INTERSTATE COMMERCE COMMISSION

REPORT OF THE CHIEF OF THE DIVISION OF SAFETY COVERING THE INVESTIGATION OF AN ACCIDENT WHICH OCCURRED ON THE PENNSYLVANIA RAILROAD AT MOUNT UNION, PA., ON FEBRUARY 27, 1917.

April 6, 1917.

To the Commission:

On February 27, 1917, there was a rear-end collision between a passenger train and a freight train on the Pennsylvania Railroad at Mount Union, Pa., which resulted in the death of 19 passengers and 1 Pullman porter and the injury of 3 employees, 2 Pullman porters, and 1 passenger. After investigation as to the nature and cause of this accident, I beg to submit the following report:

This part of the Pennsylvania Railroad is a four-track line, train movements being handled by an automatic block-signal system. The general direction of the tracks is east and west, and they are numbered from 1 to 4, beginning with the track on the south side. Tracks 1 and 2 are for eastbound trains and tracks 3 and 4 for westbound trains. Eastbound passenger trains are usually operated on track 1 and eastbound freight trains on track 2. Interlocking towers are located approximately 3 miles apart, at which points trains may be diverted from one track to another as desired. The tower immediately in the rear of the point of accident is MG tower, located nearly 1 mile west of Mount Union. Between these two points the grade varies from 0.06 per cent to 0.14 per cent, ascending for eastbound trains. The track is tangent from the tower to a point just east of signal bridge 1912. There is then a curve to the right of 1°30', 3,000 feet in length. There are then 800 feet of tangent to signal bridge 1904 and 276 feet of tangent between the signal bridge and the point of collision. Signal bridge 1912, the first signal bridge west of signal bridge 1904, is located 875 feet east of MG tower, and the distance between the two signal bridges is 3,968 feet.

Eastbound passenger train No. 6 consisted of 2 mail cars, 1 combination car, 1 coach, and 4 Pullman sleeping cars, all of all-steel construction, hauled by locomotive 748, and was in charge of Conductor Stewart and Engineman Gearhart. It left Altoona at 10.46 p. m., and at Tyrone, a station 15 miles east of Altoona, trouble was experienced with a stuck brake; there was further trouble at Huntingdon, 19 miles farther east. The train passed MU tower at 11.55 p. m., and, after passing signal bridge 1912, the engineman made an application of the air brakes preparatory to making the regular station stop at Mount Union. This brake application was made a little earlier than usual, as the engineman was not sure of his exact location in the dense fog. When he released the air, the brakes on one of the cars again stuck, resulting in more time than usual being consumed between MU tower and Mount Union. After discharging passengers, a proceed signal was given, but the engineman was unable to start the train, as the brakes on the first mail car had not released. After several attempts had been made to release the brakes, the fireman got off the locomotive and started back to locate the trouble. Finding the brake stuck on the first car, he went under it and cut out the air and released the brake, and had just gotten out from under the car when the rear end of the train was struck by eastbound freight train PG 20, the accident occurring at about 12.08 a. m.

Eastbound freight train PG 20 consisted of 35 loaded cars and a caboose, hauled by locomotive 614, and was in charge of Conductor Fagan and Engineman Cook. It left Altoona on track 2 at 10.59 p. m., and at FR tower, about 11 miles from Altoona, was diverted to track 1, the road being a three-track section from this point to SG tower, a distance of 6.5 miles. At SG tower, the train was diverted to track 2 and run on that track to PG tower, a distance of 5.8 miles. At PG tower it was again diverted to track 1, on account of a slow freight train occupying track 2, and it was operated on track 1 from PG tower to Mount Union, passing MU tower at 12.06 a. m., 13 minutes after train No. 6 had passed that point. A green, or caution, indication was received at signal bridge 1912, being observed by the fireman and head brakeman, but the engineman called it white and made no reduction of the speed, which was about 40 miles an hour. He observed the red indication on signal bridge 1904 when within a few car lengths of it, and at once made an emergency application of the air brakes, but as the rear end of train No. 6 was only 278 feet beyond the signal bridge, it is probable that there was no appreciable reduction in speed before the collision occurred.

