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INTERSTATE COMMERCE COMMISSION

REPORT OF THE DIRECTOR OF THE BUREAU OF SAFETY IN RE INVESTIGATION OF AN ACCIDENT WHICH OCCURRED ON THE PENNSYLVANIA RAILROAD NEAR SPRUCE CREEK, PA, ON APRIL 17, 1931

JUNE 8, 1931

TO THE COMMISSION

On April 17, 1931, there was a derailment of a freight train on the Pennsylvania Railroad near Spruce Creek, Pa the wreckage being struck by an opposing passenger train on an adjacent track, which resulted in the death of 2 employees and the injury of 34 passengers and 3 employees The investigation of this accident was made in conjunction with a representative of the Public Service Commission of Pennsylvania

LOCATION AND METHOD OF OPERATION

This accident occurred on that portion of the Middle Division extending between BO Block Station near Altoona, Pa, and NC Block Station, west of Harrisburg, Pa, a distance of 123 1 miles This is a 3-track line west of Spruce Block Station for a distance of 6 8 miles, the tracks being numbered from south to north, 1, 2, and 3, from Spruce Block Station eastward there are 4 tracks, numbered from south to north, 1, 2, 3, and 4, over which trains are operated by time-table, train orders, an automatic block-signal system, and an automatic train-stop and cab-signal system of the continuous coder type

Spruce Block Station is located at a point 2,256 feet east of the passenger station, and is the point at which the 3-track line changes into a 4-track line The switches and signals governing the routes at this point are controlled by an interlocking machine located in the block station The first flange mark was on track 1 at a point 491 feet east of Spruce Block Station, while the wreckage was about 513 feet farther east Approaching the scene of accident from the west, the track is tangent for a distance of 758 feet, followed by a compound curve to the left 1,558 feet in length, ranging from 1° 15′ to 2° 45′, and then 1,184 feet of tangent track, this tangent track continuing on the eastbound tracks for some distance, and the derailment occurred on the last-mentioned tangent track, 389 feet from its western end Approaching from the east on the westbound

tracks, there is tangent track for a distance of 3,225 feet, followed by a 1° 15′ curve to the right 748 feet in length, and then 1,184 feet of tangent track, on which the passenger train struck the wreckage of the freight train The grade is generally descending for eastbound trains, being 0 47 per cent in the vicinity of the accident

At a point 1,030 feet east of the wreckage there are two tunnels, eastbound tracks 1 and 2 pass through the south tunnel, 1,150 feet in length, while westbound tracks 3 and 4 pass through the north tunnel, 1,050 feet in length Due to a change of line these tunnels, which are 90 feet apart at the west portals, are 288 feet apart at the east portals There is a path through the wooded section around the foot of the hill at the east end of the tunnels, and the distance from track 2 to track 4 by this path is approximately 440 feet

The track is laid with 130-pound rails, 39 feet in length, with 22 treated oak and pine ties to the rail-length, fully tie-plated, and ballasted with rock to a depth of 22 inches The gage and elevation of the track are uniform and the track is well maintained

The weather was clear at the time of the accident, which occurred about 9 12 p m

DESCRIPTION

Eastbound freight train extra 6944 consisted of 108 loaded cars, 14 empty cars, and a caboose, hauled by engine 6944, and was in charge of Conductor Gay and Engineman Weld This train passed Forge Block Station, 6 4 miles west of Spruce Creek, at 8 54 p m, and was derailed while passing through the crossover from track 1 to track 2 near Spruce Block Station while traveling at a speed estimated to have been from 15 to 18 miles per hour.

Westbound passenger train No 21 consisted of 1 combination baggage car and coach, 3 coaches, 1 dining car, 1 sleeping car, 1 parlor car, and 1 sleeping car, in the order named, all of steel construction, hauled by engine 6882, and was in charge of Conductor Greene and Engineman Keane This train, traveling on track 4, passed Petersburg, 5 9 miles east of Spruce Creek, at 9 06 p m, three minutes late, and collided with the wreckage of extra 6944 while traveling at a speed estimated to have been 50 or 55 miles per hour

The rear truck of the forty-fifth car and the forty-sixth to the forty-ninth cars, inclusive, in the freight train were derailed The forty-sixth and forty-seventh cars came to rest across tracks 1 and 2 in an upright position, and the forty-eighth car came to rest on its side on track 3 with its rear end leaning toward track 4, while the forty-ninth car was partly tipped over in a diagonal position on track 3 with its left front corner fouling track 4 The fiftieth and fifty-second cars were slightly damaged, but were not derailed Engine 6882, of train No 21, came to rest on its right side on the shoulder

