INTERSTATE COMMERCE COMMISSION

REPORT OF THE DIRECTOR OF THE BUREAU OF SAFETY IN RE INVESTIGATION OF AN ACCIDENT WHICH OCCURRED ON THE CINCINNATI, NEW ORLEANS & TEXAS PACIFIC RAILWAY, SOUTHERN RAILWAY SYSTEM, AT CARDIFF, TENN., ON MAY 29, 1924

AUGUST 4, 1924

TO THE COMMISSION

On May 29, 1924, there was a derailment of a freight train on the Cincinnati, New Orleans & Texas Pacific Railway, Southern Railway System at Cardiff, Tenn., resulting in the death of three employees

LOCATION AND METHOD OF OPERATION

This accident occurred on the Third District of the Southwestern District, extending between Chattanooga and Oakdale, Tenn., a distance of 83.6 miles, in the vicinity of the point of accident there is a single-track line over which trains are operated by time-table, train orders, and an automatic block-signal system The first mark of derailment appeared opposite signal 264–7, located approximately 3,650 feet south of the station at Cardiff, while the engine was entirely derailed approximately 5,550 feet north of the station, at a facing-point switch for northbound trains which leads to a siding to the east of the main track, known as the Tennessee River spur Approaching the point of derailment from the south there is a 3° curve to the right 800 feet in length, then 1,600 feet of tangent, a 1° curve to the left 600 feet in length, then 4,350 feet of tangent, a 3° curve to the right 500 feet in length, then 1,000 feet of tangent, then a 3° curve to the left 600 feet in length, followed by a tangent extending to and for a considerable distance beyond the point of accident The first mark of derailment appeared on the first-mentioned curve at a point 129.2 feet south of its northern end, while the engine truck was derailed on the following tangent at a point about 240 feet from its northern end, 14 inches south of the frog of the south switch of the passing track at Cardiff the final derailment occurring on the last-mentioned tangent at a point 424.3 feet from its southern end The grade is 0.7 per cent descending for northbound trains from signal 264–7 to a point about 4,000 feet distant, then level for approximately 600 feet, 0.5 per cent ascending for 2,200 feet, level for 200 feet, and then 0.75 per cent descending to the point of accident, about 2,200 feet distant The track is laid with 85-pound rails 33 feet in length, with an average of 20 oak ties to the rail length, and ballasted with stone and slag to a depth of from 12 to 18 inches, it is maintained in fair condition It was dark and foggy at the time of the accident, which occurred at about 12.04 a. m.

DESCRIPTION

Northbound freight train first No 74, on leaving Chattanooga at 5 20 p m, May 28, consisted of five empty cars and a caboose, hauled by engine 4606, and was in charge of Conductor Stoutt and Engineman Dudley The empty cars were distributed at various stations and 27 loaded cars were picked up en route The train left Rockwood, 3 8 miles south of Cardiff, at 11 53 p m, according to the train sheet, and on reaching the switch leading to the Tennessee River spur, located approximately 1 mile north of the station at Cardiff, was derailed while traveling at a speed estimated to have been about 30 miles an hour

The first indication of the derailment was a mark on the end of a bolt on the gauge side of the east rail opposite signal 264–7, from this point for a distance of 1 491 feet, to the frog of the south switch of the passing track at Cardiff, the bolts were marked Fourteen inches south of this frog a wheel mounted the guard rail, then the bolts were marked on the outside of the east rail for a distance of 1,485 feet The first mark on the ties appeared at a point 11½ feet north of the frog The bottom portion of an equalizer hanger which was broken was found at a point 792 feet north of the frog, while the upper portion remained attached to the engine At the road crossing just south of the station the crossing plank on the east side of each rail was torn out, while at the private road crossing located about 2,500 feet north of the station the plank on the west side was torn out

Engine 4606 came to rest on its left side across the spur, about 250 feet north of the switch, the tender left its trucks and came to rest across the main track, about 315 feet beyond the engine Thirteen cars were derailed, 7 of which were demolished and 4 badly damaged, while 2 remained upright on the roadbed The employees killed were the engineman fireman, and head brakeman