The force of the collision drove the rear end of the train No. 6 forward a distance of 193 feet, including the distance lost by the telescoping of the rear car. The rear end of the frame of this car, which was the sleeping car Bellwood, was wedged under the smoke arch of locomotive 614 and held rigidly in such a position as to permit the forward end to be forced under the rear end of the car immediately ahead of it, the sleeping car Bruceville, and it was telescoped for its entire length, with the exception of about 8 feet at the rear, within which space the bodies of all the occupants of the car - 19 passengers and a Pullman porter -

were found, together with all of the interior furnishings in the car. Illustration No. 1 is a general view of the accident, while illustration No. 2 shows how the sides of the Bellwood were forced outward by the Bruceville, with a portion of the roof hanging over the side. Illustration No. 3 is a view of the rear of the train after locomotive 614 had been removed, the end of the Bruceville being raised from the Bellwood by a wrecking crane. Only one of the passengers in the Bruceville was injured, and some of them were not even awakened by the collision. Illustration No. 4 shows the condition of the Bruceville after the removal of the Bellwood. The trucks of the two rear cars were forced forward under the third car, the Grayphome. The rear truck of the fourth sleeping car was also derailed, but the balance of the train remained on the rails. The coupling between the locomotive and the first mail car was broken, and the locomotive was driven forward a short distance. Considerable damage was sustained by the front end of locomotive 614, but the forward pair of driving wheels were the only wheels under it to be derailed. Illustration No. 5 is a view of the locomotive after it had been withdrawn from the Bellwood. The tender of locomotive 614 was derailed and thrown part of the way down the embankment on the right side, while the first two cars were derailed, thrown down the embankment, and demolished. No damage was sustained by the other cars in the freight train, and there was practically no damage to the track.

Train Dispatcher Havens stated that the crossovers at the various towers were used for the purpose of handling traffic without delay. If one train was following another on the same track, and the first train should be delayed, then the second train would be crossed over to the adjacent track, so that it would not be delayed. He did not consider it detrimental to safety to allow freight trains to follow passenger trains on the same track at intervals of five or eight minutes, reliance for protection being placed upon the block-signal system in use. The crossing over of trains was not a matter of safety precaution, but one of expediting train movements. Dispatcher Havens further stated that train PG 20 came to him on track No. 1, and on account of a broken rail east of Huntingdone on track No. 2 the train was allowed to continue on track No. 1, and that in the absence of any information that train No. 6 was being delayed there would be no object in diverting the freight train to No. 2 track.

Engineman Gearhart, of train No. 6, stated that ordinarily his train consumes two or three minutes between MF tower and the time of stopping at Mount Union, but on this date it consumed four or five minutes, the engineman saying that he applied the brakes earlier than usual, and that they applied much harder than he expected. He did not know at what time his train stopped at Mount Union, but thought it was 11.57 or 11.58 p. m.; neither did he know how long his train had been standing before he received a signal to proceed. He was unable to start, and made a 15-pound reduction of the air, and then released, but was still unable to start the train. He tried to take up the slack, and also made a 25-pound reduction and released, but could not start the train. The fireman then got off to see where the trouble was, and found it to be located on the first mail car. Engineman Gearhart stated that he also got off the locomotive, and had just gotten to the station platform when the collision occurred. He did not look at his watch immediately, but did so a very short time afterwards, and it was 12.09 a. m., and he thought his train had been standing at least 8 or 10 minutes. Engineman Gearhart stated that he had had previous trouble with the air brakes at Tyrone and at Huntingdon. He said the air-brake inspector at Altoona told him the brakes were all right, and he also made a running test at Bellwood, and they worked satisfactorily there, and also at Fostoria, the first trouble being encountered at Tyrone. He stated that at ordinary station stops he would not consider it necessary to whistle out a flag, but in this case he did not know he was going to be delayed until he made a second attempt to start the train, and he then became engaged in trying to locate the trouble.

Fireman Parks stated that he thought his train consumed about three minutes between MU tower and the station at Mount Union, and that in about two minutes they were ready to proceed, but were unable to do so on account of air-brake trouble. About five minutes after the train stopped he got off the locomotive to ascertain the source of the air-brake trouble; he found it to be on the first car and then went under it in order to cut out the air brake. He stated that about five minutes were consumed from the time he got off the locomotive until he had cut out the brake and the air was released, the collision occurring just after he had gotten out from under the car. It was very foggy, and although he had looked toward the rear of the train he could not see the flagman's lantern. He said the signals could be seen very well when passing MU tower, but that the fog became very much thicker between the tower and the station.