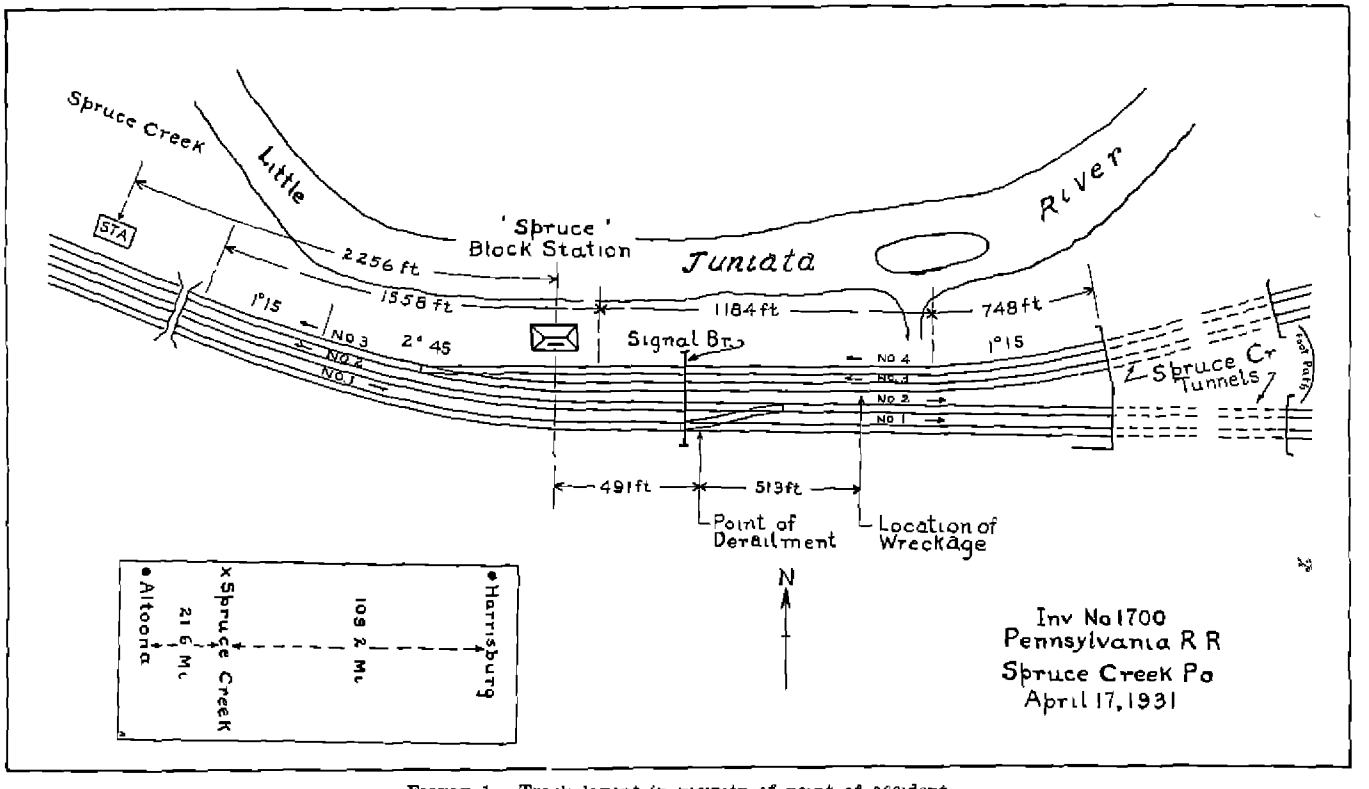

FIGURE 1.—Track layout in vicinity of point of accident

of the fill about 200 feet beyond the point of collision, with its front end about 30 feet and the rear end about 5 feet from track 4, the tender came to rest in reversed position at the foot of the embankment along the bank of the river about 25 feet below the track The first car remained upright, but at a right angle to the track with its front end down the embankment and the rear end suspended over track 4 The second and third cars and the front truck of the fourth car were derailed, these cars remained practically upright, however, and none of the remaining equipment was derailed or damaged The employees killed were the engineman and fireman and those injured were the brakeman, baggageman, and a dining-car employee, all of the passenger train

SUMMARY OF EVIDENCE

Engineman Weld, of extra 6944, stated that after picking up the front portion of his train at GD Block Station, Altoona, he proceeded to Antis, 2 7 miles from GD and 17 6 miles west of Spruce Creek, where he coupled to the rear portion of his train, the brakeman informed him that the air brakes were working on all of the cars and he instructed the brakeman to set up 14 retaining valves The air brakes worked properly when he made several applications at various points between Antis and the point of the accident, and he noticed nothing about the operation of his train that would indicate there was anything wrong He applied the air brakes when his train was diverted from track 1 to track 2, and the train seemed to run smoothly when passing through the crossover, but when the engine had reached a point slightly over halfway through the tunnel the air brakes applied in emergency and the train came to a stop with the engine about two or three car lengths from the eastern portal of the tunnel The fireman immediately got off the engine, proceeded to the portal, and crossed over to protect the westbound tracks Engineman Weld stated that he did not know what had occurred until the fireman returned sometime later and told him that train No 21 had collided with the wreckage of their train Engineman Weld estimated the speed of his train at the time the brakes applied to have been about 15 miles per hour

