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PREVENTION OF RAILROAD ACCIDENTS

ADDRESS

OF

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INTERSTATE COMMERCE COMMISSIONER

BEFORE THE ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS ON WORK OF THE FEDERAL GOVERNMENT FOR THE PREVENTION OF RAILROAD ACCIDENTS, AND ITS RESULTS

PRESENTED BY MR. BORAH

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WORK OF THE FEDERAL GOVERNMENT FOR THE PREVENTION OF RAILROAD ACCIDENTS, AND ITS RESULTS.

Address of Hon. C. C. McChord, Interstate Commerce Commissioner, before the Association of Iron and Steel Electrical Engineers.

Mr. Chairman and gentlemen of the Association of Iron and Steel Electrical Engineers: Railroad accidents, their causes, and the means for their prevention is a subject which has caused general discussion in this country for many years past; and not without reason. When we learn that during the 24 years covered by the statistics of the Interstate Commerce Commission 188,037 persons have been killed and 1,395,618 persons injured on the railroads of the United States, we are appalled at the magnitude of the slaughter. This is an average of 7,835 persons killed and 58,150 injured each year, or an annual total of nearly 66,000 persons killed and injured. This means that for every day during the past 24 years 181 persons have been killed or injured—nearly 8 every hour or 1 every seven minutes with the regularity of clockwork. The ravages of war pale into insignificance before these silent indications of the destruction of human life accompanying the peaceful operation of our railroads.

It is pertinent to inquire how much of this fearful record of slaughter is due to the unavoidable risk of the industry, and how much to causes that can be eliminated, as means for the prevention of accidents must obviously be directed to the latter causes.

Upon analysis of the above totals one can not fail to be impressed by the surprisingly large number of trespassers they include. No figures pertaining to trespassers appear in the commission's statistics previous to 1890, and as no returns of accidents to "other persons" were received by the commission for the year 1910, owing to a change in the law requiring reports of accidents, we have a complete record of acccidents to trespassers for only the 20-year period 1890 to 1909, inclusive. This record is sufficiently startling. There were 163,171 persons killed and 1,190,125 injured during this 20-year period. Of the number killed, 101,629, or more than 62 per cent of the total, are classified as "other persons"; that is, they were neither passengers nor employees; and of these 101,629 "other persons," 86,733, or more than 85 per cent, were killed while trespassing. The trespassers killed during this 20-year period were more than 53 per cent of the whole number of persons killed on railroads.

Of the 1,190,125 persons injured during this period, 142,040, or more than 11 per cent, were "other persons," and of this number 94,646, or more than 66 per cent, were trespassers. The trespassers injured constitute less than 8 per cent of the whole number of persons injured.

The following is a tabular presentation of these facts:

Persons killed and injured in railroad accidents during the 20-year period 1890 to 1909, inclusive.

	Number killed.	Number injured.
All classes	163,171	1,190,125
Other persons	101,629	142,040
Trespassers	86,733	94,646
	Per cent.	*Per cent.*
Other persons to all classes	62.2	11.9
Trespassers to other persons	85.3	66.7
Trespassers to all classes	53.09	7.9

In the five-year period from 1905 to 1909, inclusive, 31,091 other persons were killed; 26,291 of these were trespassers. In the same period 49,786 other persons were injured, of which number 28,205 were trespassers. A significant feature connected with these figures is the surprisingly large number of trespassers killed by being struck by trains, locomotives, or cars at "other points along the track." Of the 26,291 deaths to trespassers during this five-year period, 17,469 were due to this cause. The extremely fatal nature of this class of accidents is indicated by the fact that while more than 17,000 persons were killed less than 10,000 were injured, the deaths exceeding the injuries in a ratio of 1.76 to 1. It may also be noted that while more than 53 per cent of all the persons killed during the 20-year period from 1890 to 1909 were trespassers, less than 8 per cent of the total persons injured were trespassers.

Public attention for many years has been centered upon the question of abolishing grade crossings. While it is, of course, desirable that all possible precaution should be taken for the prevention of accidents at highway crossings, it is nevertheless true that the highway-crossing casualties are extremely few as compared with those occurring at other points along the track. In the five-year period above shown, 4,261 persons were killed at highway crossings as compared with 17,861 persons killed at other points along the track; 8,830 persons were injured at highway crossings as compared with 10,686 injured at other points along the track. Of the persons killed at highway crossings, 3,231 were nontrespassers and 1,030 were trespassers; of the persons killed at other points along the track, 17,469 were trespassers while only 392 were nontrespassers.

