked if he would be justified in going to his board of directors and recommending an installation of train control on what has been developed without waiting for other types to show what they can do. In this connection Mr. Beaumont said: "I would advise you to do so at once, sir."

He then discussed the cost analysis as presented in one of the briefs. Instead of reading the entire brief, he criticized the estimates of cost which were presented before the Commission by W. H. Elliott, J. A. Peabody, C. J. Kelloway, A. W. Trenholm, W. J. Eck and others. On the basis of a cost of $567 per mile of track and $884 per locomotive, Mr. Beaumont estimated that it would cost $11,414,292 to equip the territory of the 49 carriers mentioned in the order. As to the average cost of maintenance he stated that it was $14.76 per ramp per year and $116.82 per locomotive per year. Regarding facilities for manufacturing, his company could manufacture 100 units of automatic train control a week, having factories at Niagara Falls, in Great Britain and in France.

Thomas E. Clark System of Wireless Control

J. G. Dunn, in presenting a brief for Mr. Clark, stated that "he has long since deduced two basic problems, which, if solved, should give . . . unquestionable ground for the necessary orders on train control. These conclusions are: (1) An efficient method of getting the indication aboard the engine and, (2) an efficient method of getting the indication aboard the engine at any time or at any point in the block. Both of these problems have been solved by the system. The solution has come coincident with the development of radio science and its application to present day arts." Mr. Dunn then gave a brief description of the development work and of the train control which is of the continuous inductive type, its purpose being to permit the engineman to handle his train without interference so long as he does it properly, but the control will automatically correct his failure to observe or to interpret what he does observe, and will intervene to stop his train should he disregard the stop indication of an automatic block signal or run at an excessive speed where speed restrictions are prescribed.

Mr. Dunn suggested that if the order is issued now the railroads will be so busy that proprietors having devices which have not been tested will have no opportunity to show what their devices can do, and he asked that the order be held in abeyance until this system can be developed. In conclusion, he said that the Pere Marquette has given permission for a 10-mile section to be installed for test purposes.

Julian-Beggs System

Leslie M. Shaw, representing the Julian-Beggs, the Buel and the Clark systems, told of tests which were conducted on the Cincinnati, New Orleans & Texas Pacific. He asked that the Commission's order should stand substantially as it is drawn with little extension of time. It was his thought that the railroads should try out the various devices and eliminate those not proving satisfactory. He stated that it was not fair to his clients that the uncertainty be continued, but that it would be much better that they be eliminated if their devices did not prove adaptable, if such should prove to be the case. C. C.

Paulding, attorney for the Carriers' Committee, stated that it was the intention of the railroads to try out the various devices.

Shadle Automatic Train Signal Company

W. G. Fischer, representing the Shadle Company, called attention to the number of accidents, the loss of life and their cost to the railroads. He stated that train control is an air brake and not a signal problem and he felt that the railroads should now take some action in installing train control. Comparing the cost of such installations with that of other safety devices, he said that electric axle lighting for one passenger coach cost $2,200; steel underframes and telescopic ends for passenger cars, $2,350; steel underframes for freight cars, $450; modern brakes on freight cars, $250; locomotive stokers, $2,800; boosters for locomotives, $8,000 to $9,000, etc. In describing the device Mr. Fischer said that it embraces both automatic stop and speed control features with graduated application of the brakes.

The International Signal Company

J. F. Webb, Jr., secretary-treasurer of International Signal Company, said that the arguments of the carriers against the installation of these safety devices fall naturally into two classes: (a) general objection to all such devices, and (b) specific objection to the ramp type. Mr. Webb discussed the objections in detail. "The fight of the carriers against automatic train control is in line with their fight against air brakes and automatic couplers. They lost those earlier fights, but they are now blessing the days of those defeats. The day will come when the carriers will also bless the installation of this newer safety device."

James P. Whissman stated that he had developed an intermittent contact overhead, or compression trip type, and in 1908 had applied to the New York Central for permission to test it.

The General Railway Signal Company and the Union Switch & Signal Company did not take the stand, but presented statements for the consideration of the Commission.

