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, LINES WEST, AT GLEN MARY, TENN, ON NOVEMBER 11, 1929

APRIL 12 1930

To the Commission

On November 11, 1929 there was a derailment of a passenger train on the Cincinnati, New Orleans & Texas Pacific Railway, Southern Railway System Lines West, at Glen Mary, Tenn, which resulted in the death of 2 employees, 1 mail clerk, and 1 trespasser, and the injury of 74 passengers, 4 employees and 3 mail clerks

LOCATION AND METHOD OF OPERATION

This accident occurred on the second district of the Queen & Crescent district, extending between Oakdale, Tenn, and Danville Ky a distance of 137 9 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 an automatic block-signal and train-control system The accident occurred at a point 2,145 feet south of the depot at Glen Mary, on a 15-foot fill Approaching this point from the south there are several short curves and tangents, followed by a 5° 15′ curve to the left 1 937 5 feet in length, the initial point of derailment being on this curve at a point 922 8 feet from its southern end The grade for northbound trains is 1 14 per cent descending for 2 18 miles and then 0 8 per cent descending for 900 feet following which it is 0 44 per cent descending for a distance of about 400 feet to the initial point of derailment, this last-mentioned gradient extending for a considerable distance beyond that point The track is laid with 100-pound rails, 39 feet in length, with an average of 24 ties to the rail length, fully tie-plated, with 6 spikes to the tie, and ballasted with limestone to a depth of 12 inches The track is well maintained

It was cloudy at the time of the accident, which occurred about 1 30 a m

DESCRIPTION

Northbound passenger train No 2 consisted of 1 mail car, 1 combination car 6 coaches and 5 Pullman sleeping cars, in the order named, hauled by engine 6472, and was in charge of Conductor Cahoon and Engineman Eiseman The cars were of all-steel construction with the exception of the second car which was of steel-underframe construction This train passed C W tower the last open office 18 5 miles south of Glen Mary at 12 58 a m, according to the train sheet about 23 minutes late, and was approaching Glen Mary when it was derailed while traveling at a speed estimated by members of the crew to have been between 50 and 60 miles per hour

Engine 6472, its tender the first 10 cars and the forward truck of the eleventh car, were derailed The engine and tender came to rest on their right sides, the rear of the engine being nearly 100 feet from the track on the outside of the curve, with the mail car across the front portion of the engine, the second car broke away and stopped more than 900 feet beyond the point of derailment while the next 6 cars were in zigzag position on the outside of the curve, all but 2 of them being overturned The ninth and tenth cars remained upright, practically in line with the track The employees killed were the engineman and fireman

SUMMARY OF EVIDENCE

Conductor Cahoon was sitting in the coach end of the combination car the second car in the train, and the first he knew of anything wrong was when the derailment occurred, not having felt any air-brake application The air brakes had been tested at Oakdale, 28 5 miles from Glen Mary at which point a coach had been picked up, and they had worked properly Conductor Cahoon noticed nothing unusual in regard to the riding qualities of the train on this trip, saying that it was riding very smoothly on entering the curve and he estimated the speed to have been about 58 or 60 miles per hour at the time of the accident Conductor Cahoon had known Engineman Eiseman about 25 years and considered him to be a careful and competent engineman On account of injuries sustained, the conductor was removed to a hospital after the accident and made no examination to ascertain the cause of the accident Statements of Baggagemaster Whitten, Flagman Holloway and Train Porter Fitch added nothing of importance, they estimated the speed to have been between 50 and 55 miles per hour at the time of the accident

Roadmaster Self arrived at the scene of the accident about three hours after its occurrence and as soon as there was sufficient daylight he made an inspection of the track south of the initial point

of derailment and found it to be in good condition and safe for the regular speed North of the initial point of derailment there were marks on the east ends of various ties, while from the sixteenth tie to the thirty-eighth tie inclusive, the east ends were badly torn up Roadmaster Self thought that the marks on the ties were made by something dragging and that the overturned rail about 16 ties north of the first marks indicated that something had come down behind the engine, turning over the rail and pulling the rear of the engine off the track

Testimony was given to the effect that the accident might have been caused by a broken tender-truck frame, but as a result of his investigation into this phase of the situation Mr James E Howard, engineer-physicist, attributed the fractured condition of the tender-truck frames to conditions experienced immediately succeeding the derailment of the engine, and arrived at the conclusion that high speed was the responsible cause of the accident The report of the engineer-physicist next follows