Fireman Olewine, of extra 6944, stated that when the air brakes applied in emergency he felt a push from the rear end, he immediately grabbed his lanterns and fusees, got off the engine before it stopped, just inside the east portal, and started toward the north tunnel to protect the westbound tracks He saw the reflection of the headlight of train No 21 as it approached through the cut and ran as fast as he could, swinging his lanterns and shouting, but just as he reached track 3 the engine tender was going into the

tunnel and soon afterwards he heard the crash of the collision He remained at that point to protect other westbound trains, later flagging a freight train on track 3 Fireman Olewine stated that he consumed about 1½ minutes from the time he left his engine until he reached track 3, and he estimated the speed of train No 21 to have been 45 or 50 miles per hour as it passed him He did not see anyone on the engine, the blower was on, and steam and smoke were coming down over the left side of the train Fireman Olewine further stated that when his engine passed through the crossover he noticed nothing unusual, he was looking back over his train until the engine entered the tunnel, stating that he could see back a distance of about 60 or 70 car lengths, and he did not notice any sparks flying except from the first few cars, due to the retainers He estimated the speed of their train to have been about 15 miles per hour just prior to the occurrence of the accident

Brakeman Everhart, of extra 6944, who was riding on the eighth car, said he made an inspection of the train on the curves, looking on both sides, and did not notice anything unusual at any time He stated that the train was traveling at a speed of about 15 miles per hour when he felt a surge and the train stopped suddenly

Conductor Gay, of extra 6944, stated that the air brakes were reported in good condition and a road test was made at Antis He rode on the right side of the caboose and had a good view of the cars ahead as they rounded curves, but did not notice fire flying at any time When the train came to a stop at Spruce Block Station it appeared to be an ordinary stop, as though it had been made with the straight air, although one red light in the caboose was knocked out He estimated the speed of his train to have been about 18 miles per hour Conductor Gay further stated that he made an inspection of the train after the accident, but was unable to determine the cause of the derailment

The statements of the surviving members of the crew of train No 21—Conductor Green, Brakeman Gipple, Flagman Stoner and Baggageman Rung—were to the effect that their train was being operated at a speed of from 50 to 55 miles per hour approaching the point of accident, and none of them noticed an application of the air brakes before the collision occurred

Operator Espy, on duty at Forge Block Station, 6 8 miles west of Spruce Block Station, stated that he observed extra 6944 as it passed his station at a speed of about 25 miles per hour and noticed nothing unusual

Operator Steele, on duty at Spruce Block Station, stated that approximately one-third of extra 6944 had passed when he saw sparks flying from a dozen or more cars, caused he thought either by the brakes sticking or an application of the brakes As the train came

to a stop he knew something was wrong and then saw that the indicator light on track 3 was dark, although he did not have a report of an approaching train on that track He knew that train No 21 was approaching on track 4, however, and attempted to restore the home signal west of the wreckage, to the stop position, thereby giving the engineman on train No 21 a caution-slow-speed indication on the cab signal, but he did not think it registered as he heard the crash of the collision almost immediately

Master Mechanic Chaffin stated that he arrived at the scene of the accident approximately 1 hour and 15 minutes after its occurrence Inspection of the track at a point 700 feet west of the switch point of the crossover leading from track 1 to track 2 showed an indication of some object having come into contact with the south ends of the ties, this mark was very slight at first, but continued to be more pronounced up to the switch point at the west end of the crossover At a point 53 feet east of the switch point there were wheel marks on the ties, and east of that point the marks indicated that the object first causing the marks on the ends of the ties was then between the rails of track 1, gradually coming closer to the north rail of that track Examination of the equipment disclosed a journal broken off on the right or south side, about 2½ inches from the wheel fit, of the lead axle of the front truck of the forty-seventh car The trucks of this car were equipped with cast-steel truck sides and there was no indication of the bearing on this particular pair of wheels having heated, as the sponging as well as the journal bearing were apparently in good condition, and the various parts were cold The cast-steel truck box, which is part of the truck side, evidently after the journal had broken off, came into contact with the stub end that extended out past the wheel fit and the two metals coming together showed indications of heating, but that portion of the journal remaining in the box was intact and after removal showed no indication of heating A later inspection at East Altoona disclosed a fracture close to the fillet, approximately 2½ inches from the outside edge of the wheel, and extending the entire circumference of the journal, an area about 1½ by 1⅝ inches in size appeared to be a recent fracture, the outside edge of this area was about seven-eighths of an inch from the outside circumference of the journal The initial fracture was entirely concealed by the journal box, making it impossible to detect it by inspection unless the truck was dismantled This truck was equipped with a standard A R A axle, 5½ by 10 inch journal The wheels mounted on this axle were in place and in good condition, with no indication of being loose on the axle Examination of the other equipment in this train disclosed no defects that could have contributed to the