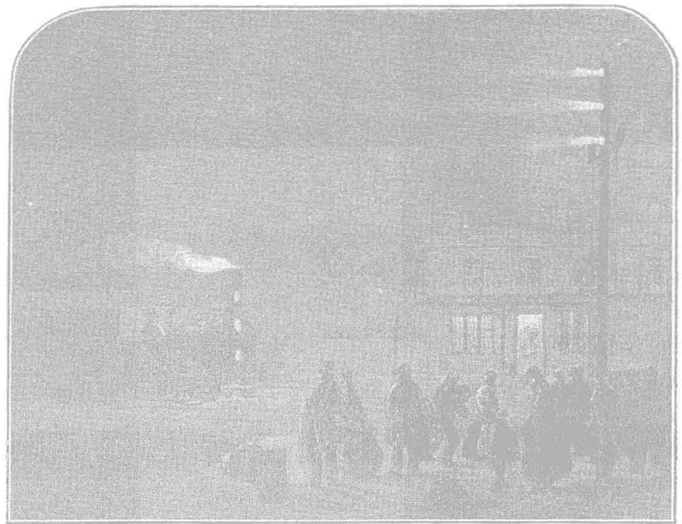
The hearing concluded at noon, Saturday, April 15. The decision of the Commission as to its action on the order will be announced at a later date.

Early Light Signals

As early as 1846 color light signals were introduced on the Liverpool to Manchester line of the Edinburgh & Glasgow Railway. This installation was no doubt the fore-runner of our present light signals. The invention is credited to a certain Mr. Forsythe and the description given in the February 21, 1846, issue of the Illustrated London News goes on to say:

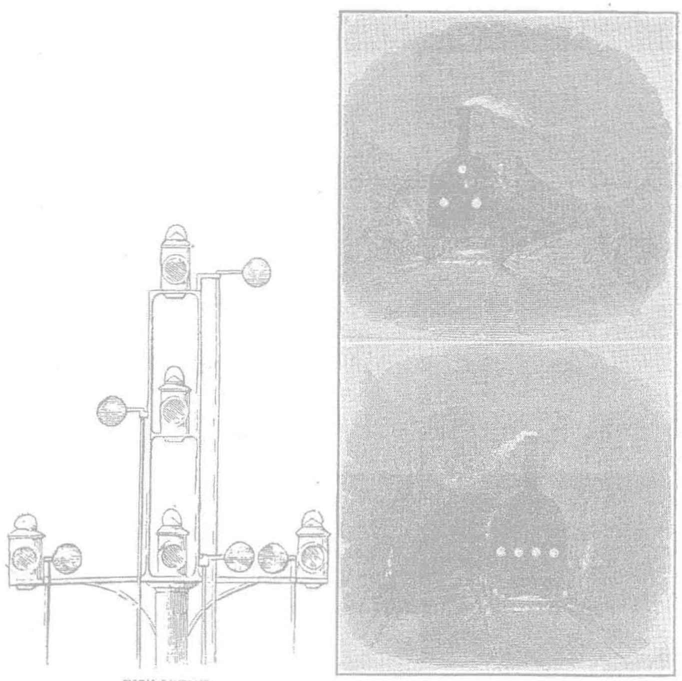
Forsythe Patent Railway Signal

The frequent recurrence of serious accidents on railways renders the necessity for improved methods of signals more and more painfully evident. Several plans have been proposed within the last few months; but they mostly lack the simplicity requisite for their application in cases of danger; or the object cannot be accomplished without interfering with other operations connected with the efficient working of the trains. We have, however, to record another plan, which combines simplicity with efficiency. Mr. Forsythe, of the Edinburgh & Glasgow Railway Company, has lately made some experiments on the Liverpool and Manchester line to prove the comparative value of colored lights for signal purposes, and purposes only to use the red light in cases of danger. He suggests that each engine should carry a different diagram of lights; and, by a signal post, with lamps arranged as shown in the engraving, should make corresponding signals, to be done by closing one or more of the lamps. Thus, the engine-driver, knowing what diagram of lights he carries, and seeing a corresponding signal at the station, would conclude it to be especially intended for his guidance; whilst persons at the station would be apprised of the particular train



Early Type Light Signal

which is coming. We have shown in the engravings three of the different forms in which the lights will be arranged. This



Two Aspects and Method of Operating Blinders

new system of signals has been secured by patent, and, we are persuaded, will be extensively adopted.

The drawing shows the blinders operated by rod connections, such that various arrangements of light in vertical lines, horizontal lines or in triangle might be accomplished.

Base ball players who are members of the Signal section, American Railway Association, and whose headquarters are in the west should write P. A. Garrity, 752 Peoples Gas Building, Chicago, of their intention to be in attendance at the annual meeting of the Signal section, which will be held in Spring Lake, N. J., on June 14, 15 and 16. Mr. Garrity has been appointed manager of the western team and it is the intention this year to have a real old time "honest to goodness" base ball game in order again to stimulate rivalry between the members of the east and west sections of the Signal association. All signalmen desiring to make the team should file their application with Mr. Garrity at once.