Conductor Stewart, of train No. 6, stated that trouble with the air brakes was experienced at Tyrone, Huntingdon, and Bellwood water trough. When making the stpp at Mount Union the brakes on one of the cars went into emergency. He did not know the exact time his train stopped, but stated that when looking at his watch shortly afterward it was about 12.01 a. m. When the train was ready to proceed, and he saw that they were unable to start, he told the head brakeman to go back to the rear of the train while he went forward to see what the trouble was. The head brakeman started back on the run and at this time he saw the red and white lanterns of the flagman, who apparently was going back to flag. Conductor Stewart also stated that at this time he was standing between the third and fourth cars of the train. This was about six minutes before the occurrence of the accident, and he said that he looked at his watch when the accident occurred and it was 12.08 a. m. He did not hear anything indicating the approach of a train.

Head Brakeman Baird stated that difficulty was experienced with the brakes when the train was ready to proceed, and he started back toward the rear of the train, looking at each truck under the various cars. When he was near the rear end of the next to the last car he called to Flagman Jacobs that they were having trouble with the air brakes, and the flagman then started back to flag. He stated that he did not think it had taken him over a minute to go back to the rear of the train. He did not look at his watch when the train stopped at Mount Union, but when he started back to look at the brakes it was 12.02 a. m. He thought the train had been standing about six minutes when the collision occurred.

Flagman Jacobs stated that he had not noticed any trouble with the air brakes previous to arriving at Mount Union, except that at Huntingdon there was a little trouble in starting. He did not know at what time his train stopped at Mount Union, but it was about 12.02 a. m. when he descended to the ground. After loading and unloading passengers he received a signal from the head end, which he answered, and the conductor then pulled the signal cord for the train to proceed. Up to this time he had not gone back to flag. He did not know how long the train had been stopped before the proceed signal was given, but said that about two or three minutes elapsed between the time he got off the train and the time the train was ready to proceed, but he was not positive as to this. When the train was ready to go, the engineman could not release the brakes, and the head brakeman came back and told him that they were having trouble with the brakes. The head brakeman was looking at the trucks on his way back and called to him before reaching the rear of the train. He then started back to flag with his lanterns. He did not know how much time elapsed before he started back, but stated that he was on his way back and was near signal bridge 1904 when the Mount Union local passed him on its way west. At this time he looked at his watch and it was 12.03 and 12.04 a. m. The train sheet shows that train to have passed MU tower at 12.07 a. m., which would indicate that it left Mount Union not later than 12.04 or 12.05 a. m. When train PG 20 passed him he was about 20 or 30 feet west of the signal bridge. He stated that he saw the headlight when it was about 30 or more car lengths distant, and that he then started to give stop signals, but no acknowledgement was given. He said he had a fusee, but that he did not stop to light it. He thought the locomotive of the freight train was working steam when it passed him. Flagman Jacobs also stated that he thought about 4½ or 5 minutes elapsed between the time he started back to flag and the time the freight train passed him, and that his train had been at Mount Union about six minutes when the collision occurred. He also stated that when going back to flag he walked fast, although the distance between the rear of his train and the point west of the signal bridge he claimed to have reached was only about 300 feet.

Brakeman Folk, a passenger on train No. 5, stated that as soon as about 20 passengers had gotten off he went to the vestibule of the car and stood on the steps of the open vestibule looking out, this being possibly two or three minutes after the train had stopped. At about this time the conductor gave a proceed signal, and the engineman tried to start, but was unable to do so. After the engineman had tried to take the slack he applied the brakes and released them, and again was unable to start; about this time he again tried to take the slack. Brakeman Folk stated that in all the engineman tried to take the slack at least twice and also applied the brakes twice. He stated that he looked backward and also forward, and finally saw the fireman get off the locomotive. He also stated that he saw the flagman on the ground at the rear of the train with his red and white lanterns, looking at the brakes on the rear truck of the rear car. He did not think over 30 seconds elapsed between the time he saw the flagman standing at the rear of the train and the time the collision occurred.