Of the persons injured at highway crossings, 7,540 were nontrespassers and 1,290 were trespassers; of those injured at other points along the track, 9,929 were trespassers and only 757 were nontrespassers. The casualties to nontrespassers at other points along the track are so comparatively few in number that they may safely be left out of consideration. It is probable that practically all of them occur to persons engaged in loading or unloading cars in railroad yards, and it is doubtful that persons engaged in such work can be surrounded with additional safeguards. When it is considered, however, that more than half of the fatal accidents on railroads in this country occur to persons who have no right upon railroad premises, it becomes apparent that there is a fertile field for reform in the method of dealing with trespassers. In England and on the Con-

tinent of Europe walking on railroad tracks is forbidden by law, and it should be here; furthermore, vigorous measures should be undertaken to make people understand that railroad tracks can not be used as footwalks with impunity.

Coming now to accidents to employees and passengers, we enter a field in which the Federal Government has displayed considerable activity, the result of which can be measured with a fair degree of accuracy. There are certain accidents which occur with more or less regularity and frequency on railroads that may properly be called unavoidable. Such are accidents due to exceptional elemental disturbances entirely unexpected—landslides or washouts, want of ordinary precaution on the part of passengers or employees, malicious tampering with roadway or equipment, etc. Such accidents are accepted as among the ordinary hazards of railroading and may be dismissed from our reckoning. We deplore the casualties which accompany such accidents, just as we deplore the loss of life that accompanies the destruction of a ship in a great storm at sea, but in the one case as in the other we know that no human foresight could have prevented the accident.

There are accidents, however, which are fairly preventable and against the occurrence of which travelers and employees on railroads have a right to demand protection. It is important, therefore, to determine the causes of these preventable accidents, in order that proper measures for their prevention may be undertaken.

The safety-appliance act of 1893 was the first attempt of the Federal Government to deal with railroad accidents. This law dealt with a class of accidents the cause of which was plainly apparent. The killing and maiming of employees through the use of link-and-pin couplers and drawbars of uneven height had been a crying evil for many years. Railroad journals had advocated reforms, State railroad commissions had discussed the question, and in some States laws had been enacted requiring the use of automatic couplers; but these State laws had made the situation worse rather than better, as they led to the adoption of different types of couplers for the different States, thus destroying the uniformity that is essential to safety where cars are universally interchanged, as is the practice on the railroads of this country.

With this situation in mind the Interstate Commerce Commission, through its secretary, Mr. Edward A. Moseley, began its agitation in 1889 for the abolition of the death-dealing link-and-pin coupler, for a standard height of drawbar, for grab irons on cars, and for power brakes on locomotives and cars. Uniformity in practice was the urgent need, and it was apparent that uniformity could not be obtained without Federal legislation.

The first safety-appliance act, passed March 2, 1893, made it unlawful after January 1, 1898, for any railroad engaged in interstate commerce to use on its line in moving interstate traffic any locomotive not equipped with a power driving-wheel brake and appliances for operating the train-brake system, or to run any train in such traffic that had not a sufficient number of cars in it equipped with power brakes, so that the engineer could control the speed of the train without requiring brakemen to use the common hand brake for that purpose. The purpose of this requirement was to reduce the number of injuries and fatalities caused by men falling from the

tops of cars or being struck by overhead obstructions while using the hand brake. The act also made it unlawful to use cars not equipped with couplers that would couple automatically by impact, and which could be uncoupled without the necessity of men going between the ends of the cars. It was further made unlawful after January 1, 1895, to use in interstate commerce cars not provided with secure grab irons on their ends and sides. Carriers were authorized to refuse to receive cars not lawfully equipped. The American Railway Association was authorized to prescribe a standard height for drawbars, which was to be legalized by an order of the commission.

