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INTERSTATE COMMERCE COMMISSION

REPORT OF THE DIRECTOR OF THE BUREAU OF SAFETY CONCERNING TWO ACCIDENTS ON THE CHICAGO, ROCK ISLAND & PACIFIC RAILWAY AT TIFFIN, IOWA, AND OTTAWA, ILLINOIS, ON APRIL 4, 1935

June 5, 1935.

To the Commission:

On April 4, 1935, there were two accidents on the Chicago, Rock Island & Pacific Railway involving the derailment of freight trains; the first occurred at Tiffin, Iowa, 244.7 miles west of Chicago, Ill., following which the derailed equipment struck another freight train, standing on the passing track, and also the depot, resulting in the injury of 1 employee; the second derailment occurred at Ottawa, Ill., 84.5 miles west of Chicago, the wreckage of which was struck by a freight train traveling in the opposite direction on an adjacent track, resulting in the death of 3 employees and the injury of 1 employee. The investigation of the accident at Tiffin was held in conjunction with the Iowa Board of Railroad Commissioners and the Illinois Commerce Commission was represented at the investigation of the accident at Ottawa.

Accident at Tiffin

Location. This accident occurred on Subdivision 4 of the Iowa-Minnesota Division, extending between Valley Junction and Missouri Division Junction, Iowa, a distance of 178.9 miles; in the vicinity of the point of accident this is a single-track line over which trains are operated by time-table, train orders, and an automatic block-signal system. The derailment occurred about 45 feet east of the point of switch leading to the house track; this is a facing-point switch for east-bound trains that leads off the main track to the left, and is located about 550 feet west of the depot. Approaching the switch from the west, there is a 1° curve to the left 3,620 feet in length, following which the track is tangent for about 1½ miles to the point of accident and for a considerable distance beyond that point. The grade for east-bound trains is descending, being 0.16 percent at the point of derailment. The passing

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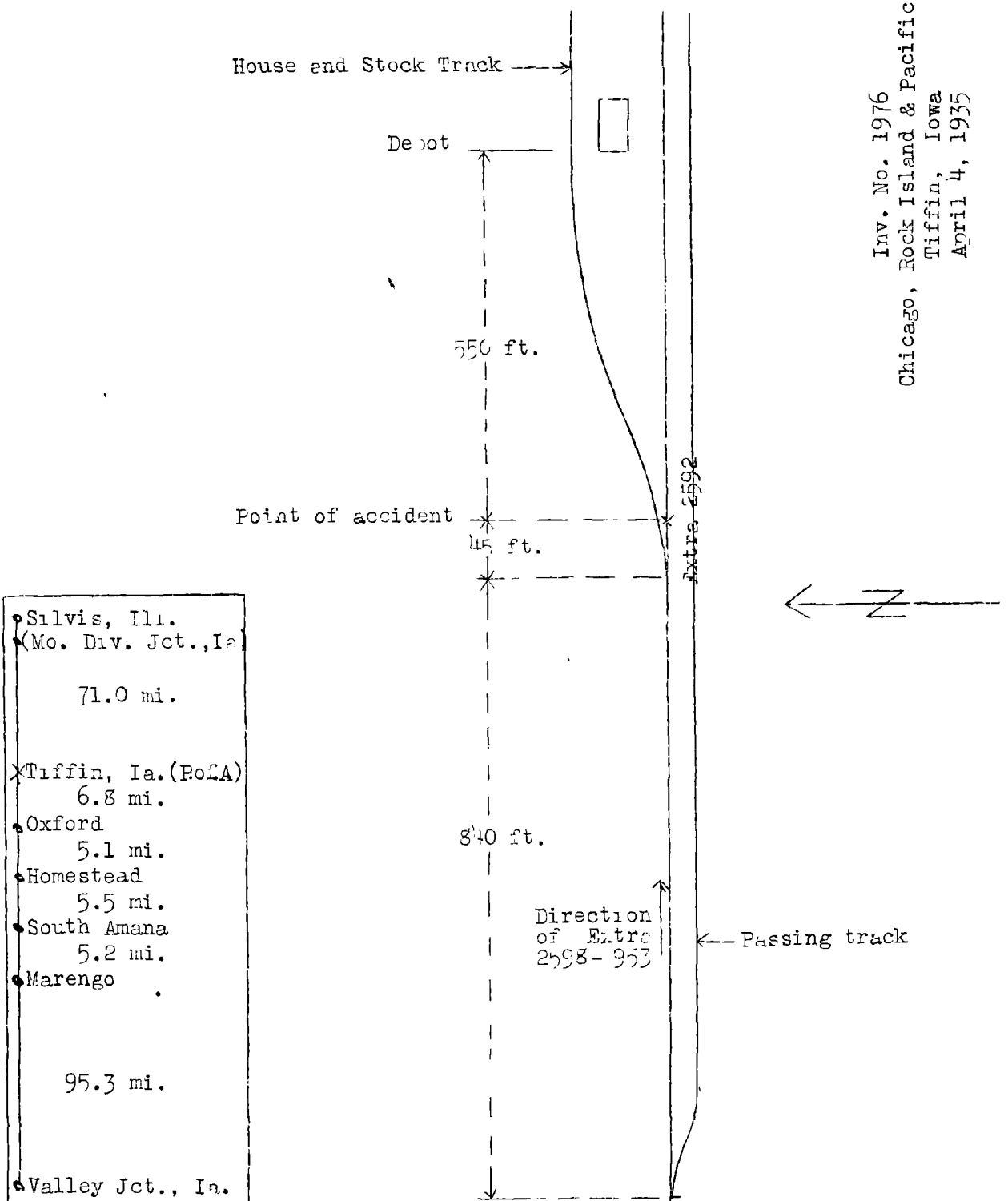


