INTERSTATE COMMERCE COMMISSION

WASHINGTON

REPORT OF THE DIRECTOR

BUREAU OF SAFETY

ACCIDENT ON THE

PENNSYLVANIA RAILROAD

PRINCETON JUNCTION, N. J.

OCTOBER 29, 1936

INVESTIGATION NO. 2108

SUMMARY

Railroad:	Pennsylvania
Date:	October 29, 1936
Location:	Princeton Junction, N. J.
Kind of accident:	Derailment
Train involved:	Passenger
Train number:	No. 39
Engine number:	4833
Consist:	13 cars
Speed:	72-73 m.p.h.
Track:	Tangent; 0.51 percent ascending grade
Weather:	Clear
Time:	9:08 p.m.
Casualties:	1 killed and 46 injured
Cause:	Broken wheel

To the Commission:

On October 29, 1936, there was a derailment of a passenger train on the Pennsylvania Railroad at Princeton Junction, N. J., which resulted in the death of 1 passenger and the injury of 41 passengers and 5 Pullman employees. The investigation of this accident was made in conjunction with representatives of the New Jersey Board of Public Utility Commissioners.

Location and method of operation

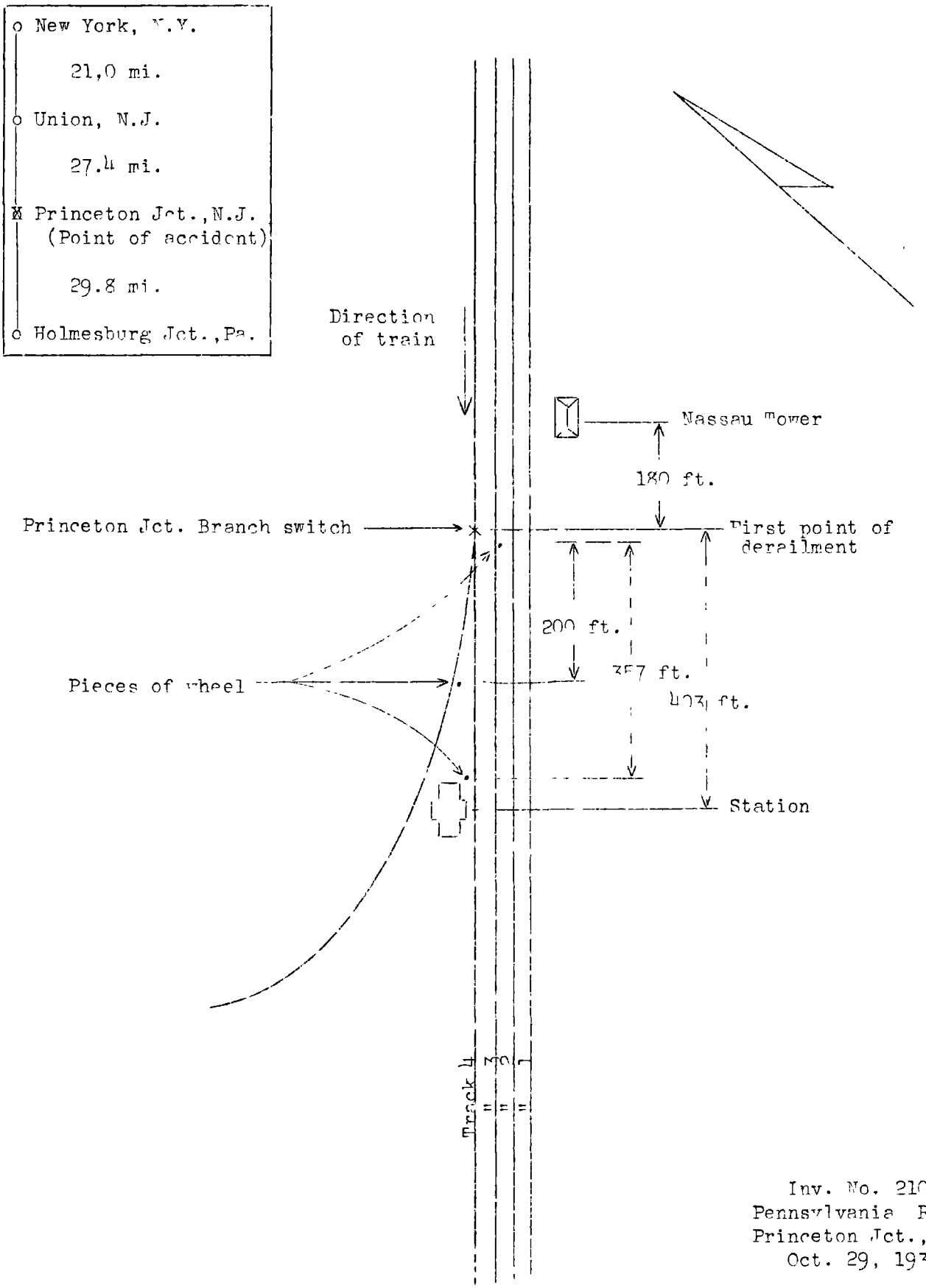
This accident occurred on that part of the New York Division extending between New York, N. Y., and Holmesburg Junction, Pa., a distance of 78.2 miles; in the vicinity of the point of accident this is a 4-track line over which both steam and electric trains are operated by timetable, train orders and an automatic block and cab-signal system. The tracks, numbered from south to north, are 1, east-bound passenger; 2, east-bound freight; 3, west-bound freight, and 4, west-bound passenger. The passenger train involved was west-bound on track 4. The accident occurred at a point approximately 9 feet west of the switch points leading to the Princeton Branch, or 403 feet east of the station at Princeton Junction. The track is tangent for several miles in each direction and the grade is 0.51 percent ascending for west-bound trains at the point of accident.