Owing to the prompt action of the American Railway Association the commission was able to announce the standard height of drawbars one month after the passage of the act. The time limit for compliance with the brake and coupler provisions was twice extended, so that the law did not become fully operative until August 1, 1900. Experience soon demonstrated the need of amendment, as the requirement that a " sufficient " number of cars should be equipped with train brakes to insure control proved too indefinite to be enforceable. To remedy this defect an amendment to the act approved March 2, 1903, provided that a minimum of 50 per cent of the cars in a train must be so equipped, and the commission was given power to increase this number from time to time. It was made 85 per cent on September 1, 1910, and so remains.

Further experience with the law demonstrated the need of an extension of its provisions to cover all the appliances included in the master car builders' standards for the protection of trainmen, as there was such a lack of uniformity in the design, location, and methods of applying certain of these appliances as to make them a source of danger to employees. To meet this difficulty, therefore, a supplemental act passed April 14, 1910, requires the equipment of cars with secure sill steps, ladders, running boards, efficient hand brakes, and grabirons on the roofs of cars. The commission was required to designate the number, dimensions, location, and manner of application of these appliances within six months from the passage of the act, the provisions of which became effective on July 1, 1911. The commission was also empowered to extend the time for compliance with the provisions of the act with respect to equipment of cars actually in service on the date of its passage.

As a result of numerous conferences and hearings, the commission, on March 13, 1911, issued an order designating in detail the number, dimensions, location, and manner of application of all appliances covered by the act, and a further order extending the time for compliance with its provisions with respect to cars actually in service on July 1, 1911. Speaking generally, these extensions range from one to five years, except that when a car is shipped for extensive repairs at any time before the expiration of the period of extension, it must be made to comply with the prescribed standards.

What have been the results of this legislation? To secure its enforcement the commission in 1899 appointed an inspector to examine railroad equipment. Aided by congressional appropriation, this practice has been extended until the inspection force now numbers 31 men. This inspection was recognized as a necessity, as the pro-

tection contemplated by the law demanded that the appliances it required should not only be supplied, but that they must also be kept in workable condition. Recognizing its remedial character, the courts as a rule have placed a liberal construction on the provisions of the law, and as a result of this, coupled with careful and efficient methods of inspection, great improvement in the condition of safety-appliance equipment has resulted.

The year 1904 is the first one for which we have a complete record of the results of inspection. In that year the number of cars found defective in every 1,000 cars inspected was 311.87. In 1911, however, only seven years later, the situation had so much improved that of every 1,000 cars inspected only 44.63 were found defective, a reduction of 267.24 in the number of defective cars per 1,000 inspected, or more than 85 per cent, in this comparatively short period.

This improvement in the condition of safety-appliance equipment quite naturally brought about a corresponding decrease in the number of those accidents to employees which the use of the appliances was designed to prevent. In the year 1893, for instance, the number of employees killed in coupling accidents was 433, and the number injured was 11,277. The number per million equipment then was 333 employees killed and 8,675 injured in coupling accidents. The total equipment in the year 1893 was one and three-tenths millions, but three-tenths million of which was equipped with automatic couplers. In 1911, with two and four-tenths millions equipment, all of which had automatic couplers, 209 employees were killed and 2,966 injured in coupling accidents, an average of but 87 killed and 1,236 injured per million equipment, thus showing a reduction from 11,710 to 3,175 in the total of deaths and injuries from this cause, or a decrease of nearly 73 per cent. The showing per million equipment, as might be expected, is even better, the deaths and injuries on this basis being reduced from a total of 9,008 in 1893, to 1,323 in 1911, or more than 85 per cent. This decrease in coupling accidents is even more favorable than at first appears, for it has taken place coincidently with an expansion of business which has resulted in the crowding of tracks and terminals and the use of heavier equipment and longer trains, thus introducing additional elements of risk. This additional risk is indicated by the following figures:

In 1893 the number of tons carried on the railroads of the United States was 745,119,482; in 1911 the number was 1,781,638,043, an increase over 1893 of 1,036,518,561 tons. The number of tons carried 1 mile was 93,588,111,833 in 1893, as against 253,783,701,839 in 1911, an increase of 160,195,590,006 ton-miles. With this increase in traffic came a relative decrease in the number of men directly employed to handle it. The number of trainmen employed by the railroads in the United States in 1893 was 146,544, and in 1911 it was 221,426. The average number of tons in a train in 1893 was 184; this had increased to 383 in 1911 or more than 100 per cent. The number of tons carried for each trainman employed in 1893 was 5,085; in 1911 it was 8,046, an increase of 2,961 tons per man. The number of tons carried 1 mile for each trainman employed increased from 638,635 in 1893 to 1,146,133 in 1911. This increase was effected, notwithstanding there was a decrease in the number of train-miles

run for each trainman employed, the figures being 5,764 in 1893 and 5,589 in 1911. These facts appear in tabular form, as follows:

	1893	1911
Number of tons carried	745,119,482	1,781,638,043
Number of tons carried 1 mile	93,588,111,833	253,783,701,839
Average number of tons in train	184	383
Number of trainmen employed	146,544	221,426
Number of tons carried for each trainman employed	5,085	8,046
Number of tons carried 1 mile for each trainman employed	638,635	1,146,133
Number of train miles run for each trainman employed	5,764	5,589

In the light of the record it may safely be asserted that, considering the accidents to employees which the coupler and air-brake laws were designed to prevent, the greater part of those which now occur are due to the ordinary hazards of the railroad industry. It is also proper to observe that the use of these appliances, in addition to so greatly reducing accidents to employees, has brought abundant returns to the railroads in economies of operation. Not only is time saved in the make-up and movement of trains by the use of the automatic coupler and air brake, but it is also certain that the great economies of modern transportation that have resulted from heavier equipment and longer trains would have been quite impossible of realization without the use of the appliances prescribed by the safety appliance acts.

Leaving those accidents the causes of which are plain and against the occurrence of which the law seems to have provided efficient safeguards, we come to a class of train accidents upon which public attention has been centered for many years but which continue to occur with distressing frequency in spite of all measures thus far taken to prevent them. Collisions and derailments were responsible for 4,163 deaths, 63,002 injuries, and a property loss of $50,025,303 during the five-year period, 1907 to 1911, inclusive. The number of collisions and derailments during this period, as reported by the Interstate Commerce Commission, was 61,806. No road can claim immunity from these accidents, as they occur on the best equipped and best managed roads quite as frequently as on roads less well managed or equipped. Moreover, there is a dreary monotony in the sameness of the reported causes of these accidents. Year after year derailments and collisions due to identical causes are reported.

For the purpose of obtaining reliable data regarding the causes of these accidents, Congress enacted a law in 1901 requiring interstate railroads to make monthly reports under oath to the Interstate Commerce Commission of all collisions and derailments, giving the nature and cause of the accidents and the circumstances connected therewith. It was expected that through the reports required by this law the causes of the accidents reported upon would be revealed and proper remedies for their prevention clearly indicated. Under the law the commission has published a series of quarterly bulletins based upon the monthly reports received from the railroads. The publication of these bulletins began with the quarter ending September 30, 1901, and the bulletin for each subsequent quarter until June 30, 1911, contains detailed accounts of the more prominent train accidents, with a statement of their causes as reported by the railroad companies. Since July 1, 1911, the bulletins have reported the causes of

collisions and derailments under another law which will be later referred to.

The publication of these bulletins quickly brought into prominence the weakness of the personal equation in railroading, showing that by far the greater number of these harrowing train accidents were due to human error. The bulletins show that errors in the operation of the train-order system are frequent and fatal. Such errors are all of a kind. Dispatchers give wrong orders, or fail to give orders where they are required; operators fail to copy orders correctly, or do not deliver orders that should be delivered; conductors and enginemen misread, misinterpret, overlook, or forget orders.

This weakness of the train-order system of operating trains, as disclosed by the commission's accident bulletins, gave impetus to agitation for the compulsory use of the block system. In its annual report for the year 1903 the commission recommended such legislation and submitted a draft of a tentative bill requiring the use of the block system on all interstate lines within a certain period. A bill following the suggestions of the commission was introduced in Congress in the winter of 1905 and has been reintroduced at every subsequent session, but has not yet been enacted into law. In the meantime, the block system has been considerably extended, the block-signal mileage reported for the year 1911 being 76,409.7 miles, as against 48,743.2 miles in 1906.