track parallels the main track on the south, the west switch being about 840 feet west of the house-track switch. The depot is located between the main track and the house track.

The track is laid with 100-pound rails, 33 feet in length, with 20 ties to the rail length, fully tieplated, single-spiked, and ballasted with gravel and rock to a depth of 22 inches. The speed of freight trains is limited to 45 miles an hour.

The weather was clear at the time of the accident, which occurred about 12:15 a.m.

Description. Extra 2598-953, an east-bound freight train, consisted from east to west of engine 2598 and 9 loaded freight cars, then engine 953 and 8 more loaded cars and a caboose, and was in charge of Conductor Niswander and Enginemen Sproat and Frey, respectively. The engines were spaced apart on account of bridge limitations. This train left Marengo, the last open office, 22.6 miles west of Tiffin, at 11:43 p.m., according to the train sheet, and was passing Tiffin when it was derailed while traveling at a speed estimated to have been between 40 and 45 miles an hour.

Engine 2598 and its tender became parted from the train and were not derailed, but the 8 cars between engines 2598 and 953 were derailed and badly damaged, engine 953 and its tender were derailed and stopped on the roadbed leaning to the left at an angle of about 30°, partly jackknifed, and the first 2 cars behind engine 953 and the forward truck of the following car also were derailed. West-bound Extra 2512, which was standing on the passing track with the engine in the vicinity of the house-track switch, was struck by the derailed equipment, with the result that 5 cars in its train were derailed and damaged and 4 others were damaged but not derailed. The depot was demolished, the employee injured being the agent, who was off duty and asleep in the office.

Summary of evidence. Engineman Sproat, of Engine 2598, stated that a stop had been made at Marengo, 22.6 miles west of Tiffin, for the purpose of setting out a car from near the head end of the train; after leaving Marengo he looked back along his side of the train to inspect it while rounding curves, and Fireman Trask and Head Brakeman

Hull did the same on the opposite side, but nothing was said about anything wrong being noticed. The train was traveling at a speed of 40 or 45 miles an hour when he felt an emergency application of the air brakes; he immediately released the engine brake, and the engine, which had broken away from the train, continued on down the track and stopped east of the depot. After the accident Engineman Sproat saw a broken arch bar on box car M&StL 20302, the first car in the train; the bottom ends of the column bolts were battered where they had been striking something, and in his opinion this broken arch bar was the cause of the accident. Head Brakeman Hull stated that he inspected the forward portion of the train at Marengo, looking at each side, but found nothing wrong with the head car, and while a car was being set out at Marengo he was standing on the south side as the cars were backed through the cross-over switches, and on the north side as the engine pulled the car out after making the set-out; he then rode on the side of the third car to the coal chute, but at no time did he hear the sound of metal striking against metal. Fireman Hayes, of engine 953, a hand-fired engine, said he had looked ahead along the north side of the train when not engaged in firing but had not seen any indications of dragging equipment or sparks flying, but there were times when dust and smoke trailing down had obscured his view.

Conductor Niswander stated that the fourth car from the head end was set out at Marengo, and in doing this work the first car remained coupled to the engine. He inspected the north side of the train at that point, and stood on the south side when the train was departing, but found nothing wrong. After leaving Marengo he rode in the cupola, on the north side, and observed the movement of the train, but he saw no sparks flying or other condition to indicate that there was anything dragging and the first he knew of anything wrong was when he heard something strike the bottom of the caboose and the train stopped. It was Conductor Niswander's opinion that he would have detected the broken arch bar had it been parted as much as $\frac{1}{4}$ inch at Marengo, and he did not think it caused the accident but rather that a car jumped the track. Flagman Euler said that at the time the car was set out at Marengo and the engine and cars pulled back on the main track he did not see or hear any indication of equipment being down on the north side of the train; he merely glanced at the cars as they passed, however, in order to observe the brake rigging and did not look at the

arch bars. He was of the opinion that a broken arch bar caused the accident.