REPORT OF THE ENGINEER-PHYSICIST

On November 11, 1929 at 1 30 a m northbound passenger train No 2 was derailed at a point 2,100 feet south of Glen Mary station The train was on a 5° 15′ curve, on a descending grade 0 44 per cent at the place of derailment, and immediately beyond a descending grade of 1 14 per cent, the latter 2 miles in length

The engine, tender, and seven cars left the roadbed on the outside of the curve, while an eighth car, although the second car of the train, was entirely detached from the others and alone followed the track a distance of about 900 feet Five Pullman sleepers, which formed the rear portion of the train, were in part derailed and in part remained on the track Four persons were killed—the engineman, fireman, a mail clerk, and a trespasser who was riding on the tender Eighty-one persons were injured

Figure No 1, a diagram reproduced from a blue print furnished by the Southern Railway shows the position of the engine, tender, and eight cars of the derailed train Mail car 43 was next to the tender in the train Combination car 3602, the second car of the train, remained on the road bed, to the left of and beyond the limits of the diagram while the Pullmans were beyond on the right

GENERAL DESCRIPTION OF WHAT TRANSPIRED

A general description of what transpired at the time of the derailment is believed to have been as follows

The engine left the track at an overturned rail, and was followed by the tender and mail car 43 This group of three units

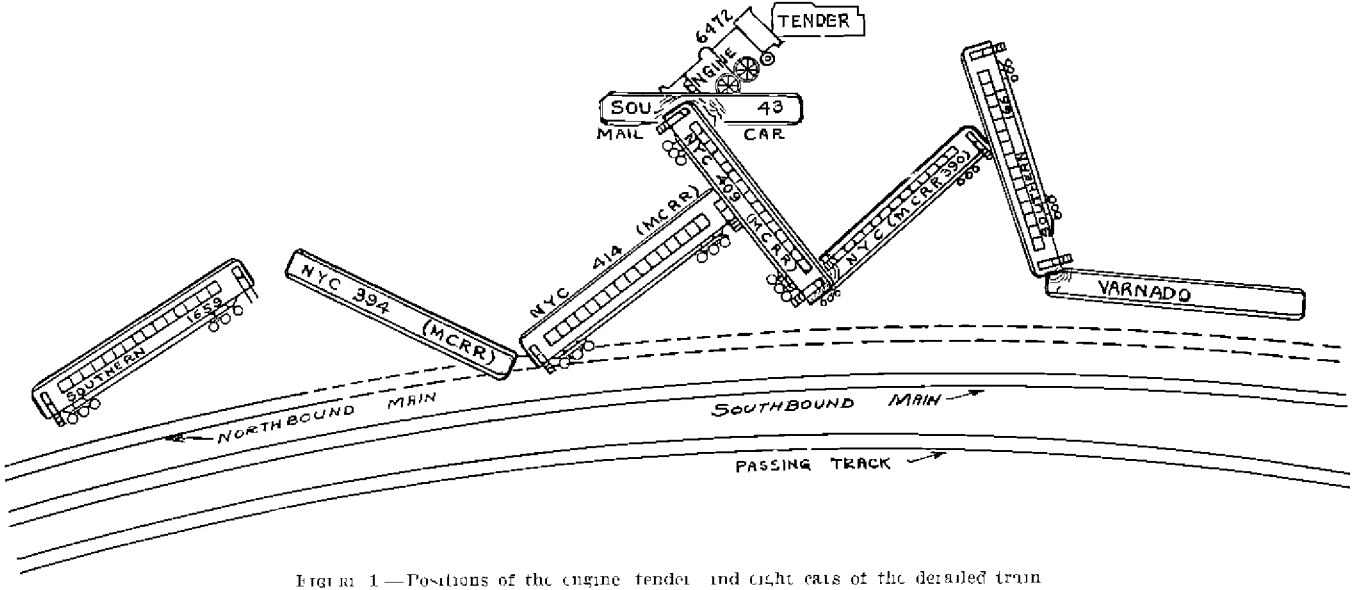

FIGURE 1.—Positions of the engine, tender, and eight cars of the derailed train.

took a tangent course and came to rest some 335 feet from the point of derailment The second car, combination 3602, detached front and rear ends, continued on the roadbed a distance of 900 feet Evidently the track at this stage was not seriously injured, inasmuch as the engine passed over the overturned high rail of the curve, while the combination car continued on or between the rails Six coaches which next followed were derailed, the track being torn up for a distance of 400 to 500 feet These coaches came to rest in zigzag formation, the leading three on the slope of the roadbed nearly abreast the place reached by the engine The fourth coach, 409, left the roadbed, struck and embedded itself in the side of the mail car, apparently forcing the latter against the overturned engine Four coaches were damaged by colliding with each other, the greatest display of energy occurring in this vicinity A tree, 15 inches in diameter, was struck and moved several feet without overturning, testifying to the forces of impact and the striking velocities of the moving cars