occurrence of this accident, and Master Mechanic Chaffin was of the opinion that the accident was due to the failure of this journal Inspection of engine 6882, of train No 21, indicated that the pilot beam and front frame casting on the left side, as well as the front end of the cylinder on the left side, had come in contact with the wreckage while the engine was traveling at a good rate of speed, and Master Mechanic Chaffin said it was possible the car extended sufficiently northward to foul track 4 without coming in contact with the rails and thus not operating the signals He also said there was nothing to indicate that the engine equipment of the train-stop device was not in proper working order

Car Inspector Locke stated that he made a few minor repairs on some of the cars in the train of extra 6944, and the records showed that he inspected the car involved in this accident He raised the journal box lids on all of the cars and stated that if there had been a fracture in the journal, 10 or 10½ inches from the face of the journal, he would not have been able to detect it by ordinary inspection

The statements of the other car inspectors, gang foremen, and a car oiler who inspected extra 6944, were to the effect that the air brakes on all the cars were working properly, that the car directly involved had been carefully inspected, and that a fractured journal, similar to that which existed on this car prior to the accident, could not have been detected by ordinary inspection

The first mark on the track was at a point 234 feet west of Spruce Block Station, or 708 feet west of the crossover, and indicated that something had been dragging, a nut on the south side of the south rail had been broken off, and numerous bolts on the following joints, as well as spikes, were damaged or broken At a point 54 feet east of the first mark there was a mark on a tie about 10 inches south of the south rail, and another tie 10 feet beyond was similarly marked, from this point eastward various ties, spikes, bolts, and all splices bore evidence of having been struck by some dragging part of the equipment Approximately 725 feet east of the first dragging mark there were flange marks on the north side of track 1, indicating that the wheels were first derailed at that point, flange marks were also found on the base of the left-hand switch point, between the switch point and the stock rail, there was a mark on the heel block and the heel had been forced out of position, the next mark was a deep flange mark on the receiving end of the rail immediately east of the heel of the switch point Flange marks were then found on the ties and at the base of the gage side of the south rail of track 2, marks indicating a dragging truck frame were on the ties on the gage side of the north rail of track 1, these marks continuing to the point where the derailed cars finally came to rest, 513 feet beyond, or 1,238 feet east of the first mark of dragging equipment

Inspectors of the Bureau of Safety examined all the equipment involved The broken axle was on the forty-seventh car, PRR 202243 This car was a steel hopper, built in October, 1899, and had a capacity of 100,000 pounds and a load limit of 130,800 pounds, it was equipped with cast-steel truck sides of the Bettendorf type, ARA "D" type axles with 5½ by 10 inch journals The car was loaded with 103,000 pounds of bituminous coal The broken axle was the lead axle of the front truck and the wheels mounted on this axle were in place Examination of the broken ends of the axle after the wheels had been removed disclosed the condition described by the master mechanic, there was an old fracture close to the fillet, approximately 2½ inches from the outside edge of the right or south wheel, and this fracture extended the entire circumference of the axle and covered nearly 90 per cent of the cross-sectional area, an area about 1½ by 1¾ inches indicated a very recent fracture, the outside edge of this area being about seven-eighths inch from the outside circumference of the axle

Further examination was made of the broken axle by the test department of the railroad company at Altoona, Pa, and the following report was made to Chief of Motive Power Hankins under date of April 20, 1931

We received the complete axle with wheels mounted The failure had occurred near the root of inside journal fillet The axle was a PRR axle, turned center portion, inspector's marking "39" (inside of Keystone) on one end, the other end showing the markings "SO–107" The wheel bore the following markings "NYO & WRY 171528–750 lbs—11–21–27—S220" This wheel was on the side of the failed journal and showed no defective condition The other wheel was marked "NYO & WRY—171593–750 lbs—11–21–27—S220", a small portion of the flange was broken out, this was, however, secondary

The back collars on the axle were turned very narrow, three eights of an inch wide, and are badly rusted No identification as to the manufacturer could be found on this account The markings available are insufficient to identify the axle with any manufacturer The fracture of the axle remaining in the wheel was badly burned, caused by friction subsequent to the accident. The original failure, as represented on photograph T–23495, showed a 90 per cent detail fracture evidently started from the entire periphery The view below this fracture shows rough turning marks in the fillet portion This condition of rough turning existed on both journals on this axle