The track is laid with 130-pound rails, 39 feet in length, with 22 ties to the rail-length, double-spiked, fully tieplated and ballasted with stone. At a signal bridge located approximately 2 1/8 miles east of the point of accident there is a device on each of the four tracks which is designed to detect dragging equipment; if dragging or derailed equipment comes in contact with the device, the automatic block signals are caused to display stop indications. The maximum speed limit for passenger trains is 75 miles per hour.

The weather was clear at the time of the accident, which occurred about 9:08 p. m.

Description

Train No. 39, "The Clevelander", a west-bound passenger train, consisted of 1 deadhead Pullman parlor car, 1 postal storage car, 1 postal mail car, 1 postal storage car, 2 baggage cars, 1 combination baggage car and coach, 1 coach, 4 Pullman



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sleeping cars and 1 Pullman lounge car, all of steel construction, hauled by electric engine 4833, and was in charge of Conductor Sackrider and Engineman Gaffney. This train passed Union, 27.4 miles from Princeton Junction at 8:46 p. m., according to the train sheet, 3 minutes late, passed Nassau, 0.1 mile from Princeton Junction at 9:08 p. m., 2 minutes ahead of time, and was derailed at Princeton Junction while traveling at a speed indicated by the speed recorder on the engine to have been from 72 to 73 miles per hour.

The engine and first five cars remained coupled and stopped with the engine 3,622 feet beyond the point of derailment; the fourth and fifth cars were derailed but remained in general line with the track. The sixth and seventh cars stopped behind the fifth car, with the front end of the seventh car fouling track 3. The remaining cars in the train were derailed to the right, stopping 1,201 feet behind the seventh car. The eighth car struck a catenary pole, tearing it from its base and bending it in a hair-pin shape around the forward end of the coach where it was carried until the cars stopped, to the right of an parallel with the track, 285 feet beyond; the front end of the car was badly damaged. The ninth car stopped at an angle to the track, while the four remaining cars stopped in general line with the track.

Summary of evidence

Engineman Gaffney stated that on passing through Princeton Junction at a speed of 72 or 73 miles per hour the air brakes were applied in emergency, there was a heavy electric arc and the power was lost; he immediately let go of the deadman's lever and placed the automatic brake valve in emergency position, leaving it in that position until the train stopped. He did not feel any jerking or jolting of the train to indicate that any portion was derailed and he thought at the time that the train had broken in two. Both he and Fireman Shibla had made several running inspections of the train en route and nothing unusual was noted.