However, notwithstanding the theoretical merits of the block system as a means of safety, it by no means insures immunity from collisions. Some of the worst collisions noted in the accident bulletins have occurred on block-signaled roads. Obviously, the block system can only afford protection when its danger warnings are observed and obeyed. The intensity of attention and quickness of perception required of enginemen on our modern high-speed trains leads to the result that they sometimes fail to observe or obey signal indications, and when this happens disastrous consequences are almost sure to follow. In the operation of the manual block system also, block operators sometimes make mistakes which lead to fatal results.

Noting these disasters, due to human error under the most highly approved system of train operation, the question naturally suggested itself, Is it not possible to employ mechanical means that will automatically assume control of a train and bring it to a stop whenever a danger signal is for any reason disregarded? Automatic stops had been in successful operation for several years on underground and elevated lines, but their general use on roads in the open country was not considered practicable. To determine the general practicability of such devices, therefore, Congress in 1906 directed the commission to conduct an investigation, accompanied by experimental tests, of appliances for the automatic control of trains. To comply with the direction of Congress, the commission appointed a board of experts which conducted an investigation extending over a period of nearly five years. Plans and specifications of numerous automatic train-control devices were examined and reported upon and tests of several such devices under actual operating conditions were made. Reports stating the results of the board's investigations were issued annually. The last of these reports, issued December 26, 1911, states that "the information obtained from tests, together with knowledge of the general state of development of the art of auto-

matic train control, leads the board to conclude that there are several types of apparatus and methods of application which, if put into use by railroads, would quickly develop to a degree of efficiency adequate to meet all reasonable demands. Such devices properly installed and maintained would add materially to safety in the operation of trains. In many situations, under conditions existing in this country, the board is convinced that the use of automatic train stops is necessary to the safety of trains."

Another matter made prominent by the accident bulletins was the long hours of service to which train employees were subjected. Accidents were reported in the bulletins where the employees involved had been on duty an excessive number of hours, and it seemed apparent that such accidents were largely contributed to, if not directly caused by, excessive periods of service. Could events be traced to their first cause, it would doubtless have appeared that many of the reported cases of misreading, overlooking, or forgetting orders were also due to the fact that wits were dulled and senses benumbed by lack of rest.

When the facts in this situation became sufficiently prominent, Congress took prompt action, and on March 4, 1910, a law was passed limiting the hours of labor of trainmen and telegraph operators. The law became effective one year from the date of its passage and has been enforced by the commission with the aid of a force of inspectors which now numbers six men.

Whether the enforcement of the hours-of-service law has resulted in any increase of safety in train operation it is impossible to say, as a statistical presentation of results can not be made. That the law has been of great benefit to employees, however, is certain. No longer do we hear of trainmen being kept on duty 40, 50, or 60 hours in the ordinary process of moving their trains over a 100-mile division of road. Such excessive periods of service, which were formerly quite common, are now only met with in these extraordinary emergencies which furnish a legitimate and excusable reason for excess service. As a result, there can be no doubt that the efficiency and morale of railroad train service has improved. Furthermore, the economic result of the law's operation is believed to be of benefit to the railroads. Trains are moved over the road in less time than formerly, and the number of train-miles run for each trainman employed has considerably increased since the law became effective. This increase is especially significant in view of the fact that there was a steady decrease in this item for a number of years previous to 1908, the figures being 5,764 train-miles run for each trainman employed in 1893, which had been reduced to 5,420 in 1908. In 1911 the number was 5,589, showing an increase of 169 miles as compared with 1908. The number of tons carried for each trainman employed was 7,358 in 1908 and 8,046 in 1911, an increase of 688 tons. The number of tons carried 1 mile for each trainman employed was 1,048,238 in 1908 and 1,146,133 in 1911, an increase of 97,895 tons in this item. On the whole, therefore, it would seem that the economic results under the operation of the law have been satisfactory.

Experience with the accident report law soon developed the fact that its underlying purpose, which was to secure accurate information respecting the actual cause of train accidents, could not be accomplished by relying upon the reports made by railroad managers.

Railroad officials often seemed to think it their duty to withhold essential facts on account of some real or fancied liability that might impair the company's rights or interests in future court proceedings. Some companies seemed to have adopted a settled policy of furnishing the least possible information on all matters connected with accidents on their lines. Moreover, it was found impracticable to formulate a code of questions that would elicit satisfactory answers by letter in cases where the cause of a collision or derailment was at all complicated or obscure, or where the responsibility was chargeable to two or more persons. In such cases cross-examination is necessary to get at the true facts.