Tensile test specimens prepared from the journal portion, near the surface and near the center, showed the following figures

	Pounds per square inch		Elongation in 2 inches	Reduction of area
	Elongation limit	Ultimate strength		
			Per cent	*Per cent*
1	37,750	71,300	25	40 27
2	37 050	73, 000	26	43 00

These results indicate a good quality of material

Chemical analysis, while slightly low in manganese, verifies the uniformity and good quality of the steel, the results obtained being shown herewith

	"O"	"M"		"O"	"M"
Carbon	0 448	0 413	Silicon	0 009	
Manganese	37		Sulphur	036	
Phosphorus	006				

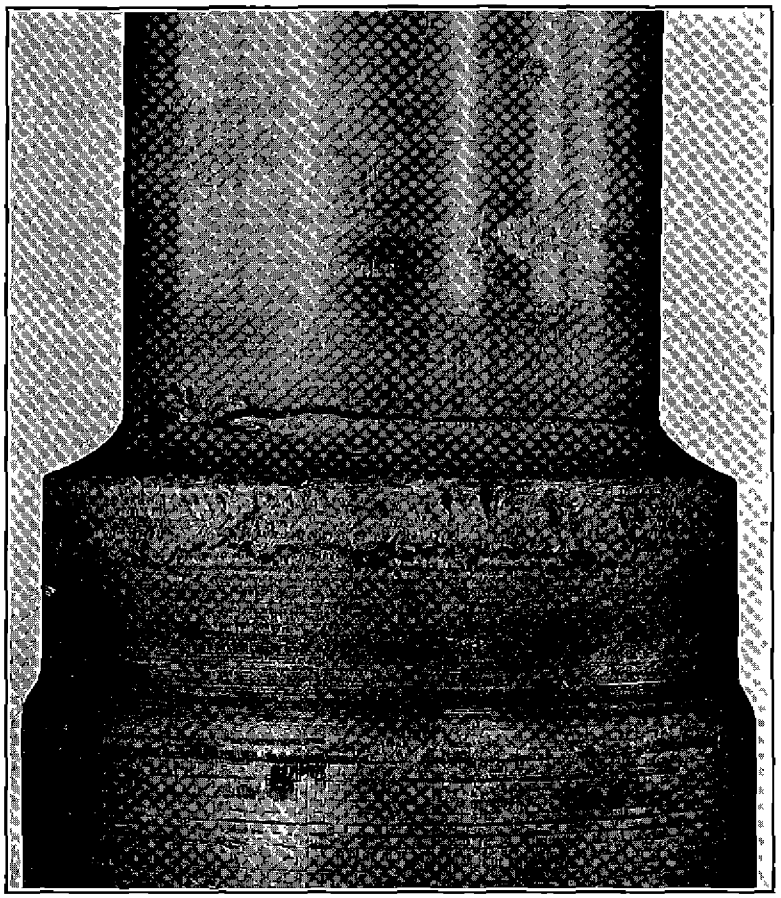

FIGURE 2.—Appearance of surface of welded fillet after etching with 10 per cent nitric acid

Macroscopical examination at the location of the fracture showed that this axle had been welded in the fillet location as indicated by the dark areas shown on photograph T–23496 (magnified 2 diameters), pointed out by arrow. The rough tool marks which have cut below the bearing area of the journal were evidently produced at the time of smoothing out the welded fillet which also points out that this welding was done after this axle had been in service for

some time, and was probably used to restore the worn journals to their original nominal length

The origin of the detail fracture with ragged areas around the entire circumference is typical of failures resulting from welding of axles, and the failure was solely due to this welding