SUMMARY OF EVIDENCE

Conductor Stoutt stated that the air brakes were tested at Rockwood and worked properly He rode in the cupola leaving this point, but owing to the fog and darkness he could not see ahead more than half the length of the train There was no unusual swaying of the train At the south switch of the passing track at Cardiff the speed was 25 or 30 miles an hour, Conductor Stoutt was of the impression that steam was shut off near this point and not worked again prior to the derailment, as the slack bunched and remained so until the accident occurred, at which time he estimated the speed to have been about 30 miles an hour He did not think the brakes were applied between these points Flagman Thomas's statements practically corroborated those of Conductor Stoutt, at the time of the accident he was writing up bills in the caboose, and judging from the way the caboose rode the speed was not over 30 miles an hour

Several enginemen who had operated engine 4606 within a few days prior to the accident stated that they had noticed nothing unusual with its riding qualities

Trainmaster Dearing stated that freight trains of the kind involved, a fruit train, are allowed to attain a speed of 35 miles an hour He arrived at the scene of the accident about 45 minutes after its occurrence and on examining the engine found that the equalizer hanger was broken He was of the opinion that when the hanger broke excessive weight was placed on the engine truck, which made it rigid and caused it to be derailed

Roadmaster New stated that about 1½ inches of the side of the guard rail was sheared off at the frog of the south switch of the passing track at Cardiff where the engine truck was derailed Also that two cattle guards were torn out just south of where the engine overturned He was of the opinion that the accident was caused by the equalizer hanger breaking

Road Foreman of Engines Hicks was of the opinion that when the equalizer hanger broke it should have been detected immediately, also as the derailed engine truck traveled approximately 1½ miles before the engine overturned, climbing the guard rail running over switches and on the ties and tearing out crossing planks and cattle guards, that it would have caused sparks to fly and should have attracted the attention of the engine crew Furthermore, an unusual motion or vibration would have been created He thought that the engine was working steam at the switch leading to the Tennessee River spur

Master Mechanic Shults stated that the last record he had of any work being performed on the equalizer hanger was at the Ferguson shops on March 26, 1924 At this time the slot in the cross equalizer was not deep enough and allowed the hanger to slip out of place permitting one spring to go up and the other to go down, therefore, the slot was made deeper with an acetylene torch and the hanger knocked back into place He was of the opinion that the hanger had been worked on since, but when where, or by whom he did not know

Engine 4606 is of the 2–8–2 type, having a total weight engine and tender, loaded, of 425,940 pounds the weight of the engine is distributed as follows Engine truck, 22,860 pounds driving wheels, 215,700 pounds, trailing truck, 34,380 pounds Its driving-wheel base is 16 feet 6 inches, and total wheel base, engine and tender, 67 feet ½ inch

This accident was caused by a broken equalizer hanger, which apparently took place in the vicinity of signal 264–7 On encountering the frog of the south switch of the passing track at Cardiff, the engine truck became derailed, the wheels dropping to the right of their respective rails while the driving wheels remained on the

rails On reaching the switch leading to the Tennessee River spur, which was closed the engine truck wheels followed the turnout while the driving wheels continued on the main line, resulting in the overturning of the engine An investigation into the reason for the failure of this equalizer hanger was conducted by Mr James E Howard, engineer-physicist, whose report immediately follows

REPORT OF THE ENGINEER-PHYSICIST

The cause of the derailment of train No 74 at Cardiff, Tenn, attaches to the fracture of the wrought-iron hanger of the forward equalizer lever of engine No 4606 The circumstances attending the derailment are consistently explained upon this premise

Examination of the fractured hanger shows it to have been a defective forging, its failure being chiefly attributable to that fact In service, however, it had been exposed to battering and abrasive effects which tended toward final rupture

The function of this hanger was to transmit that portion of the weight of the engine which is carried by the front truck to the forward system of leaf springs through necessary levers The weight on the front truck was given at 22,860 pounds This weight represents substantially the tensile stress on the hanger under static conditions

This load, if uniformly distributed amounts to only about 4,000 pounds per square inch a stress which should leave a very liberal margin in strength on a well-made hanger The use of wrought iron in this member is doubtless well chosen