Engineman Cook, of train PG 20, stated that the automatic signal east of MU tower, located on signal bridge 1912, was white on track 1 and also on track 2, and that he saw both of them very distinctly. He called the signal white and the fireman then came to him and asked if the signal was not green. By this time the train had just passed under the signal and he told the fireman that it was white. Engineman Cook said that in a fog it was customary to strain every muscle of one's eye in order to observe the signals as clearly as possible, and that he would not consider that he had seen a signal unless he saw the signals governing both tracks. In this case he did not ignore what the fireman had told him, but said he gave consideration to it, and as the fireman had just been working on the fire he thought he might have been blinded temporarily and could not see the signals clearly. He said he was so confident that he had received a clear signal that he made no attempt to reduce the speed. He did not hear the head brakeman say anything about the indication of the signals, and said he would not say that the brakeman did not call the signal, as he might have called to him and he would not have heard him on account of the roar of the locomotive. Approaching signal bridge 1904, west of the station, he saw the red signal, but did not see the flagman or any other warning. The speed of his train was then 40 miles an hour.

At this time he was about 8 car lengths from the red signal, this being the distance he could see it in the fog. After seeing the red signal he did not stop to look for a flagman, but applied the emergency air brakes, shut off steam, and opened the sanders. He saw the rear end of train No. 6 just as he passed under the signal bridge, and jumped down behind the boilerhead just before the collision occurred. Engineman Cook further stated that he went off duty on February 24 at 6.05 p. m., and was called to resume duty at 7 p. m., February 25. He arrived at Altoona at 9.50 a. m., February 26, being on duty altogether a total of 15 hours and 32 minutes. After going off duty and cleaning up he had dinner and smoked a cigar, going to bed at 12.20 p. m. At 5 p. m. he was called to go out at 6.30 p. m., this being the trip on which the accident occurred. From these figures it appears that Engineman Cook had opportunity for only 4 hours and 40 minutes sleep before starting on this trip.

Fireman Thomas, of train PG 20, stated that after passing the signal just west of MU tower he threw some coal in the fire box and then looked out to see the signal east of the tower. The brakeman called it green, and he called it green, but it was called white by the engineman. He said it looked to him to be a pale green color, and he then crossed over to the engineman and asked him if they did not receive a green signal, and the engineman told him it was white. He thought possibly he might have been blinded by the fire in the fire box sufficiently to raise a question as to the color of the signal indication. He stated that he saw the signal on track 2 and it was white, and that there was very little difference between the appearance of the two signals. He then tried to look again, but was unable to do so as the signal had been passed. He saw the red signal on signal bridge 1904 at about the time the engineman applied the brakes in emergency, this being about 6 or 8 car lengths from the signal. Fireman Thomas also said that he saw the flagman giving stop signals, the flagman being located about at the signal bridge.

Head Brakeman Barr stated that the first signal east of MU tower was green, and that he called it green, as did the fireman. He claimed that he called it green twice, and said that the fireman walked over to the engineman and told him that it was green; the engineman said it was white and continued to work steam until the red signal on signal bridge 1904 was encountered. The red signal, the markers on the train, and the flagman, were all so close together that he could not say which one he saw first. Head Brakeman Barr also stated that the signal on track 2 at signal bridge 1912 was white.

Conductor Fagan stated that the speed was about 48 miles an hour when he felt the emergency application of the air brakes, followed within a couple of seconds by the shock of the collision, the speed of the train not having been reduced in the meantime. The two brakemen, who were riding in the caboose, thought the speed was from 45 to 50 miles an hour.

Signalman Clemens, on duty at MU tower, stated that train No. 6 passed at 11.58 p. m., and that train PG 20 passed at 12.08 a. m. At times the fog would lift enough to enable him to see both signals on signal bridge 1912, and at other times he could not see either of them. At the time train PG 20 passed, he saw one of the signals, and it was in the clear position. He did not know which signal he saw, and said that the probable reason for seeing only one signal was the smoke from the locomotive of the freight train. He did not know of any recent trouble having been experienced with these signals.

W. U. Todd, foreman of the Huntingdon shops, stated that he assisted in clearing away the wreckage, and that in his opinion, when the locomotive of the freight train collided with the rear end of the passenger train it raised the rear end of the Bellwood, allowing the Bruceville to enter the front end and telescope it for its entire length. He stated that it was telescoped to within about 8 feet of the rear end.

H. B. Miller, in charge of the car inspectors at Altoona, stated that a test of the air brakes was made at that point, an application of the brakes being made; the inspectors examined the piston travel, the brakes then being released and signals passed from the rear end to the front end, men usually being stationed opposite every car, or every other car. Car Inspector B. L. Miller stated that he tested the first mail car in train No. 6, that there was nothing wrong with the brakes, and that they released properly. The piston travel was about 5½ inches.