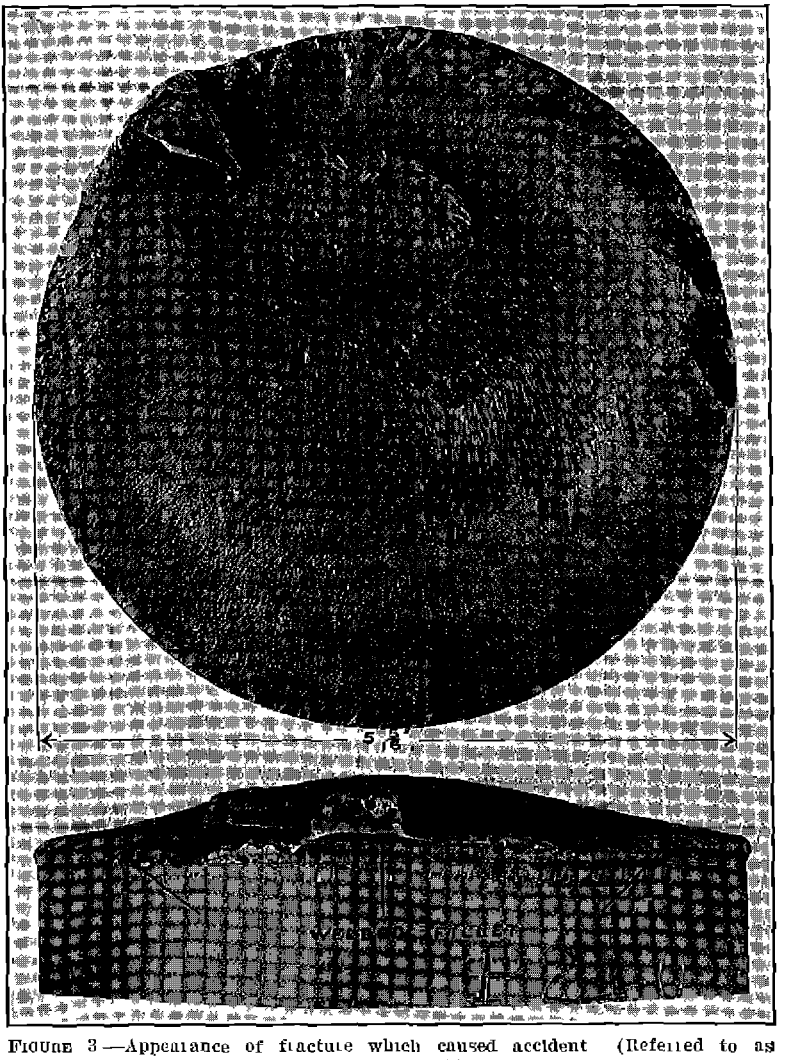

FIGURE 3.—Appearance of fracture which caused accident (Referred to as photograph T–23495)

Longitudinal etching through the entire length of the opposite journal including part of the wheel seat is shown on photograph T–23497 This side of the axle also shows that the fillet adjacent to the wheel seat had been built up by electric welding

Investigation to develop when and where the failed axle was welded resulted substantially as follows The wheels which were on

the axle at the time of its failure were mounted on a secondhand axle at the Norwich (N Y) shops of the New York, Ontario & Western Railway on March 1, 1928, and applied to PRR car 199765 at Oneida, N Y, on March 6, 1928 This axle and wheels remained under that car until November 21, 1930, at which time the arch-bar trucks were changed to trucks with cast-steel truck side frames at Mahoningtown (Pa) shop, on the Pennsylvania Railroad Three

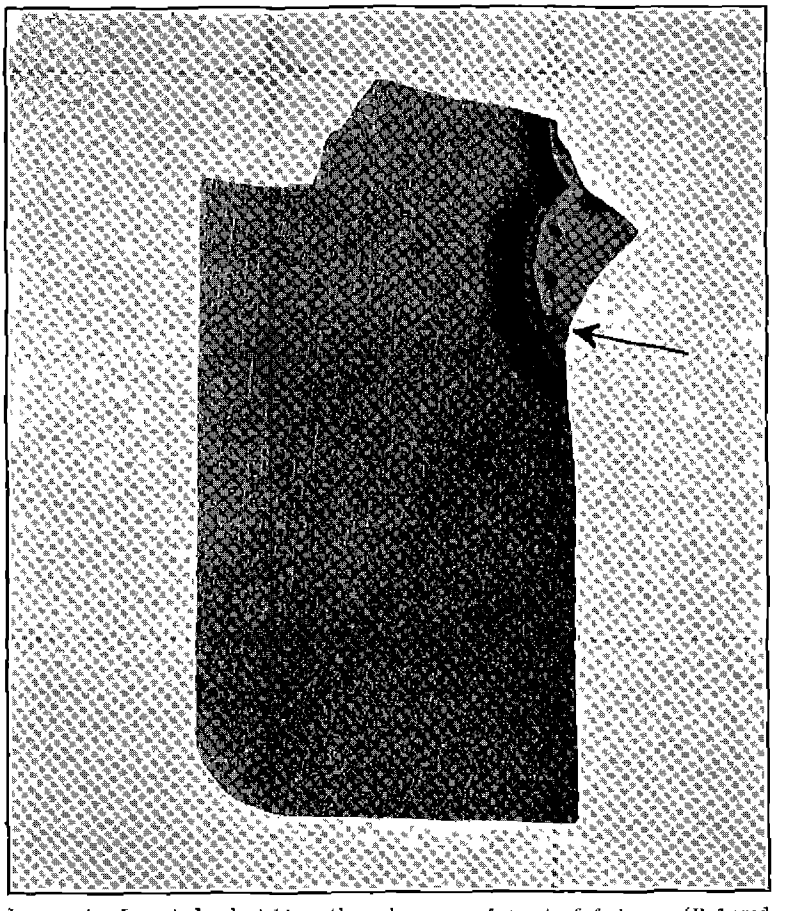

FIGURE 4.—Longitudinal etching through origin of point of failure (Referred to as photograph 1–23496)