Track Inspector Neubauer stated that on the morning following the accident he inspected the track for indications of anything dragging. He found marks 9 inches outside the gauge side of the north rail of the main track on lead rails, and also wing rails of frogs, at turnouts leading off the main track to the north at Marengo, as well as at South Amana, Homestead and Oxford, these stations being located 28.8, 17.4, 11.9, and 6.3 miles, respectively, west of Tiffin, while at road crossings between a point 3 miles west of Marengo and the point of accident, a distance of about 28 miles, marks were found on the planking 8 inches north of the gauge side of the north rail, indicating that a truck had been broken at a point west of Marengo and that it had sagged sufficiently for the column bolts to strike the crossing planks. All the marks were of the same character and at the same distance from the gauge side of the rail, and none was found east of the point of accident, and in his opinion they were made by the column bolts of the broken arch bar.

Roadmaster Pugh arrived at the scene of the accident about 1 hour after its occurrence; inspection of the west switch of the house track, near where the first wheel marks were in evidence, disclosed that the switch was in proper condition and locked for the main track. The track was in good condition as to line and surface and the joints were well maintained.

Division Engineer Bradley, General Car Foreman Butler, Trainmasters Lafler and Sullivan, and Roadmaster Pugh were of the opinion that the accident was caused by the failure of the bottom arch bar on the north side of the forward truck of M&StL box 20302, and that the marks at crossings previously described were caused by the lead column bolt gouging the planks.

Rip Track Foreman King stated that at Valley Junction on April 3, M&StL 20302, loaded with cement, was "bad-ordered" by the car inspectors on account of a cracked bottom arch bar, and on April 3 the bar was removed. There was no bar steel in stock the exact size of the old bar, which was 1 3/8 by $4\frac{1}{2}$ inches, and consequently a piece of bar steel measuring $1\frac{1}{2}$ by $4\frac{1}{2}$ inches was selected and was shaped at the blacksmith shop. After this had been done,

the new bar was brought to the car department and the old top bar was used as a template and the holes marked off and drilled on the drill press, after which the new arch bar was applied to the truck, the work being completed about 4 p.m.; new bolts, 1 5/8 inches in diameter, as well as new lock washers and nuts, were used. He said that the old bar that was removed was not broken all the way through, but had a hair-line crack, and this crack was located at the bottom bend; the new bar that was installed failed at the top bend.

Blacksmith Keenan stated that he made four heats in forming the bar, one for each bend and used a steam hammer in making the bends. The bar was heated to about a cherry-red color and allowed to cool by radiation after each heat, no portion being submerged in water.

M&StL box 30302 was of 80,000 pounds capacity and had a net load limit of 88,160 pounds with an actual load at the time of the accident of 88,160 pounds of cement.

Engineer of Tests Sedrick reported that examination showed that the bottom bar failed near a top bend at the oil box; the box bolts and column bolts were in good condition and there was no appreciable elongation, due to wear, in either the box or column-bolt holes in any of the bars. The dimensions of the failed bar, 1.0 inches in thickness and 4.52 inches in width, did not conform to present standards for 40-ton trucks, which are $1\frac{1}{4}$ by $4\frac{1}{2}$ inches or $1\frac{1}{2}$ by 5 inches. The break was new, the lines of fracture indicating that the initial break started on the under face, which showed a bruised or dented surface. As to the fit of the bar on the bearing face of the box, the bend had been so made that the change of contour for the bend started at the center of the box-bolt hole, instead of 1 inch from that location, and the result was a line contact bearing at the edge of the box. The top surface of the box showed old rust, not disturbed, with the edge of the box polished, indicating that the old arch bar might not have made full contact. Such a condition resulted in the stresses being concentrated locally, instead of being distributed over the arc of the bend as intended; the bend showed a radius of approximately 3 inches instead of the standard radius of $1\frac{1}{2}$ inches. The major bending apparently was made at the proper temperature. Damaging bruises and indentations, however, were made either in finishing the bending proper, doing this work at too low temperature, or in adjusting the bent sections to desired positions after cooling. The

chemical analysis of the bar showed it to be of a soft mild steel. These tests, as well as others made by the engineer of tests, resulted in his attributing the failure of the arch bar to any one or to the combined influences of the following conditions, (1) improper bearing of bar on oil box, having line contact at the edge of the box, (2) thermal stresses induced in manufacture, (3) stresses due to cold working and change of shape while below forging heat, (4) presence of distorted metal and indentations in the surface of the bar at critical points, and (5) the coincidence that the abrasions and indentations occurred at the same location, where the junction of abrupt changes in metal structure was present and he reported that the above conditions would be conducive to failure under stresses resulting from the contributing influences of weight of lading, speed, and track conditions.