After the collision the mail car, No. 6506, upon which the brake failed to release, was taken to Huntington and kept there until March 1, on which date the car was taken to Altoona for examination by the Commission's investigators.

Examination showed that this car was equipped with Westinghouse PM brake equipment, with 16 by 12 inch brake cylinder, 16 by 42 inch auxiliary reservoir, high-speed reducing valve, and P2 triple. The stencil marks indicated that both triple and reducing valve were cleaned and tested at Pitcairn shops of the Pennsylvania Railroad on February 12, 1917. A locomotive having 140 pounds air pressure in main reservoir and 110 pounds brake pipe pressure was attached to this car, thus duplicating the operating pressures at the time of the accident, and a thorough series of tests were made. In all these tests the brake applied and released properly. The maximum piston travel was 9 inches, and the slack adjuster worked satisfactorily. After these tests the triple and reducing valve were removed from the car and placed on the test rack in the machine shop. The triple was subjected to another series of tests, all of which were met in a satisfactory manner. It was then dismantled, and all its internal parts were removed and carefully examined. All parts were found in good condition, whereupon they were again assembled in place, and the valve was once more subjected to a series of rack tests, without failure of any sort. A test of the high-speed reducing valve demonstrated that it also was in good working condition. The triple and reducing valve werethen again applied to the car and once more subjected to a series of tests similar to those which had been conducted prior to their removal. In no instance did the apparatus tested fail to operate properly.

After noting the results of these tests it can not be assumed that there was any defect in this brake at the time of the accident. It is probable that its improper action was dueto some slight irregularity in manipulation. The location of the car which carried this brake points to he conclusion that after slowing down his train by making a light brake-pipe reduction the engineman left his brake valve in full release position a little too long, resulting in a slight overcharge of the brke pipe at the head end of the train. Then, when the brake-valve handle was moved back to running position, there was a slight drop in brake-pipe pressure, resulting in the triple on the head car reapplying. This is a common occurrence with a P type triple on the head end of a train, and results in what is termed a "stuck brake." It sometimes happens that hurried attempts to release such a stuck brake merely aggravate the trouble.

This accident was caused by the failure of Engineman Cook properly to observe the caution indication of the signal governing train movements on track No. 1 at signal bridge 1912. The engineman's failure to read this signal correctly is hard to explain, in view of the fact that two other men on the locomotive observed it in the caution position. In the dense fog that prevailed at the time it is probable that the engineman was expecting to see a white signal, and as the light flashed upon his vision but for an instant it actually impressed him as white and did not remain within his range of vision long enough to enable him to correct his false impression. He was examined as to his color sense on December 31, 1915, and was pronounced "O.K."

A very material contributing cause of the accident was the failure of Flagman Jacobs to go back a sufficient distance to protect his train. By the best evidence obtainable, which is confirmed by the statement of Flagman Jacobs himself, at least four minutes elapsed between the time he was informed of the cause of delay to his train and the time train PG 20 passed him. In this four minutes Flagman Jacobs got back a distance of but 300 feet from the rear end of his train. This lapse from duty is inexcusable, especially in view of the dense fog prevailing at the time. He failed entirely to perform his duty as a flagman, and to the extent of such failure must bear his full share of responsibility for this distressing accident.

In this connection attention is directed to the vague and indefinite character of the flagging rule in force on this division of the Pennsylvania Railroad. The only regulation which defines the duties of flagmen is the rule, No. 99, contained in the American Railway Association Standard Code previous to its last revision, namely:

> When a train stops or is delayed, under circumstances in which it may be overtaken by another train, the flagman must go back immediately with stop signals a sufficient distance to insure full protection. When recalled he may return to his train, first placing two torpedoes on the rail when conditions require it. When conditions require it a fusee must be used.

It will be noted that this rule leaves entirely to the judgment of the flagman not alone the distance he should go back to insure full protection but also the circumstances under which any flagging should be deemed necessary, as well as the conditions under which torpedoes and fusees should be used. The measure of flagging protection which a train receives, therefore, will depend entirely upon the quality of the flagman's judgment, coupled with his moral attitude toward the responsibility resting upon him.

It is true that the judgment of the man must be a controlling factor in determining the quality of service rendered by him in emergencies, or when not directly under the eye of an overseer. It can not be considered safe, however, to place full reliance on a man's judgment in applying the general principles stated in the old standard flagging rule, and it is believed that the rule should be amplified by special instructions suited to the various conditions of operation of individual roads.