days later the axle in question, together with the wheels, was placed under PRR car 202243, which was also in the shops for changing arch-bar trucks to trucks with cast-steel truck side frames, no work being done on the axle or wheels while in the shop, and checking of the records further indicated that no work was done subsequent to that time, either on the axle or wheels, up to the time of the accident Inquiry was made of the New York Ontario & Western Railway,

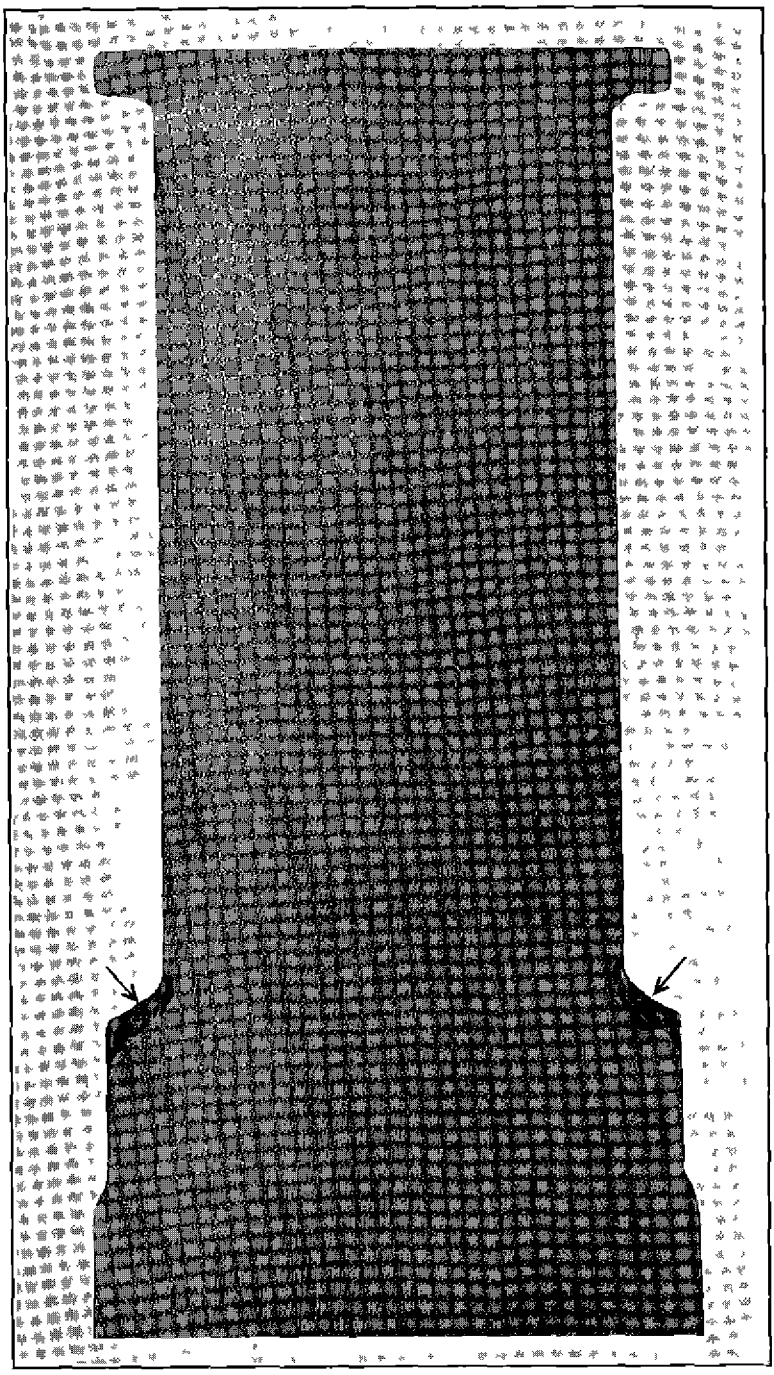

FIGURE 5.—Longitudinal etching through journal at opposite end of broken axle (Referred to as photograph T–23497)

and the following statement was made by Superintendent of Motive Power Flory, of the New York, Ontario & Western Railway, in a letter to Mr Hankins under date of April 27, 1931

Some time ago, we electric welded axles at journal fillets, which, however, was discontinued about September, 1927 It is possible, of course, that this axle might have been welded at our shops, but the probability is that it was not, for the reason that we keep only a comparatively small supply of axles, and do not believe we would have this axle in stock from September, 1927, to March 1, 1928, nor do our records show where this axle came from before it was in our stock at that time