Inspection of the track near the scene of the accident by the Commission's inspectors disclosed that there was a recent gouged mark, 18 inches in length, about 1 inch wide and one-fourth inch deep, 9 inches north of the gauge side of the north rail on the plank of a highway crossing located 1½ miles west of the point of accident. On a plank at a crossing 1 mile west of the point of accident there was a similar gouged mark, 3 feet 2 inches in length, similarly located. The north plank of the crossing just west of the point of accident was below the level of the running rail and at the time of this inspection it showed no marks, but the stock rail of the west house-track switch had been scraped on the inside of the bull for a distance of about 16 feet, and the spikes showed evidence of having been pulled by pressure brought on the rail. The first mark on this rail was 9 inches from the gauge side of the main track running rail. This inspection disclosed nothing irregular in maintenance of the track, nothing was found in the wrecked equipment, other than a broken arch bar, which could have contributed to the cause of the accident, and no marks were found on the track east of the point of accident. Inspection of the truck side which contained the broken arch bar developed that the lead column bolt was badly battered and worn, with every indication of having been striking for some distance. The box and column bolts were intact, tight, and secured by lock washers, and there was no evidence of the bolts having been loose previous to this time. Measurements of the truck side left no doubt that the marks described in the evidence, 9 inches north of the gauge side of the rail, were made by a column bolt.

Accident at Ottawa

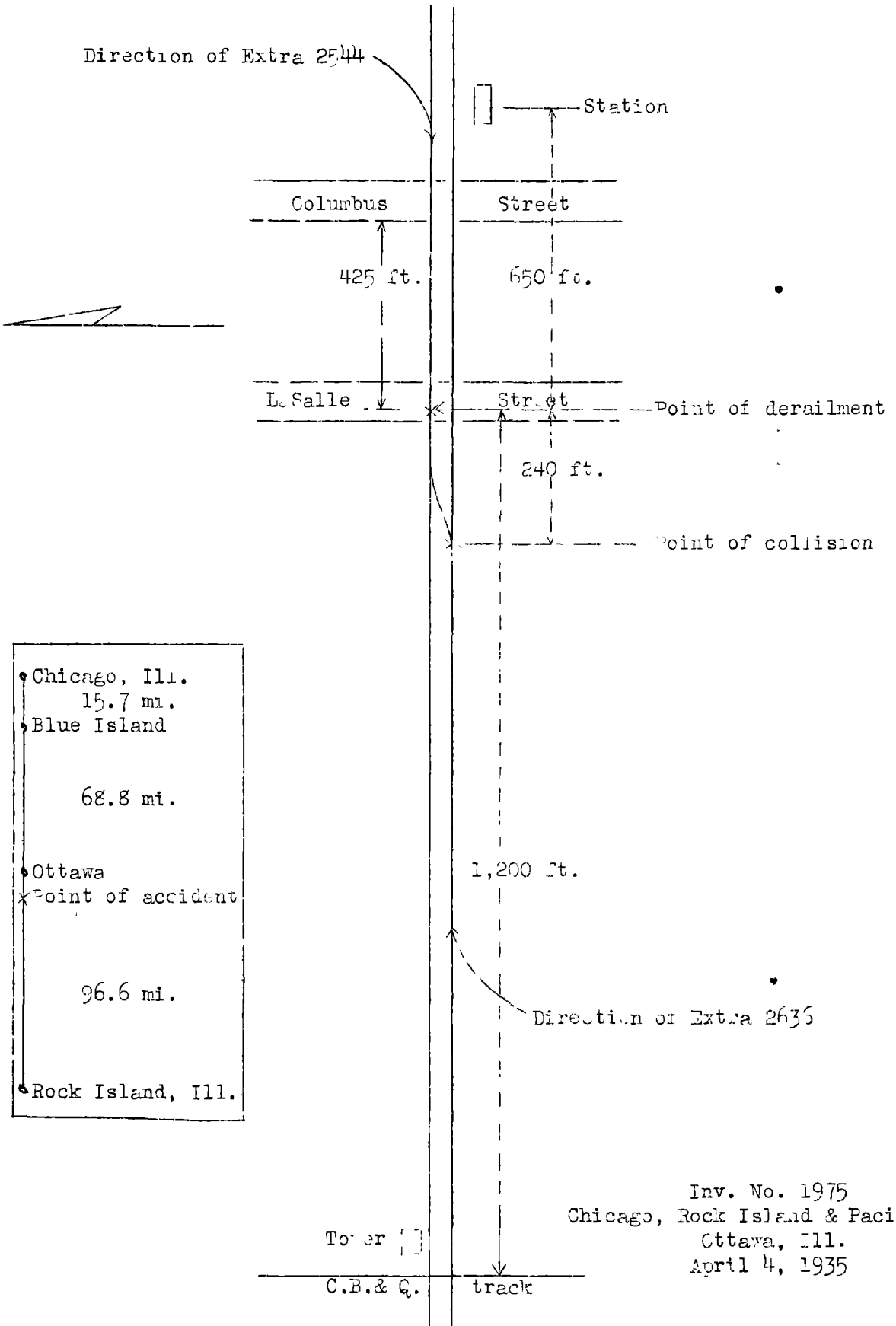
Location. This accident occurred on Sub-division 2 of the Illinois Division, which extends between Chicago and Rock Island, Ill., a distance of 181.1 miles; in the vicinity of the point of accident this is a double-track line over which trains are operated by time-table, train orders, and automatic block-signal and train-control systems. The derailment occurred on the west-bound track about 650 feet west of the station at Ottawa and the wreckage was struck by an east-bound train at a point about 240 feet farther west. In the vicinity of the point of accident the track is tangent for approximately 1 mile, the accident occurring at a point about 1,080 feet from the eastern end of this tangent. The track is level in the immediate vicinity of the point of derailment, and just west thereof the grade is 0.4 percent descending for east-bound trains for a distance of 500 feet. A cross-over connecting the two main tracks is located just west of the point of derailment, the east switch being a facing-point switch for west-bound trains.