Conductor Sackrider stated that on rounding the curve west of Deans, 8.5 miles from Princeton Junction he looked out along the train and saw nothing wrong; on passing the station at Princeton Junction, he was walking through the seventh car in the train when he heard flying ballast. He immediately pulled the emergency cord in the baggage end of the car and as he did so the car became derailed. Some time after the accident he saw that the right

front journal box on the fourth car was gone and nothing remained of the wheel but the hub; the journal and hub were cold. He also observed a piece of the rim of the wheel lying north of track 4 and west of the switch leading to the Princeton Branch. This piece was about 15 or 16 inches of the circumferential length and showed a fresh break with the exception of one place at which about 4 or 5 inches appeared to be an old break.

Train Baggageman Beatty stated that he last looked the train over on the reverse curve in the vicinity of Metuchen, 21.2 miles from Princeton Junction, and Flagman Butler stated that he last made a running inspection on the curve in the vicinity of Canal, 14.2 miles from Princeton Junction.

Operator Culver, on duty at Nassau Tower, opposite Princeton Junction, stated that he observed Train No. 39 as it passed the interlocking tower. He heard a crash and observed fire flying from under the fifth or sixth car. The fire was not caused by an application of the brakes, but came from one place and appeared to be caused by a car dropping down on the rail or ties. When the train reached a point just west of Princeton Junction Station the electric current went off and the lights and signals went out, and at the time this occurred he saw a great arc at the train indicating that the wires had become grounded. About 1 or 2 minutes later the engineman of another train advised him by telephone that he had picked up a piece of wheel on the station platform and had placed it in the baggage room.

Engineman Stonaker stated that he was sitting in a coach at the station, when Train No. 39 passed Princeton Junction, and he observed fire flying from underneath one of the cars in about the middle of the train, and when he got out of the coach he heard the crash of the derailed train. About 2 minutes after the train had passed he picked up a piece of wheel which he found lying near the waiting room door and he placed it in the baggage room for safekeeping; there was no indication of the piece of wheel being heated.

Foreman Wyrough arrived at Princeton Junction about 9.35 p. m. and examined the piece of wheel that had been found on the station platform; the temperature of the wheel was normal and the break appeared to be new; he also examined the remaining portion of the wheel on the axle and found no indication of overheating.

Master Mechanic Bickley stated that the load wheel on the south side of the fourth car, PRR 9050, was broken into four pieces, three of which were strewn along the track. The hub was intact on the axle with a portion of tread 18½ inches in circumferential length. The first piece was found 6 feet west of the

point of derailment, south of track 3 and measured 16¼ inches in circumferential length. The next piece, measuring 46 inches, was found about 200 feet farther west, and north of track 4, and the third piece, measuring 25 inches, was found near the east end of the station. Examination of these pieces did not indicate an old fracture as all of the metal was bright except where dirt had been picked up during the derailment. The fractures showed clear, granular metal. There were no cracks or thermal checks visible to the naked eye, nor was there any indication that the wheel had been overheated. The inner surface was greasy and this grease would have been burned or dried off if the wheel had been hot. The first mark of derailment was 8 feet 7 inches west of the switch points leading to the Princeton Branch; this was a flange mark on the tieplate 7 inches from the gauge side of the north rail; the next mark was approximately 6 feet farther west and on the outside of the south rail. There were also marks on the ties about 40 or 50 feet east of the first mark of derailment. Master Mechanic Bickley stated that in his opinion the wheel broke before the derailment occurred, and the momentum of the turning wheel may have caused the broken part of the wheel to strike the ground in a number of places. He further stated that car 9050 was equipped with clasp type brakes, with two tread-type brake shoes per wheel. After the derailment he found that the inside brake beam of the broken wheel was bent upward about 12 inches; the front or outside brake beam was intact, but the keyway in the brake head was torn out and the brake shoe was missing. Broken brake shoes were found at the point of accident, but their relation to the various wheels could not be definitely determined. He found no evidence of unequal braking pressure on the wheels. Master Mechanic Bickley also stated that trains received in terminal yards are inspected by qualified inspectors, for all mechanical and safety appliance defects, that particular attention is paid to wheels for flange and tread defects, loose wheels, thermal cracks, etc., and when such are found the inspectors submit Form MP-111 reports to the foreman's office and a copy of the report is furnished to the yardmaster's office, and that a book record, showing the defects, is also made of shopped cars. Fourteen wheels had been removed from service at Sunnyside Yard in the last 30 days prior to the accident, on account of thermal cracks having been found in them.