It is recognized that on multiple-track roads equipped with automatic signals, with trains following one another at comparatively short intervals of time, different methods must be adopted than are used on single-track lines where there are but few trains, which are not fully protected by signals. Where automatic signals are used it is beyond question that far more protection is afforded by the signals than by the flagman. On such roads it is undoubtedly true that flagmen do form the habit of relying upon signals to convey warning to approaching trains, and that this practice is recognized and silently acquiesced in by those in authority. This is a dangerous practice and one that can not be justified by considerations of safety in train operation on any road which relies upon the practice of flagging for protection of its trains.

If this railroad is to continue to rely upon flagmen for train protection it should revise its flagging rule so as to embody specific instructions to flagmen respecting the performance of their duties.

Engineman Cook was employed as locomotive fireman on the Middle Division of the Pennsylvania Lines East on September 8, 1902. He was promoted to engineman on August 10, 1913, demoted to fireman on April 23, 1914, and again promoted to engineman on January 21, 1916. His discipline and efficiency records are good.

Flagman Jacobs entered the service of the Pennsylvania Railroad as passenger brakeman in July, 1911, and has been employed as such since that time. His discipline record is good, and his efficiency record, relating entirely to observation of the flagging rule, is perfect. This record covers the period from March, 1914, to December, 1916.

The signals on this section of road were installed in 1913, and so far as their electrical and mechanical features are concerned they represent the highest development in the art of railway signaling. They are of the semaphore type, giving three indications in the upper right-hand quadrant, and are installed on signal bridges extending across all four tracks. The signal mechanisms are Union Switch and Signal Co's style T-2, operated by alternating current at 110 volts. The track circuit is alternating current, and the relays are of the polyphase type, three-position; there are no line wires or line relays. The signals are not overlapped, there being but one caution and one danger indication in the rear of each train. Block sections are approximately 4,000 feet long; this represents the minimum braking distance between trains under the most unfavorable condition permissible with normal operation of the signals. The signals are electrically lighted, and the colors of their night indications are white, green, and red, for clear, caution, and stop, respectively. In respect to these colors the signals do not conform to the best practice. Green for clear and yellow for caution are the colors most highly approved and now most generally used on the railroads of the United States; the Pennsylvania Lines, both east and west of Pittsburgh, have already authorized the use of these colors, and the present color scheme is to be abandoned as soon as material for changing to the new colors can be received.

Immediately after the collision the signals on bridges 1904 and 1912 were placed under observation and men were detailed to watch them, and at about 3 p. m. on the day of the accident the relay and mechanism cases at both signal bridges were sealed. These seals were not broken until the Commission's investigators arrived on the ground, at which time a careful examination of the signals was made. Particular attention was given to the signal governing train movements on track No. 1 at bridge 1912. A number of tests were made to determine if any electrical condition which might occur would cause the signal to display a false clear indication. These tests indicated that there was no tendency for the signal to assume a clear position wrongfully. Voltage readings were taken across the rails at the relay end of the circuit; the track relays were examined and their operations were observed during the passage of trains through the block, and the signal mechanism carefully observed during the movements of the semaphore.

These various tests and observations indicated a normal condition of the track circuit and demonstrated that there was no apparent reason, either electrical or mechanical, why this signal should not operate as intended. All mechanisms, relays, and other apparatus connected with the signals showed that their installation was proper and maintenance excellent.

In view of the fact that the cars composing train No. 6 were of all-steel construction, the exceedingly fatal result of the collision to the occupants of the rear sleeping car calls for some consideration of its construction details.

The sleeping car Bellwood was built by the Pullman Co., being completed November 15, 1910. It was shopped for special and accident repairs in 1911, and again in 1913. It was released from shop after undergoing minor repairs on April 12, 1913, October 27, 1914, and May 24, 1916.

Blue prints show the construction of this car to have consisted of cast-steel platforms and body bolsters, between which, and forming the floor system, were plate girder sills. There were side sheathing-plates having a depth of about 3 feet each. The girder strength of the car appeared to have been comprised in the members above mentioned.

Upon the floor system were placed, and riveted to it by means of angle irons, channels, and I beams, the latter constituting the frame-work of the superstructure. The end construction showed one 4-inch I beam, 6.5 pounds per foot-weight, and three 4-inch channels 6.25 pounds per foot-weight, at each side of the end door.