The track is laid with 100-pound rails, 39 feet in length, with an average of 24 ties to the rail length, fully tieplated, and is ballasted with crushed gravel to a depth of 14 inches. The track is maintained in good condition. Through the city of Ottawa the speed of freight trains is limited by time-table rule to 20 miles per hour.

The weather was partly cloudy at the time of the accident, which occurred about 12:35 a.m.

Description. Extra 2544, a west-bound freight train, consisted of 27 cars and caboose, hauled by engine 2544, and was in charge of Conductor Diltz and Engineman Burgess. This train left Morris, 28.3 miles east of Ottawa, at 12.02 a.m., according to the train sheet, and was derailed shortly after passing the station at Ottawa while traveling at a speed variously estimated to have been between 30 and 35 miles per hour.

Extra 2636, an east-bound freight train, consisted of 53 cars and a caboose, hauled by engine 2636, and was in charge of Conductor Sutton and Engineman Wolff. This train passed LaSalle, 14.5 miles west of Ottawa, at 12:13 a.m., according to the train sheet, and collided with the wreckage of Extra 2544 at Ottawa while traveling at a speed estimated to have been about 20 miles per hour.



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Engine 2544 and the first 15 cars remained coupled and were not derailed. The sixteenth to the twenty-fifth cars, inclusive, were derailed; the sixteenth car stopped on the east-bound track near the west end of the cross-over, approximately 240 feet west of the point of derailment, while the other derailed cars in this train, with the exception of the twenty-fifth car, stopped in various positions beyond the sixteenth car, the twenty-fifth car stopping on the west-bound track opposite the sixteenth car. Engine 2636 was derailed to the right and stopped on its right side almost parallel with the track and just west of the sixteenth car in Extra 2544; the first eight cars in this train were derailed, six of these cars stopping at right angles to and on the tracks. The employees killed were the engineman, fireman and head brakeman of Extra 2636 and the employee injured was the flagman of the same train.

Summary of evidence. Engineman Burgess, of Extra 2544, stated that his train was approaching Burlington crossing, located about 1,200 feet beyond the point of derailment, when the air brakes were applied in emergency and about the same time the engine of the east-bound train passed his own engine; the speed of his train at that time was about 20 miles per hour. Fireman Brinegar thought the head portion of his train traveled about 300 feet after the brakes were applied in emergency, and said engine 2636 of the east-bound train passed just as his own engine was coming to a stop. Head Brakeman Drava stated that he inspected the train when the stop was made at Morris, walking back along the south side of the train until he met the rear brakeman; he then crossed over and inspected the cars on the north side, but found nothing wrong. His statements corroborated those of Engineman Burgess as to when engine 2636 passed them at the point of accident.

Conductor Diltz, of Extra 2544, stated that he was in the cupola of the caboose, looking out of the south window, and the first intimation he had of anything wrong was when he saw a signal given by the crossing watchman at LaSalle Street, in Ottawa, but the cars were being derailed before he could take any action. Conductor Diltz stated that when the stop was made at Morris, the only stop en route, he inspected the cars on the north side while the flagman inspected them on the south side, until they reached the fifteenth car from the engine, where they met the head brakeman; no defects were found and they then returned to the caboose.

Flagman Stringfellow, of Extra 2544, stated that he was on the rear steps on the south side of the caboose when passing the station at Ottawa and received a proceed signal from the operator. It was his opinion that only a few seconds elapsed between the time the derailed portion of his train stopped and the time it was struck by Extra 2330.

Conductor Sutton and Flagman Greene, of Extra 2533, stated that their train was traveling at a speed of about 20 miles per hour when the train stopped suddenly due to the impact.

Operator Hoekendoner, on duty at the station at Ottawa, which is located on the south side of the tracks, was standing on the station platform for the purpose of inspecting Extra 2544 as it passed. He noticed nothing wrong and gave a proceed signal to a member of the train crew in the caboose. He estimated the speed of this train to have been about 30 miles per hour.

Crossing Flagman E. L. Fish, on duty at Columbus Street, situated about 210 feet west of the station, stated that when about two-thirds of Extra 2544 had passed over the crossing he heard a noise and saw sparks flying from the rear trucks of a tank car, the sparks and fire increasing until he saw the cars pile up.