It became apparent, therefore, that independent investigations, conducted under authority of the Federal Government, were necessary to develop the true facts, and after an agitation extending over a period of six years a law authorizing such investigations was placed on the Federal statute books on May 6, 1910.

This law empowers the commission to investigate all collisions, derailments, or other accidents resulting in serious injury to persons or to the property of a railroad engaged in interstate commerce. This provision is in addition to the requirement that carriers shall make report of all accidents monthly, on forms prescribed by the commission, which remains as in the law of 1901. The commission is authorized to employ any impartial investigator to inquire into all the facts, conditions, and circumstances surrounding any accident investigated, and is clothed with ample authority to get all the facts.

Investigations under this law are made by the commission's safety appliance and hours of service inspectors, under the direction of the chief of the division of safety appliances, and reports showing the causes of accidents investigated are made to the commission by the chief of the division of safety appliances. These reports are summarized in the quarterly accident bulletins, such summaries taking the place of the detailed reports of important accidents which were published in the bulletins under the law of 1901, publication of which was discontinued on June 30, 1911.

Investigations under this law began in June, 1911, and up to date 85 accidents have been investigated and reported upon by the various inspectors. The chief of the division of safety appliances has submitted his reports to the commission on 72 of these accidents, and 53 have been summarized in accident bulletins 41, 42, and 43. Detailed reports of the more important accidents investigated have been printed as separate documents by the commission.

In the investigation of a number of prominent accidents involving the failure of rails, the resources of the Bureau of Standards of the Department of Commerce and Labor have been utilized. This bureau is well equipped with facilities necessary for making tests of the physical and chemical properties of rails, and its engineer-physicist, Dr. Howard, is one of the most capable rail experts in this country. The aid rendered by the bureau has been of much service in disclosing the underlying causes of serious rail failures. The examinations made by Dr. Howard have been painstaking and thorough, and the conclusions reached by him have the weight of authority.

Coming now to the causes of the accidents that have been investigated under the terms of this law, we find many instances of bad

practice and are able to indicate certain unsafe methods of operation which should be changed. The investigations have not yet proceeded far enough to indicate the need of any specific legislation other than that which has already been proposed, but they have confirmed the need of a law for the compulsory use of the block system and for the use of automatic stops in certain situations, as also for a uniform code of signals and rules, a bill providing for which has already been introduced in Congress.

The inherent weakness of the train-order system appears from the fact that of 47 collisions investigated 23 were due to failure of conductors or enginemen to understand or obey orders; mistakes of dispatchers or operators in issuing, transmitting, copying, or delivering orders; for getting or failing to keep clear of superior class trains; misreading watches, and improperly checking train register. These identical errors have been the cause of collisions with more or less frequency throughout all the years the train-order system has been in operation. They occur under both the double and single order system, as well as with the intermediate order, and are inevitable wherever absolute reliance is placed upon the human element. It is universally admitted that the defects of the train-order system can not be cured by any improvement in the details of its operation. The only certain remedy is some form of block system that will insure the maintenance of an interval of space between moving trains.

But, as previously noted, collisions also occur under the block system. Such accidents in most cases are due to improper flagging or to failure of enginemen to observe or obey signals. Occasionally, where manually operated signals are in use, collisions are caused by mistakes on the part of signalmen. In short, collisions under the block system are due to the same fundamental cause as under the train-order system, namely, human error. From the standpoint of safety, the block system is superior to the train-order system only because it presents fewer opportunities for men to make mistakes.

To prevent collisions, therefore, we must reduce the chance of human error to a minimum and introduce measures to neutralize its effects when it does occur. This is a trite conclusion, but it is sometimes necessary to restate a truism in order that the importance of a too-familiar fact may be made prominent. To reduce the chance of human error in the operation of trains is a problem that has occupied the attention of railroad managers for many years. Rules innumerable have been formulated with this end in view, and various disciplinary measures have been taken for the enforcement of such rules. But the results have not been entirely satisfactory. Why? Mainly because the rules, as well as the disciplinary measures for their enforcement, have too often been mere makeshifts. Rules have been violated with impunity, with the full knowledge of officials whose duty it was to enforce them, and disciplinary measures have been applied only in cases where disaster has followed disobedience. The crying need in railway service to-day is a sensible and entirely workable code of rules governing the operation of trains—a code that can be obeyed under all conditions of operation; a code the primary purpose of which shall be the prevention of accidents rather than the avoidance of legal responsibility for their occurrence.