A series of photographs illustrate the appearance of different units of the train after the derailment Figure No 2 is a partial view of the derailed engine, showing in the background two of its driving wheels The end of the tender appears on the right of the cut resting on its side, the end of the mail car in upright position on the left Figure No 3 is a closer view of the overturned engine Its trailing axle is shown standing on end, partly submerged in water Its leading truck was intact and occupied a place a few feet in front of the forward end of the engine The side of the mail car is in partial view on the left of the cut Figure No 4 shows the area bounded on two sides by the mail car and coach 409 In the foreground are shown the fragments of the forward truck frame of the tender The forward axle of the frame, carrying with it the ends of the side rails and pedestal jaws, was detached from the rear portion of the frame The rear portion of the frame, together with the equalizer bars and rear axle, occupied a place alongside the forward portion The rear truck frame, intact, with the exception of a crack in the east side rail and slight bend of the same, was found a few feet to the right of this cut It was standing on edge, nearly buried in the soft ground, as shown at the corner of the next cut, Figure No 5

These frames and fragments were carried about the same distance as the tank of the tender from the initial point of derailment The rear portion of the forward frame was turned end for end and faced the rear

Figure No 6 shows the forward tender truck with its parts reassembled, viewed from the east side The frame was a steel cast-

FIGURE 2.—Derailed engine on its side. Ends of tender and mail car appear in the foreground.

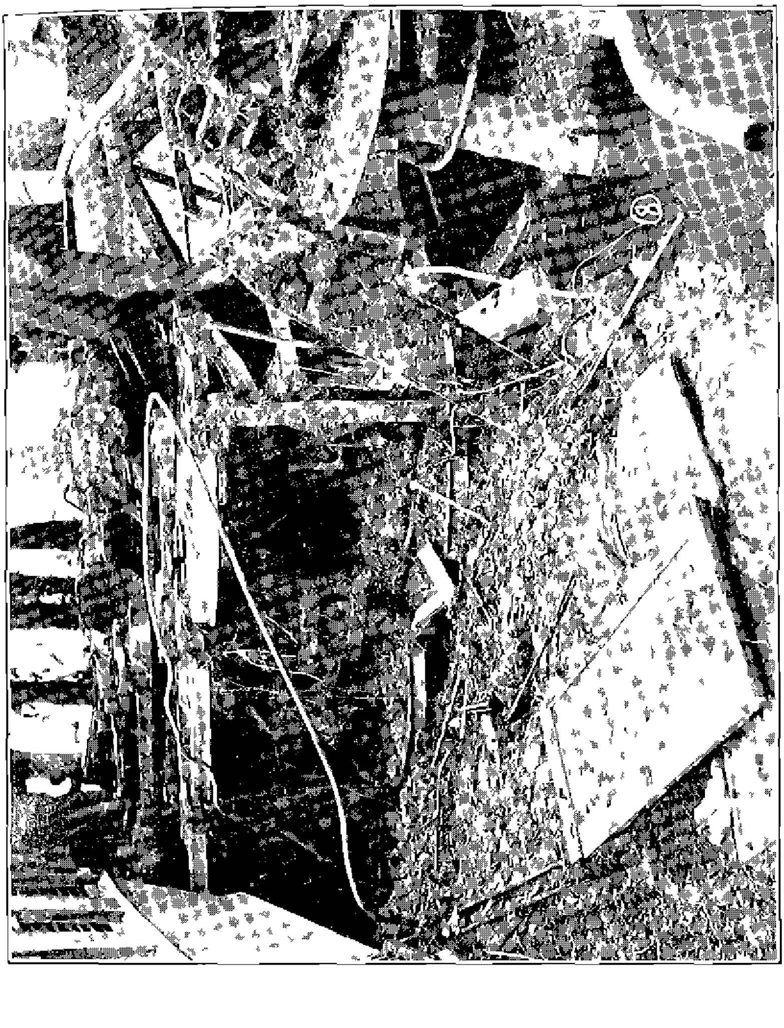

FIGURE 3.—Closer view of the derailed engine. Tender axle on end partly submerged. Side of mail car on left of cut.