Crossing Flagman Robert Fish, on duty at LaSalle Street, about 400 feet west of Columbus Street, stated that as Extra 2544 passed he was on the south side and saw sparks flying and then saw the cars pile up. As the caboose passed him he gave the crew on the caboose signals to stop, and he said the caboose had just about stopped, west of the crossing, when he heard the crash of the east-bound train striking the wreckage. Both crossing flagmen estimated the speed of Extra 2544 to have been from 30 to 35 miles per hour.

Towerman Kerste, on duty at the interlocking tower located just east of the Burlington crossing, or about 1,200 feet west of the point of accident, stated that when the engine of Extra 2544 passed the tower the engine of the east-bound train was a short distance west of the tower. He estimated the speed of Extra 2544 to have been from 25 to 30 miles per hour but was unable to estimate the speed of the east-bound train as his view was obstructed.

Division Engineer Thompson arrived at the scene of the accident about 4 a.m., and after observing the position of the wreckage he made an inspection of the track and found a flange mark on the south rail of the west-bound track at LaSalle Street showing where a wheel had crossed over the rail.

Car Foreman Gregory stated that on his arrival at the scene he made an inspection of the track, for a distance of approximately three-fourths mile east of the point of accident. The first mark was on the south side of the west-bound track at Columbia Street crossing, indicating that a nut or something had been dragging. The heads of two journal box bolts were found lying from 9 to 12 inches from the south side of the west-bound track and about 4½ rail lengths west of the marks on the crossing planks. The next marks were at LaSalle Street crossing, there being no marks between the two crossings. There were flange marks on the ties from LaSalle Street crossing to the cross-over frog, apparently having been made by a slued truck. Examination of the rear truck of GCK tank 6474, the sixteenth car in the train, was made with Master Mechanic Kerwin. This was an arch-bar truck and the middle and top arch bars on the left side were bent upward; wood was found between the front column nut and tie strap and around the threads on the rear column bolt. The right side of this truck was damaged to some extent, and the general condition of the arch bars, sand plank, and truck bolsters showed corrosion due to age and acid. All column and journal-box bolts that remained intact were tight; the double-coil truck springs, however, showed evidence of the coils striking together and the arch bars were worn in places; there was no evidence of loose or hot wheels or hot boxes. The front truck of this car was damaged considerably, two of the arch bars being broken, but these were new breaks, and Car Foreman Gregory stated that in his opinion these breaks were a result of the derailment. It was his opinion that this accident was due to the breaking of the box bolts of the front left journal box of the rear truck, which allowed the truck to drop low enough for the column bolts to engage the crossing planks and finally derail the car, then the east end of the car followed the facing-point switch of the cross-over and resulted in the west end of the car also being derailed. Other officials of the railway agreed with this explanation of the cause of the accident.

Superintendent of Car Department Kass stated that there was evidence of the coil springs having been striking together, which in his opinion set up a stress in the truck, causing the journal-box bolts to break between the top and bottom arch bars, this allowed the truck to drop low enough to engage the crossing planks, and with the further sagging of the truck the brake rigging scraped the ties and on reaching the cross-over frog the truck became slued, resulting in its derailment.

Car Inspector Casey stated that he inspected GCX tank 6474 when it was received in interchange from the Belt Railway in South Chicago on the day prior to the accident, giving it class "A" inspection and that he used a mirror when inspecting the arch bars; he did not find any defects. This car was then given another thorough inspection by two car inspectors on its arrival at Blue Island and was again inspected by three other inspectors as Extra 2544 was being made up, and nothing wrong was found.

Inspection of the track by the Commission's inspectors disclosed the first marks to be at Columbus Street; these marks were on the crossing planks about 3 inches south of the south or left rail of the west-bound track and appeared to have been made by column bolts. Beginning just west of LaSalle Street and on the gauge side of the right or north rail, flange marks appeared on the ties, these marks following the lead rail of the cross-over but not striking it until the frog was reached, the frog was badly damaged. There was a mark on the south rail opposite the point where the flange marks on the ties started, which appeared to have been made by a wheel flange passing over the rail.

Engineer of Tests Sedrick's report of his examination of the trucks of GCX 6474 is summarized as follows: The initial failure occurred at the box bolts of the front journal box on the south side of the rear truck These bolts had sheared off at the bottom face of the top bar, and only the heads and lengths corresponding to the thickness of the top bar were found. The inside surfaces of the bolt holes, bearing surfaces of the bolts and nuts, and the contact surfaces between the bars, all showed normal corrosion, with no indication of the bolts having been loose or the parts working against one another. The nominal original diameter of these bolts was 1.25 inches, but due to corrosion the diameter had been reduced to 1.2 inches and 1.19 inches.