The remarkable increase in speed and weight of trains within recent years and the crowding of tracks and terminals caused by movement of the enormously enlarged volume of railroad traffic have greatly increased the duties of employees and multiplied the chances of error on their part. Rules which a few years back were perhaps reasonable and proper can no longer be observed and comply with the demands of traffic. Many such rules have remained in force, although it is well known that they are honored more in the breach than in the observance of them. Such a condition can not fail to weaken respect for all rules and render really effective discipline impossible. Whenever it becomes the unwritten law on a railroad that schedules must be maintained and trains moved over the road regardless of rules that have been enacted to secure safety, the conditions of disaster on that road are ever present and its managers are gambling with fate. A terribly disastrous head-end collision, caused by a train approaching a meeting point for another train at excessive speed, was due to disobedience of a rule requiring the air brakes to be controlled from the leading engine of a double-header. At the investigation of the accident the trainmaster of the railroad testified that this rule was habitually disregarded with his full knowledge. He also said that a rule which required all trains to make a running test of air brakes was not expected to be obeyed except by passenger-train crews.

Excessive speed as a factor in train accidents deserves serious consideration. A number of derailments investigated were directly due to speed too high for the existing conditions of track or roadbed, and in several serious collisions high speed was an important factor. It is of course extremely difficult, if not impossible, to say absolutely what is a safe limit for the speed of trains. With heavy rails, well-maintained track and roadway, properly spaced signals, and track kept clear of slow trains high-speed trains can be run with comparative safety. But the effort to maintain the schedules of these fast trains and to bring them in on time creates an undesirable mental condition and increases the chances of mistakes by employees. In a collision involving a high-speed passenger train upon one of our best equipped and operated railroads the towerman at an interlocking plant lined up the switches for a freight train to make a cross-over movement, the fast train coming from the opposite direction being several minutes late. Before the freight-train movement had been completed the fast train approached and whistled for a clear track. In his anxiety to facilitate the passage of the fast train the towerman forgot that the switches were lined up for the freight train and changed them so that the fast train might proceed. The towerman was clearly responsible for the resulting collision, but behind his mistake there was the anxiety that there should be no delay to the fast train, a mental condition which affects all employees in greater or less degree.

This mental condition—this desire to bring the fast train in on time at all hazards—leads to the disobedience of many rules, and such disobedience is often winked at by the very officials whose duty it is to enforce the rules. Trainmen are thus encouraged to take dangerous chances, knowing that if they come through without accident their infraction of the rules will be ignored. It thus happens that most of the accidents to high-speed trains are directly caused by

failure of some employee to perform his duty. Many such accidents occur through failure of enginemen to properly control speed at dangerous points. In the rear-end collision on the Illinois Central at Kinmundy, Ill., on January 22, 1912, the standing train was struck at a speed of at least 30 miles per hour, although a speed limit of 10 miles per hour for all trains was in force through the station limits at Kinmundy.

Failure of railway officials to determine with scientific accuracy the limits of safety, especially with respect to speed on curves, no doubt has led to many derailments. There are no accurate engineering data showing the actual stresses which are set up in railway-track structures by locomotives and cars of different weights and moving at different rates of speed. That an enormous strain is placed upon track by our heavy, modern trains, hauled by engines weighing upward of 200 tons, at 60 miles or more per hour, is beyond question. There is urgent need for accurate information on this point.

In a number of derailments investigation showed that track conditions were unsafe for the movement of trains at even ordinary speed, and no adequate measures had been taken by those in authority to insure speed reductions. This condition is by no means confined to the less prominent roads where no special effort is made to run trains at phenomenal speed, but has also been found on the more prominent roads in connection with the most widely advertised high-speed trains in the country. It is apparent therefore that both collisions and derailments can be materially reduced by the introduction of adequate measures for the enforcement of speed restrictions where conditions demand it.