Air Brake Inspectors Rapp and Uhrin, at Sunnyside Yard, Long Island, N.Y., stated that they made an air brake test of 10 of the cars of Train No. 39 on October 29, 8 cars being tested from the yard air line, with the standard testing device, and 2 cars from a road engine. The piston travel was adjusted on several of the cars, and the brakes on all of the cars were found to apply and release properly.

Assistant Foreman Fitzgerald at the Pennsylvania Station, New York, stated that PRR car 9050 arrived at the Pennsylvania station in Train No. 252, and after being unloaded was later switched to Yard "D" where it was inspected by Inspector McGovern, a competent man.

Car Inspector McGovern stated that he inspected the car involved at about 7 a. m. on the day of the accident. His inspection included diaphragms, couplers, and draft gears; he found that all bolts and nuts were tight and intact, the air brake pins were in good condition, with cotter keys properly opened. The wheels were within the gauge and free from such defects as heat cracks, flat spots, or cracks from hub across plate to the flange. The journals and bearings were in good condition and there was no indication of a loose wheel. He did not notice any defects of any kind on the wheels of this car; in making his inspection of the inner sides of wheels he examined them from the opposite side of the car. Car Inspector McGovern stated that he had been inspecting cars for 21 years and was thoroughly familiar with wheel gauging and understood heat cracks.

Inspection of the track by the Commission's inspectors disclosed the first marks of derailment to be as described by Master Mechanic Bickley. The marks on the inside of the right rail continued to a point where the track was torn up, while the marks on the outside of the left rail were not continuous flange marks on all the ties as were those near the north rail, but they were successively interrupted and broken and showed various gouges and scraping on the ties, as might be expected from a wheel broken as on car 9050. Some minor fresh marks were noted on the ties from 50 to 160 feet east of the switch, but they were not well defined so as to indicate definitely what caused them, nor were they uniform in shape, intensity or sequence.

Examination of the broken wheel showed that the fracture extended practically at right angles through the rim section of the wheel and into the plate about halfway to the hub and then circumferentially around the plate section; approximately 18½ inches of the rim and flange remained on the wheel, the balance being broken off into three pieces. The flange and tread were found to have nearly a full contour, and no thermal checks, cracks or flaws were visible as a cause for the fracture, nor was there any discoloration or other indication that the wheel had been recently heated. The inside face of the cast steel truck frame and the journal box pedestal bore pronounced gouged marks and were newly scarred, plainly indicating that serious friction and blows had occurred at these points before the large segments had become free and separated from the wheel.