Chemical analysis showed one of the bolts to consist of a mild grade of steel, while the other was of iron with comparatively high manganese content, containing some steel material. The steel bolt would be considered as conforming to present requirements, while the iron bolt would not. As to the insufficient shear resistance of these bolts with this type of design, it is not felt that this deficiency could be attributed entirely to loss of material or quality (one bolt not being considered of first-class material); that is, the car construction committee have recognized the existence of inadequate shear resistance of this type of design at this location for some time past, recommending the use of higher grade material for box bolts, also a change in design of the end of the lower arch bar, to increase shear resistance. Examination of the springs showed appreciable reduction in outside diameter of the coils, due to corrosion. Without taking into account the corrosion product remaining on the springs, the loss in weight was from 8.32 to 16.4 percent less than the minimum allowed. Loss of solid height amounted to 21.9 to 36.6 percent below that shown by a new Class "D" spring. Faces of adjacent turns in the coil presented surfaces indicating that in the past the springs had been solid, but none of the springs showed permanent set after test. The above tests were on a static load basis and under shock conditions the margin of safety would be materially reduced, depending upon the severity of the shocks encountered.

The report of the engineer of tests concludes that this investigation would justify the conclusion that the structural collapse of this truck side frame was due to the contributing influence, under shock stress, of the reduced capacity of the springs and the insufficient shear resistance of the box bolts.

CCX tank car 6474 was built in June, 1911, and the tank proper was renewed in October, 1929; the light weight of the car was 43,600 pounds and it had a capacity of 100,000 pounds, or a liquid capacity of 6,502 gallons; at the time of the accident the car contained sulphuric acid having a weight of 91,800 pounds. The trucks were of the plain, non-lip, arch-bar type, the arch bars measuring $1\frac{1}{2}$ by 5 inches, and journals $5\frac{1}{2}$ by 10 inches. The repair records show that new wheels were applied to this truck November 29, 1934, by the Indiana Harbor Belt Railroad at Blue Island, Ill., and the examination of the damaged truck showed they were applied at the R and L-2 location, this being on the end of the truck which failed.

Discussion

The arch bar which failed in the Tiffin accident was applied the day prior thereto and the failure occurred after the car had traveled only 38 miles, as evidenced by marks which were found along the track for a distance of approximately 36 miles west of the point of derailment. At Marengo, about 3 miles east of where the first marks were found, a car was set out and the head car, M&StL box 20302, the one which had the broken arch bar, remained coupled to the engine while this movement was being made, and the train crew had an opportunity to see or hear the column bolt strike the rails at the cross-over switch, but nothing of this kind was noticed. Between Marengo and Tiffin, the head brakeman and fireman were in favorable positions on the engine to detect the trouble, and the fireman of the second engine, located 9 cars back of the leading engine, also had an opportunity to see evidence of dragging equipment on that side of the train, although his view was somewhat obscured by smoke and dust, however, none of these employees noticed anything wrong until the derailment occurred.

According to the report of the engineer of tests, it appears that this arch bar had not been accurately or properly shaped and its failure could be attributed to the improper bearing of the bar on the oil box, causing the stresses to be localized at the edge of the box instead of being distributed as intended, to thermal stresses, to stresses due to cold working, to distorted metal and indentations in the surface of the bar at critical points, or to the fact that abrasions and indentations occurred at the location of the junction of abrupt changes in metal structure, or to a combination of these factors.

Attention is called to the fact that when renewing the bottom arch bar at Valley Junction on April 2, a bar was used which measured 1⅝ by 4½ inches, whereas under the Manual of Standard and Recommended Practice, Mechanical Division, Association of American Railroads, issue of 1935, it is provided that for 40-ton trucks the arch bars shall be either 1¾ by 4½ inches or 1¼ by 5 inches; this manual further provides that when it becomes necessary to renew an arch bar, and the construction of truck and car body will permit, it shall conform to these requirements. Not only did the arch bar as renewed fail to conform to this standard, but the engineer of tests pointed out that damaging bruises and indentations were made either in finishing the bending proper

or in adjusting the bent sections to the desired positions after cooling. These facts, coupled with the improper bearing of the arch bar on the oil box, are evidence of careless shop work which played a prominent part in the failure of the truck in question.

In the Ottawa accident, it appeared that the truck failed immediately prior to the accident, with no opportunity being afforded for detecting the failure or stopping the train before the accident was precipitated. The investigation made by the engineer of tests regarding the structural collapse of the truck side frame of GCX tank 6474 showed that one of the box bolts involved was of steel but that the other was of iron, containing some steel material and did not conform to present requirements, and while his report stated that the insufficient shear resistance could not be attributed entirely to loss of material or quality, yet he reached the conclusion that the failure was due to the contributing influence, under shock stress, of the reduced capacity of the springs and insufficient shear resistance of the bolts. The investigation showed that new wheels had been applied to this end of the truck on November 29, 1934, at which time the bolts had to be removed to permit the work to be done.