Figure No 1 shows two views of the hanger as it appeared after recovery from the derailed engine The upper end was separated from the shank and the loop partially opened The left leg of the loop as shown on the cut appears to have been the one which fractured first but was immediately followed by the other The seat of the loop, on the cross equalizer beam from which it is suspended, was battered as well as that of the stirrup at the lower end of the hanger The battering of the seats of hangers does not appear, however to be an unusual occurrence

The cross-equalizer beam passes through the loop at the upper end of the hanger This beam has a depth at the middle of its length of 10 inches, the ends tapering off to about 3½ inches It is notched at its end bearings where connections are made with leaf springs and also notched at the middle of its length where the hanger is seated This beam is subject to rocking motion on its seat when the engine is running, the amplitude of which is limited by the sides of the loop of the hanger Abrasion of the sides of the loop results In the present case, one leg of the loop was abraded a depth of one-fourth inch, the other leg a depth of three-sixteenth inch

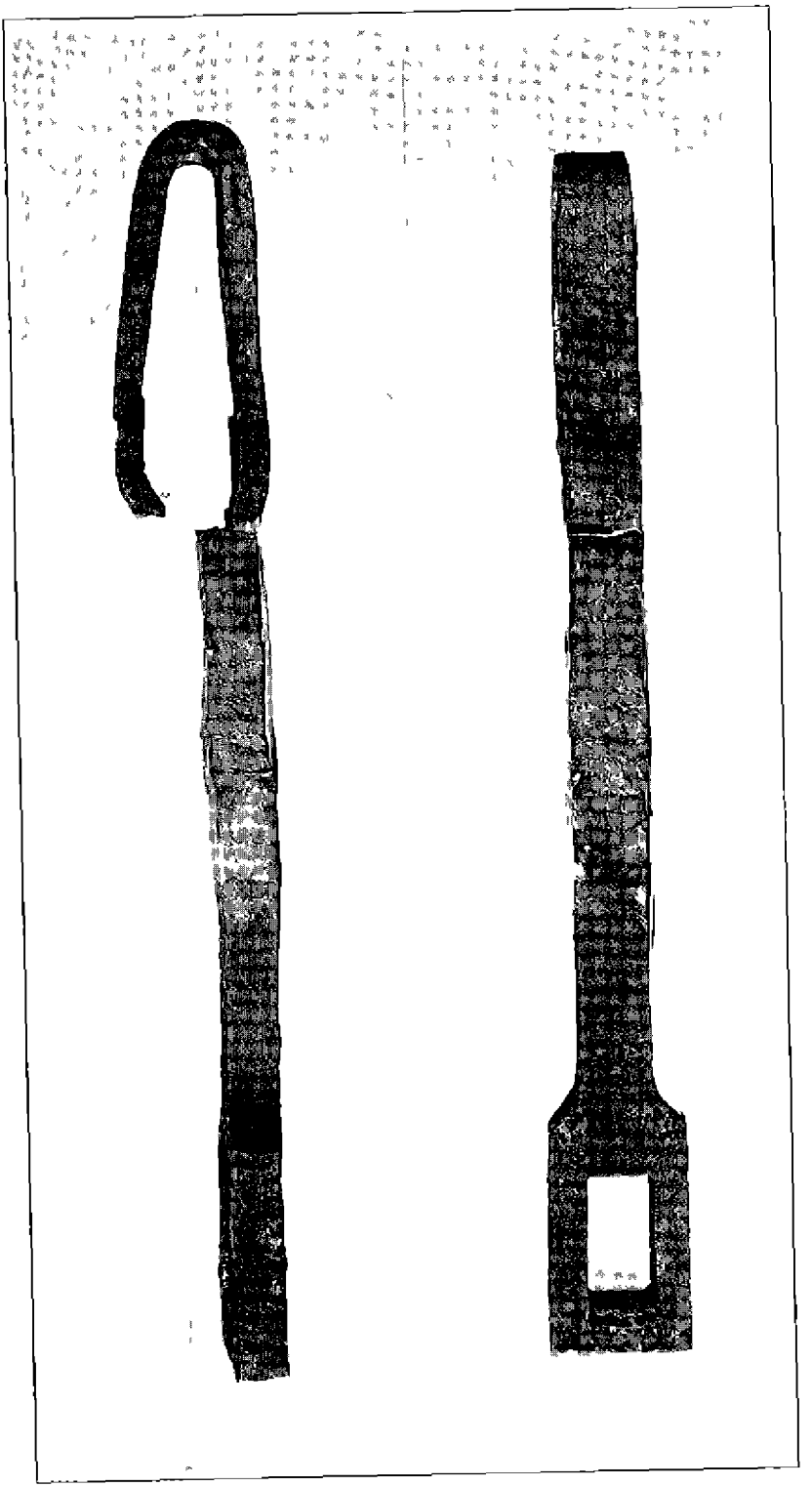

FIG. 1.—Two views of the fractured hanger. This hanger consisted of four pieces

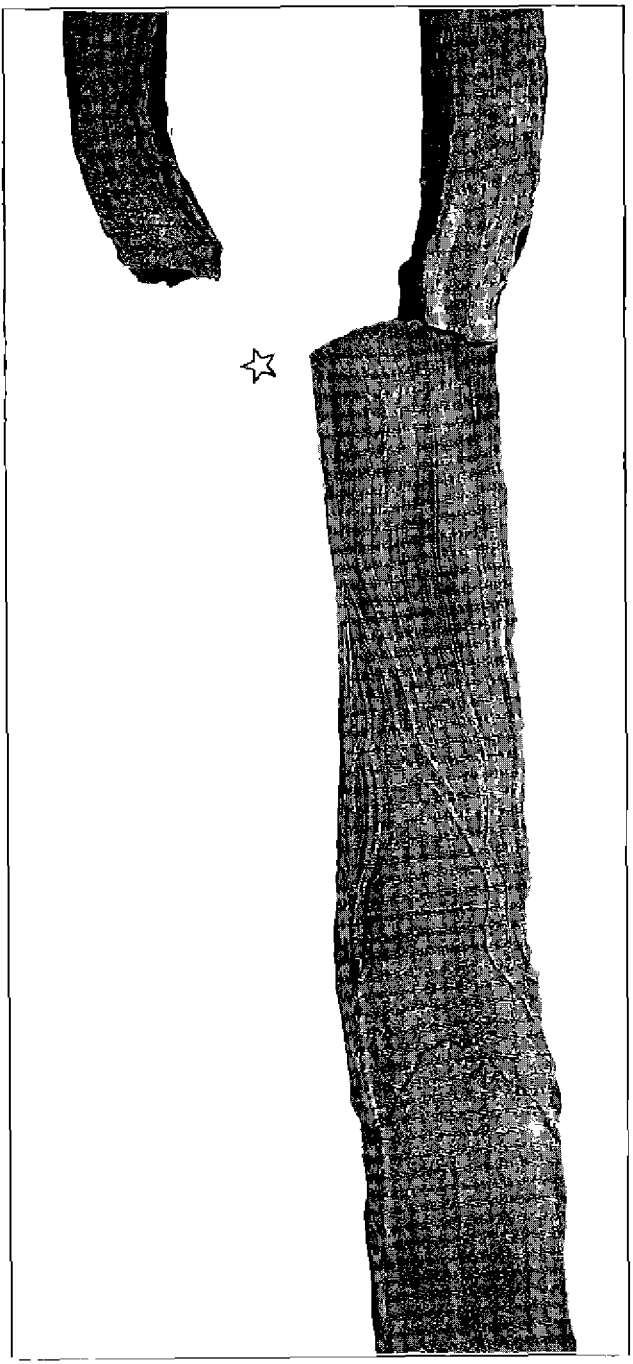

FIG. 2.—View showing welds in hanger and distortion of the fibers of the iron at incipient point of fracture. Star on cut indicates the place where fracture began.