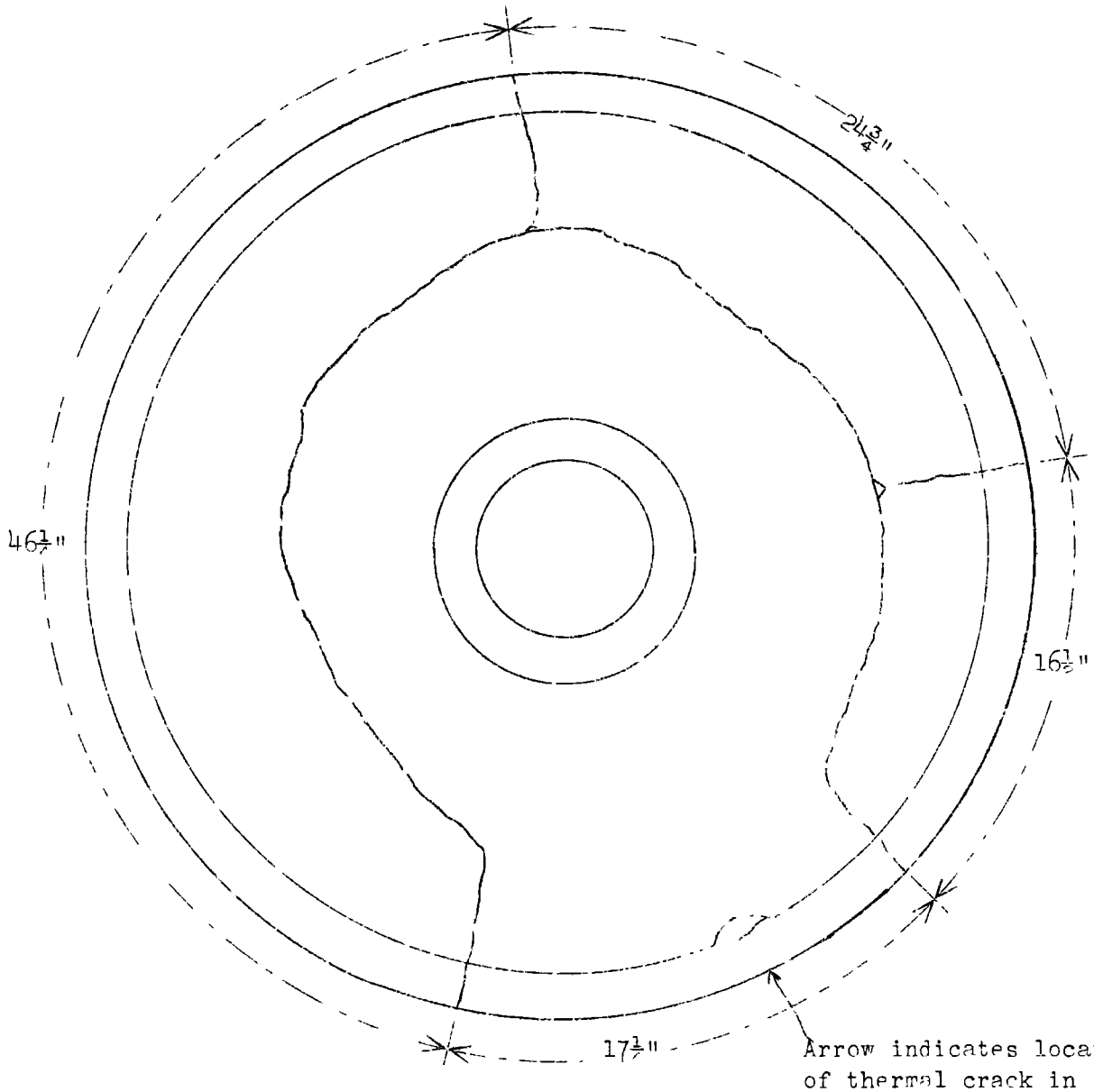
The broken wheel, together with the axle and the mate wheel were sent to the Test Department of the Pennsylvania Railroad for inspection and analysis, and the report of the Engineer of Tests disclosed the following:

The axle, with journals measuring 10 1/8 by 5 7/16 inches, was not defective. The wheels were of Carnegie rolled steel, multiple wear, No. 3 type, 7 by 7-inch bore; tread thickness of the broken wheel was 1 3/16 inches and that of the mate wheel was 1 7/32 inches; rail wear was 1/16 inch on each wheel tread, and the flange contours were good. The wheels were found tight on the axle and a pressure of 210 tons was required to move the broken wheel from its seat on the axle, with a decrease in the pressure as the dismantling was continued. This pressure was considered normal as the general range is from 200 to 250 tons. A deep abrasion was found on the inside of the portion of rim which remained on the wheel, showing that a heavy impact had occurred at that point and directly opposite this mark a crack was found in the outer portion of the wheel tread.

Examination of the surfaces showed the ruptures all to be of a sudden type with no apparent defective condition in either the rim or plate portion; no old defects were visible but several abrasion and batter-marks were indicated. The Brinell hardness at various points in the radial cross section from rim to bore was reported as ranging from 272 to 260, which is somewhat high, 230 to 250 being normal for rolled steel wheels, but the variation from 272 to 260 is within reasonable range and indicates chemically non-segregated steel.

Chemical tests made from samples taken at various locations in the broken wheel disclosed the following results, which are shown in direct comparison to A. A. R. standard specifications for multiple wear wrought steel wheels.

	A.A.R. Standard Specification M-107-34. Revised 1934	P.R.R. Test Dept. Report on broken wheel P.R.R. 9050
Carbon	0.67 to 0.82%	0.707 to 0.765%
Manganese	0.60 to 0.85%	0.74 to 0.75%
Silicon, not less than	0.15%	0.211%
Phosphorous, not over	0.05%	0.035 to 0.037%
Sulphur, not over	0.05%	0.037 to 0.038%



Sketch showing location of ruptures.