These end I beams and channels represent the members upon which the strength of the car was founded and against which telescoping action took place. The resistance of these members resided chiefly in the shearing strength of the angle-iron connections. The connections are not of a kind which could be classed as shock absorbers, as the initial resistance of the riveting constitutes the strength of the system. Comparatively little mechanical work is required to shear rivets. Any force adequate to overcome the initial resistance of the rivets would find thereafter very slight resistance to further progress along the length of the car.

These end beams and channels were stripped fromm their connections with the floor system at the time of the collision. A wedge action took place by the opening of the sides of the car as it was forced under the car Bruceville, next in front of it. The structural members of the car offered practically no further resistance against telescoping after the end members were detached from the floor system.

Importance attaches to the method of end construction in steel cars - that is, for the portion above the sills or floor line. Under the usual conditions of service the tractive forces are applied and transmitted in the plane or nearly in the plane of the sills. Under reversed conditions, compressive stresses are resisted in substantially the same planes.

In the Railway Mail Service, specifications require a static resistance in the underframe members of 400000 pounds, the several structural parts to act as a unit, the stresses being restricted to 16,000 pounds per square inch. It is further stipulated that the ends shall be proportioned to resist horizontal forces applied at a distance of 18 inches above the floor line. The latter provision is for the purpose of providing strength to resist telescoping.

It is recognized in the construction of mail cars that in case of emergency the forces to be resisted will not always be directed in the plane of the sills, and end strength is provided to meet the condition when the sills of adjacent cars are not in the same plane.

Shearing forces of great magnitude are present in cases of collision when the sills of one car are raised above those of its neighbor, tending to strip the superstructure of the adjacent car, or by wedge action separating the sides of the adjacent car. A superstructure which affords shelter but not strength virtually leaves the vehicle a flat car in cases of emergency, not adapted to resist exceptional stresses received above the sills.

There are two features of prominence pertaining to end construction of cars with particular reference to passenger service in order to ameliorate the shocks of collision. The end construction must be adequate to prevent telescoping; that is, prevention of the penetration of one car into another, and for the further safety of the passengers there must be some shock-absorbing feature in the construction of the car. In order to meet the latter consideration, collapsible vestibules have been proposed.

The practicability of providing shock-absorbing features is governed by the speeds involved, also the masses which are to be put into motion, or, on the other hand, the motion of which is to be destroyed. Colliding bodies may have such velocities that they become virtually projectiles, as in ordnance and gunnery. With increased speed of trains the tendency is toward such a result.

Covering certain ranges in speeds and intervals within which shocks may be absorbed, the use of cars of strong end construction and with collapsible vestibules would be expected to lessen the severity of collisions.

In the present case the inadequacy of the end construction of the car which was telescoped is clearly shown. It possessed but little strength in a comparative sense against telescoping, while its horrible shock-absorbing feature was the mass of humanity forced from all parts of its length into its extreme end.

Types of construction have been proposed, and cars are in service which offer greater resistance than the car which was telescoped and in which all of the occupants were killed. The features of adequate strength in end construction and collapsibility of vestibules as the means of lessening the dangers of collisions demand serious consideration.

The circumstances surrounding this collision point clearly to the conclusion, often reiterated in previous reports, that if accidents of this character are to be guarded against some form of automatic device must be used which will assume control of a train and bring it to a stop within the zone of safety whenever an engineman fails for any reason to obey a signal indication that restricts the movement of his train. The only alternative that suggests itself is reduction of speed to a point that will enable an engineman to bring his train to a stop within the range of vision under all conditions of weather.

The signal system in use where this accident occurred is of comparatively recent installation and no doubt represents the highest development of automatic signaling practice on railroads. No expense has been spared to make the installation first class in every particular, and every effort of a highly competent and well organized signal department is exerted to surround it with all safeguards necessary to insure its proper operation.

Considering the train-service personnel, there can be no question that, with respect to competency, good character, and high regard for the proper performance of duty, it represents the best that can be found upon American railroads. The men are products of a long-established, well-organized, and carefully conducted system of training and discipline; they are subjected to periodic examinations, both mental and physical; they are required to meet efficiency tests at irregular and unexpected times; and are kept under observation to an extent which makes it almost unthinkable that incompetent or habitually neglectful persons can long remain in the service.