Investigation of derailments due to broken rails has developed the fact that current specifications for the manufacture of rails are not adequate to guard against the most common type of fractures, and that the drop test does not reveal the presence of interior defects of a serious character. There is urgent need of reform in the requirements of the specifications as well as in the methods of inspection at the mills, so as to insure that structurally sound rails will be obtained. This need is particularly urgent in view of the constantly increasing strains to which rails are subjected, due to increase in the weight and speed of trains.

The superiority of the steel car from the standpoint of safety has been confirmed by the results of investigations both with respect to collisions and derailments. Antiquated wooden cars have been totally destroyed with serious results in loss of life and injury to persons in accidents less severe than those involving steel cars, the occupants of which have escaped practically unscathed. The steel car is rapidly superseding the wooden car on practically all the prominent roads, and it may safely be predicted that unnecessary injury and loss of life in collisions and derailments by reason of the use of antiquated and structurally unsound cars will soon be a thing of the past.

Numerous accidents due to the explosion of locomotive boilers led to agitation for a law providing for Federal inspection of the boilers of locomotives used in interstate commerce, and such a law was enacted and received the approval of the President on February 17, 1911. This act makes it unlawful from and after July 1, 1911, for

any common carrier to use a steam locomotive in interstate commerce unless the boiler of such locomotive and the appurtenances thereof are in proper condition and safe to operate. The act also provides for the inspection of boilers and authorizes the appointment by the President of a chief inspector, two assistant chief inspectors, and the employment of 50 district inspectors. The chief inspector is directed to divide the territory of the United States into 50 inspection districts and to assign an inspector to each district. Provision is made for the establishment of a code of rules and instructions for the inspection of boilers. The rules are to be approved by the Interstate Commerce Commission, and the chief inspector is required to make annual reports to the commission, as well as special reports covering the details of any accident that may have been caused by failure of a locomotive boiler or its appurtenances, whenever called upon by the commission.

As soon as practicable after this law became effective, the chief and assistant inspectors provided for were appointed by the President, and the 50 district inspectors were selected through competitive examination conducted by the Civil Service Commission. Rules and instructions for the inspection and testing of locomotive boilers and their appurtenances were formulated by the chief inspector and adopted after approval by the Interstate Commerce Commission, after a hearing at which parties interested were represented, as provided by the law. These rules and instructions were promulgated by the commission in a formal order dated June 2, 1911, and became effective July 1, 1911.

This law has not been in operation long enough to enable any statistical statement to be made concerning its effect in reducing the number of boiler explosions. There can be no doubt, however, that the law has had a good effect in enforcing better attention to the condition of boilers and in retiring from service many boilers which did not meet the established standards of safety. The first annual report of the chief inspector will shortly appear, and this will no doubt contain information of value demonstrating the benefits of the law.

We have now passed in review the various measures taken by the Federal Government for the prevention of railroad accidents, with the results of their operation so far as known. No specific cure for these disasters can be offered, for none is at hand. Experience has shown, however, that the number and severity of railway accidents can be materially reduced by the introduction of methods and appliances which are entirely practicable, and it is particularly encouraging to note that there has recently occurred a general awakening among railroad managers and railway trainmen's organizations which has led to a well-organized movement on the more prominent railroads of the country to secure greater safety.

In the working out of this problem of greater safety on railroads we shall get no aid from a study of the railroads of other countries. Our problem is essentially peculiar to this country, and must be solved in the light of conditions existing here. The most difficult and perplexing factor in this problem is the personal equation. The failure of the man at the critical moment is the thing to be guarded against, and this involves generally a reformation in methods of discipline and rules of operation.

The publication of reports of accidents investigated by the Federal Government acts as a powerful tonic on the whole situation, as shiftless methods which endanger life and property can not long endure in the light of a merciless publicity.

Great possibilities in the direction of a solution of the problem lie in the organization of so-called safety committees. These are now features in the administration of many prominent roads, and the slogan "Safety first" has become a watchword in the details of their operation. In making safety the dominant idea in the minds of employees, by continually talking about it and pointing out methods for its attainment, an important step in the right direction is taken. It is necessary for the employee to think right before he can act right. These safety committees are also bound to be an important factor in reawakening in employees that old-time feeling of personal interest and pride in the record of "our road" that has been so largely dissipated by modern railroad development. In short, cooperation for definite results all along the line is bound to result from the well-directed efforts of these committees.

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