These analyses show non-segregated steel, well within the requirements of the specification and the carbon content further indicates that the rather high Brinell hardness was caused by too rapid cooling of the wheel during manufacture rather than its chemical composition. Severe local acid attack produced in deep etching tests indicated that the steel, in the center portion of the rim and down into the web, contained a large amount of impurities.

The ultimate strength, limit of elasticity, and reduction of area were found by tests to be good, although the limit of elasticity was slightly low, probably caused by the impurities.

Microscopic examinations at 100 diameters revealed practically normal cordition. Numerous minute cracks along the surface of the tread were disclosed, but this condition is typical of practically all steel wheels subjected to heat produced by brake shoe applications.

The crack in rim, opposite the abrasion on inside, was opened at the laboratory and a thermal crack, about 2 inches in length, was then disclosed, with a secondary crack extending through the thermal crack, which evidently resulted from the heavy impact on the inside of rim. No evidence of any such cracks could be found on any of the ruptures which resulted in the wreck, nor were any well defined thermal cracks found on any other portion of the wheel tread. Examination showed that the broken wheel was of proper contour and well above the established road limit; that the surface of tread on outer portion showed a slight heat discoloration from brake shoe application; that the few very small thermal checks found in the wheel tread were so small that they could not be detected under ordinary inspection.

In conclusion, the report states that all of the fractures through rim and web were entirely sudden with no evidence of an old defective condition. The tensile properties were normal with the exception of a slightly low limit of elasticity. The Brinell hardness was somewhat high and the steel was rather high in slag and oxide, and the type of fracture, in view of all these facts, leads to the conclusion that the bursting of this wheel was directly due to internal stresses, the presence of which cannot be determined without destroying the wheel. It was considered that the plate stresses were present in the wheel when new and the rim had sufficient band resistance to hold these locked up plate stresses, but when the rim thickness was reduced (the wheel having been turned to restore contour) the center zone of the rim, weakened by a high oxide and slag content, was reached, and this, together with the stresses set up by brake shoe heating, was evidently sufficient to permit the plate stresses to overcome the band resistance of the rim, resulting in the bursting rupture of the wheel.

Discussion

The investigation developed that the left front wheel of the lead truck of P.R.R. baggage car, 9050, the fourth car in the train, broke into four pieces. The first piece was found in the immediate vicinity of the first mark of derailment, the next two pieces were 200 and 357 feet, respectively, west thereof, while the hub and a portion of the tread remained on the axle. Prior to the accident, the crew noticed nothing wrong, but just as the train was passing Nassau Tower at Princeton Junction the operator heard a crashing sound and saw fire flying from underneath one of the cars, which no doubt was caused by the large segments of the broken wheel coming in contact with the truck frame and the car underframe when they became separated from the wheel. The car had been given careful inspection by a qualified car inspector before leaving its initial terminal, and the examination of the wheels for the purpose of discovering wear, cracks or indications of defects, failed to reveal any visible defects.

Microscopic examination made by the test department of this railroad, failed to reveal any old defects that would cause the wheel rupture. The only well defined evidence of thermal cracking was found in the rim of the segment that remained on the hub and this was visible only after this section was broken in the laboratory. The analysis revealed that the chemical composition was well within the requirements of the specification for rolled steel wheels, but there was an excessive and weakening amount of oxide and slag in the center zone of the rim section. It is evident that the broken wheel had been turned on one or more occasions, the rim thickness being 1 3/16 inches, but this was well above the minimum of 1 inch prescribed by A. A. R. rules for rolled steel wheels in passenger service. It is the conclusion of the test department that the reduced rim section, being weakened by excessive impurities in its center zone, no longer furnished sufficient band resistance to withstand the internal stresses in the plate of the wheel and this resulted in the bursting rupture of the wheel. It is therefore evident that the rupture of this wheel was due to stresses and conditions inherent within the wheel, which could not be detected by ordinary inspection.

Conclusion

This accident was caused by a broken wheel.

Respectfully submitted,

W. J. PATTERSON,

Director.