Notwithstanding this excellent personnel and high-grade signal system, since July 30, 1913, the Commission has been called upon to investigate four serious rear-end collisions on track sections of the Pennsylvania Railroad where these modern signals are used. All of the collisions referred to were due to the nonobservance of signal indications by enginemen, and in each case the engineman at fault was a man of long experience and good record.

The collision at Tyrone, on July 30, 1913, occurred in daylight and under clear weather conditions. It was a case of mistaking the location of a semaphore arm instead of the color of a signal light. The engineman, who was killed in the collision, no doubt accepted the clear indication on a parallel track as the signal for his train when the signal on the track upon which his train was running indicated caution. The collisions at Conemaugh, on January 29, 1914; Lewistown Junction, on October 5, 1916; and Mount Union, on February 27, 1917, all occurred at night and under foggy weather conditions. In each of these accidents the engineman accepted the indication of a white-colored light when, as a matter of fact, the light was green. In each case the fog was so dense that the signal light could be seen but a short distance away. At Conemaugh the range of vision was three or four car lengths, at Lewistown Junction the engineman said he could see about an engine length, and at Mount Union the lights could be seen four or five car lengths.

This condition of dense fog is an almost invariable accompaniment of accidents of this character. In numerous reports attention has been called to the danger of permitting fast trains to proceed at undiminished speed when signals are obscured by fog or storm so as to limit greatly an engineman's range of vision. When operating trains in block-signal territory in foggy weather, enginemen usually make no reduction in speed as long as they are sure of the signal indications, even though signals can be observed but a few feet ahead of the engine. Theoretically this is safe, as the signals indicate the condition of the track ahead with as great certainty in foggy weather as in clear, and if a signal is seen and known to be clear there is no good reason why speed should be reduced. But, however, safe this practice may be in theory, experience has amply demonstrated that as a practical matter it is not safe. The chance of misreading a signal from a rapidly moving train is immeasurably greater when fog is so dense that the signal can be observed but a short distance than when the atmosphere is clear enough to permit observation of signals at normal range of vision. In clear weather a signal can be seen far enough away to permit it to become fixed upon the vision with certainty; by the time the locomotive reaches the signal location the indication of the signal has been in the eye of the engineman long enough to insure accuracy of observation. But in foggy weather the signal flashes upon the vision of the engineman but for an instant and then disappears. He has time to take but a fleeting glance at it, and if he fails to observe it correctly he has no opportunity to alter his first impression; the safety of his train and of the preceding train then depends entirely upon the condition of the signal in advance or upon the flagman of the preceding train.

In this case, Engineman Cook was so absolutely sure that he observed a clear signal on bridge 1912 that he made no effort to reduce speed, even though his fireman's question should have created a doubt in his mind and caused him to take the safe side. He had been observing white signals; the home signal for MU tower, a short distance in the rear of bridge 1912, was white. He was straining his eyes to catch the signal at bridge 1912, expecting it also to be white, and as it flashed upon his vision for an instant and then disappeared he observed the white signal he was expecting to see. When the fireman questioned the color of the signal the engine had already passed it, and there was no chance to correct the wrong impression. Had the weather been clear the signal would have remained in the engineman's line of vision long enough to have fixed itself correctly upon his consciousness, or, in case it had been misread, the signal in advance could have been seen for a sufficient distance to have enabled the engineman to bring his train to a stop before passing it. Indeed, Engineman Cook stated that if the weather had been clear the accident would not have occurred, as he would then have been able to see the signal on bridge 1904 far enough away to have enabled him to bring his train to a stop in time to prevent the accident.

To have required the speed of this train to be reduced so that it could be stopped within the engineman's range of vision might well be considered excess caution, yet, in view of the engineman's feeling of certainty that his observation of the signal was accurate, this was obviously the only absolutely safe course under the existing conditions. Had there been an automatic train stop installed braking distance in the rear of signal bridge 1904, however, neither the speed of the train nor the misreading of the signal at bridge 1912 would have prevented the train from being brought to a stop in time to prevent this collision.

There are a number of automatic stop devices now available for use which are capable of development to meet railway operating conditions in a practicable manner. This work of development must be done by the railroads themselves. The work which the Government is doing in examining and testing automatic train-control devices can go no further than to indicate whether or not the devices tested are correctly designed and capable of being developed so as to perform their intended functions in a proper manner. It is obviously a duty which the railroads owe to the traveling public to develop and use these devices to the end that these distressing accidents, due to human error, may be eliminated from railway travel.

Respectfully submitted,

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