The wearing away of the metal in this manner is a slow process, therefore the depth to which the loop was worn is taken to indicate that this forging was made at a time considerably antedating its failure

The lower or stirrup end of the hanger had a jaw $4\frac{13}{16}$ inches deep, thirteen-sixteenths inch deeper than called for on a blue print submitted by the railway company Across the lower end the hanger had been reinforced by a piece of iron three-fourths inch deep, welded to it This method of reinforcement or restoration differs from current practice in one of the shops of the Southern Railway, which is to build up the seat of a worn stirrup by means of an oxy-acetylene torch The use of a torch is no doubt less detrimental on wrought iron than on steel, and at such a place as this less hazardous than in many other examples of its general use

Hangers preferably should be made of one piece of wrought iron, avoiding the use of welds Single-piece forgings constitute the practice at the Knoxville shops of the Southern Railway This hanger, however, consisted of four pieces in all Enumerated in their order from bottom upward they were as follows A reinforcing strip across the lower end, the stirrup and lower half of the shank an intermediate section of the shank, and the loop at the upper end

The hanger was rough looking, but a rough forging is not necessarily an inferior one The contrary is frequently the case Hammer-hardening at low-finishing temperatures impairs the toughness of forgings

Figure No 2 shows the appearance of the hanger in the vicinity of the loop It was photographed after taking off a chip in a machine tool and light pickling in hydrochloric acid A V-shaped weld in the shank is shown The short intermediate section next above was scarfed and the loop welded to that piece These were good welds A very hot fire apparently was used in which pitting of the iron on the inside of the loop took place

The objectionable feature of the forging was at the junction of the two legs at the base of the loop, indicated by a star on the cut At this place, it is believed, the fracture of the hanger began Locally the fibers of the iron were distorted A fuller was probably used in the smith shop for closing the loop and was accountable for the distortion of the grain of the iron The reliability of a forging depends upon the manner in which the work is done In order to judge of its excellence the proper time for inspecting a forging is when and where the work is being done

It is well known that the strength and ductility of wrought iron is greatest in the direction of its grain, showing a considerable reduction in crosswise direction Specifically, the forging defect in the present hanger was the distortion of the grain of the iron at the lower end of one of the legs of the loop Stresses of tension on the

hanger were virtually crosswise the fibers of the iron at that place Rupture was facilitated by this circumstance

Responsibility for the fracture of the hanger in part attaches to its use, which was continued after so much abrasion at the sides of the loop Eccentricity of loading on the legs of some degree, would occur as one leg was abraded and then the other during the rocking of the crossbeam The battering of the seats of the loop and stirrup ends respectively is significant They had received loads of varying intensity

The total tensile stress on the hanger under static conditions as stated was approximately 23,000 pounds This stress would vary with track conditions It is not known whether oscillations would be sufficiently rapid at high speeds to momentarily relieve the hanger from load Shop repair records show, however, that the loop had been known to leave its seat on the crossbeam and give an unequal load on the forward springs of the engine A deeper notch was burnt in the crossbeam by means of a torch to prevent the recurrence of such eccentric loading The battered seats indicate that the contact surfaces shift their positions from time to time in this member, in respect to centers of effort

In conclusion it is believed that the derailment of train No 74 was caused by the fracture of the hanger, the fracture occurring where the fibers of the iron were crimped during the operation of forging

SUMMARY

The present derailment appears to have been caused by the fracture of the hanger of the front equalizer lever of the engine The reason for the failure of the hanger is attributable to a forging condition The hanger was found to have been built up of four separate pieces welded together In the forging of the loop at the upper end of the hanger the fibers of the iron was crimped, bringing the principal strains of tension crosswise the grain In wrought iron the strength is known to be weaker crosswise than in the direction of the grain Incipient rupture began at this crimped point followed by complete fracture

The hanger showed wear, abraded sides of the loop and battered seats at each end Its condition immediately preceding its fracture was unsatisfactory Inasmuch as this engine had been in the shops for repairs in connection with this particular member within a period of two months prior to the derailment, the worn condition of the hanger should have been noticed

Furthermore since it is the practice of the railroad company to fabricate hangers from a single piece of wrought iron to avoid the uncertainty of welds, the opportunity should have been taken to replace this hanger with one of improved fabrication

Respectfully submitted

W P BORLAND, *Director*

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