Figures furnished by the Chicago, Rock Island & Pacific Railway show that of a system total of 40,905 freight cars, exclusive of ballast, caboose and miscellaneous work equipment, as of January 1, 1935, there were 8,858 cars, or 21.6 percent, equipped with arch-bar trucks. Of this number, 3,109 have been set aside for dismantling, as of April 15, 1935. There are 221 additional cars to be set aside for dismantling during the current year and the estimated number of cars to be set aside in addition to those scheduled for dismantling is 1,500. It is expected that 50 cars will be equipped with steel truck sides, leaving at the end of 1935 a total of 4,978 cars equipped with arch-bar trucks. It also was stated that with the exception of 911 box and 245 stock cars, all cars equipped with arch-bar trucks are scheduled to be removed from revenue service within the next 3 years. As of January 1, 1935, this railway reported 21.6 percent of its freight cars equipped with arch-bar trucks, as against a total of 32.5 percent for all railroads and private car lines. With respect to engines it appeared that 90 engines having arch-bar tender trucks are now out of service and will be retired during the present year, as follows: Switch, 7; freight, 23; passenger, 60. After allowing for these retirements, the situation on the system will be as follows:

	Switch	Freight	Passenger	Total
Number of engines	319	735	221	1275
Number with arch-bar tender trucks	175	337	137	649
Percent equipped with arch-bar trucks	54.86	45.85	61.99	50.90

In the report upon an accident on the Missouri Pacific Railroad at Cunningham Spur, Ark., on February 25, 1935, it was stated that during the year 1934 the number of arch-bar trucks repaired on that road amounted to 6,467 and that arch-bar trucks caused 59 accidents during the same period; the cost of repairs was $90,397.00, while the accidents represented a cost of $93,420.00, or a total expense for these two items amounting to $183,817.00. On the Chicago, Rock Island & Pacific Railway a record is not maintained covering the cost of repairs to arch-bar trucks; the number of such trucks repaired in 1934, however, amounted to 7,325, and if the cost per truck averaged the same as for the Missouri Pacific, then the repairs to these 7,325 trucks cost the company slightly more than $100,000.00. This figure, when added to the expense of $31,732.00 which was involved as a result of the 13 arch-bar truck accidents said to have occurred on this railway in 1934, indicates a total expense for the year which was well in excess of $130,000.00 The two accidents here under investigation were even more expensive; they resulted in the loss of three lives and in an estimated damage of $53,584.00, exclusive of damage to lading.

These figures represent the expense to only two railroads occasioned by the use of trucks which have shown structural weakness sufficient to stamp them as being of improper design. In addition to improper design, there are other important factors in the failure of arch-bar trucks, such as weight of load, speed, and track conditions. The trend is toward higher speed levels; increased rates of speed necessarily result in increased stresses due to shock, thus presenting two factors, improper design and higher speeds, which can be offset only by a material reduction in load limits as long as arch-bar trucks are in use.

The elimination of arch-bar trucks, however, is the real remedy; progress along this line is not restricted because of any lack of better trucks - better and safer trucks are available and have been in extensive use for many years, and some railroads have entirely removed the arch-bar type of truck from their own equipment. Other railroads, however, by repairs and replacements, amounting in some instances almost to complete renewal, have continued in service trucks of this type in practically undiminished numbers, thereby wasting their own resources and causing serious damage losses not only to themselves but also to the more progressive lines which receive such equipment in interchange and thereby incur risk of accidents caused by the failures of such trucks. In the case of the two disastrous accidents here under investigation, which occurred on the line of a railway making definite progress in eliminating arch-bar trucks, neither of the cars involved was a system car; faulty repair work, however, contributed to the occurrence of one of the accidents, and thus emphasizes the need for giving increased attention to the question of repairs, as well as to complete elimination. It is common practice for carriers to place a limit on repairs which may be made to cars, which on account of age, condition, design, or adaptability, are not suited for present day service, the repair limit for arch-bar trucks should be low enough to prevent extensive renewals or rebuilding of trucks of this type.

The facts disclosed by these investigations direct attention to the necessity for adhering strictly to prescribed standards when making repairs to arch-bar trucks. In the Tiffin accident the material used for the shaping of a new arch bar was not of the proper size, while the actual work of shaping it was not done with that degree of care and accurracy which must be followed in all work on arch-bar trucks if the introduction of additional dangers is to be avoided. In the Ottawa accident the evidence indicated that one of the bolts was not of the proper material, while it appeared also that the capacity of the coil springs had been reduced to the extent that they did not provide an adequate margin of safety. These various factors were important in leading to the occurrence of the accidents in question and serve to emphasize the fact that when making repairs the utmost care and vigilance must be used to see that the requirements which experience has shown to be essential to safety are observed.

Conclusions

The accident at Tiffin was caused by a broken arch-bar and the accident at Ottawa was caused by the collapse of the side frame of an arch-bar truck.

Recommendations

1. That arch-bar trucks be removed from service at the earliest practicable date.

2. That until arch-bar trucks can be eliminated from service, a reduction of at least 30 percent should be made in the permissible load limit on cars equipped with such trucks.

3. That provision be made in interchange rules whereby a receiving line may refuse to accept from a connecting line any car equipped with arch-bar trucks.

Respectfully submitted,

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Director.