Under date of May 21, 1931, the mechanical division of the American Railway Association issued a circular, No D V 728, based on the occurrence of the accident here under investigation This circular quotes from that part of the report made by the railroad's test department to Mr Hankins, wherein the results of tensile tests and chemical analysis are given, and then goes on to state as follows

The road on which the accident occurred had never welded axles and the pair of wheels and axle were applied in interchange on some other railroad

The 1924 report of the committee on autogenous and electric welding prohibits the welding of steel and steel tired wheels, rolled steel wheels and the building up of axles by the welding process, with the exception of building up of end collars where practically no stresses occur, and the following is quoted from the report of this committee

"Axles A similar condition of structural transformation due to the welding heat, exists on axles where the carbon ranges above 0 30 per cent Plates E and F represent longitudinal sections through the journal end of axles on which worn fillets had been built up by means of the electric and gas welding processes, respectively, without preheating or annealing subsequent to welding

"The transformation in structure with corresponding internal stresses at points in an axle where bending stresses of any magnitude occur, will readily permit development of detail fractures, and welds can, therefore, not be permitted on any part of the axle, with exception of the building up of end collars where practically no bending stresses exist Such welding may be done without preheating or annealing by the electric welding method The gas method is not recommended unless it is controlled so as to avoid the possibility of excessive heating during welding, which may, if not properly controlled, cause the transformation of the structure at the point where bending stresses occur "

The interchange rules prohibit the welding of steel and steel-tired wheels, rolled steel wheels and axles in accordance with this committee's report

The welding of axles at any point except the building up of worn collars at the end of journals has long been recognized as bad practice and this case is brought to the attention of all members of the association as an illustration of the serious consequences that may result from failure to observe existing rules which prohibit such practices

It is also imperative to remove from service, as promptly as possible, all axles that may have been welded in the fillets of the journals It is difficult to detect such welding and, therefore, the following method for inspection of journals when they are out from under the cars for wheel exchanges and when going through the wheel shop should be placed in force

(*a*) The journal fillets on all wheels should be inspected for porosity in the fillet If there is any indication of such a condition, a 10 per cent solution of nitric acid in water applied to the fillet will show dark areas at the junction between the welding metal and axle base material which is a positive proof of existence of welded material The nitric acid solution should be carefully wiped off on such axles which do not show the dark areas and which are continued in service

(*b*) Lathe operators in truing up journals should be instructed to observe the character of the chips when turning the fillet On welded material, the chips will be short and ragged

(*c*) Any axles which show indications of having been welded in any manner (except the building up of end collars) must be destroyed, so that there will be no possibility of such axles becoming mixed with good secondhand axles and being subsequently used

CONCLUSIONS

This accident was caused by the failure of a fusion-welded axle on the front truck of the forty-seventh car in extra 6944

According to the statements of the crew of extra 6944, nothing unusual was noted until the air brakes applied in emergency Subsequent to the accident the front truck of the forty-seventh car was found with a broken axle, this break occurring close to the fillet, approximately 2½ inches outside of the edge of the right lead wheel, 90 per cent of the break represented an old defect Examination of the broken journal and bearing, as well as the packing in the journal box did not show any indication of heating The first marks in the track, indicating that some part of this truck had been dragging, were found at a joint on the outside of the south rail of track 1 at a point 1 238 feet west of where the derailed cars stopped, these marks continuing intermittently for a distance of 725 feet, at which point the truck apparently became derailed to the left as it entered the crossover leading from track 1 to track 2, resulting in its being entirely derailed, followed by the derailment of other cars and the fouling of the track on which train No 21 was approaching

It appears that as soon as extra 6944 came to a stop, or as it was coming to a stop, the fireman got off and attempted to flag the crew of the approaching train, but he was unable to reach the north tunnel before the engine of that train entered it The operator at Spruce Block Station likewise attempted to give the crew of train No 21 a warning by changing the home signal to the stop position, thereby giving the engineman a caution cab indication, but the collision occurred almost immediately after he had operated the lever governing that signal

Building up fillets of worn axles by the welding process has been prohibited by the American Railway Association rules of interchange since 1924, and that association has by circular above referred to

directed attention of all member roads to this case of violation of its rules and the accident which followed It has also directed attention to the imperative need for promptly removing from service all axles now in service which may have been welded in the fillets of the journals and has outlined a special method of inspection to discover such axles The association is to be commended for the prompt and vigorous action which it has taken in this case

All of the employees involved were experienced men, and at the time of the accident none of them had been on duty in violation of any of the provisions of the hours-of-service law

Respectfully submitted

W P BORLAND, *Director*

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