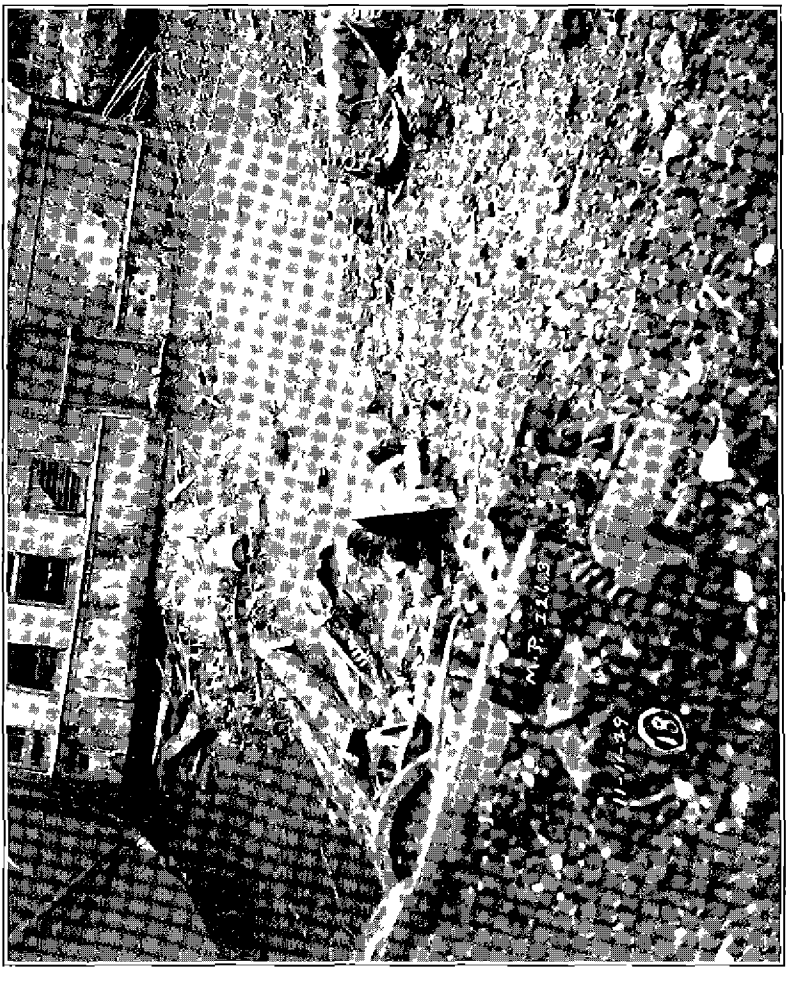

FIGURE 4.—Angular space between car 409 and mail car. Fragments of forward fender and frame in foreground. Forward axle near middle of car.

FIGURE 5.—Rear tender truck nearly buried in soft ground. About 20 feet from fragments of forward truck frame.

ing, consisting of side rails, connected by two intermediate transoms A bolster between the transoms transmitted the weight of the tank through elliptic and helical springs by means of four hangers to the spring plank and intermediate parts of the side rails, thence to the equalizer bars, which in turn transmitted the weight to the journal boxes The ends of the side rails, of which the pedestals were integral parts, carried none of the principal stresses of the truck

The forward frame was fractured at two principal places The east rail was fractured immediately forward of the seats of the helical springs and to the rear of the pedestal jaws The fracture had its origin at the lower outside corner of the rail This appeared to have been the first fracture which took place in the frame It was immediately followed by the fracture of the west rail, the origin of which was at the lower side of the forward transom and abreast the forward wall of the same The forward part of the west rail was torn from the transom, the rail itself also being separated between the junctions of the two transoms At an early stage of rupture the forward and rear axles made a slight angle with each other, opening on the east side Secondary fractures occurred as the rear portion of the frame was bent out of shape

Figure No 7 is a view of the rear truck of the tender, taken from the east side A line of rupture occurred in this frame, at the same place as the original fracture in the forward frame except at the opposite end of the side rail Three sides of the box-shaped cross section of the rail were separated The truck was dismantled and the fourth side broken by means of a battering ram It displayed toughness of metal Each fracture exhibited by the two frames showed sound steel The chemical composition of the metal of the forward frame, furnished by the Alexandria laboratory of the Southern Railway, was as follows

	C	P	S	Mn	Si
East side of frame	0 26	0 015	0 027	0 69	0 35
West side of frame	24	016	027	69	35

Chips were taken from the immediate vicinity of the origins of fractures in the east and west rails respectively

Check analyses by the General Steel Castings Corporation, the makers of these steel frames, were as follows

C	P	S	Mn	Si
0 22	0 011	0 020	0 75	0 45

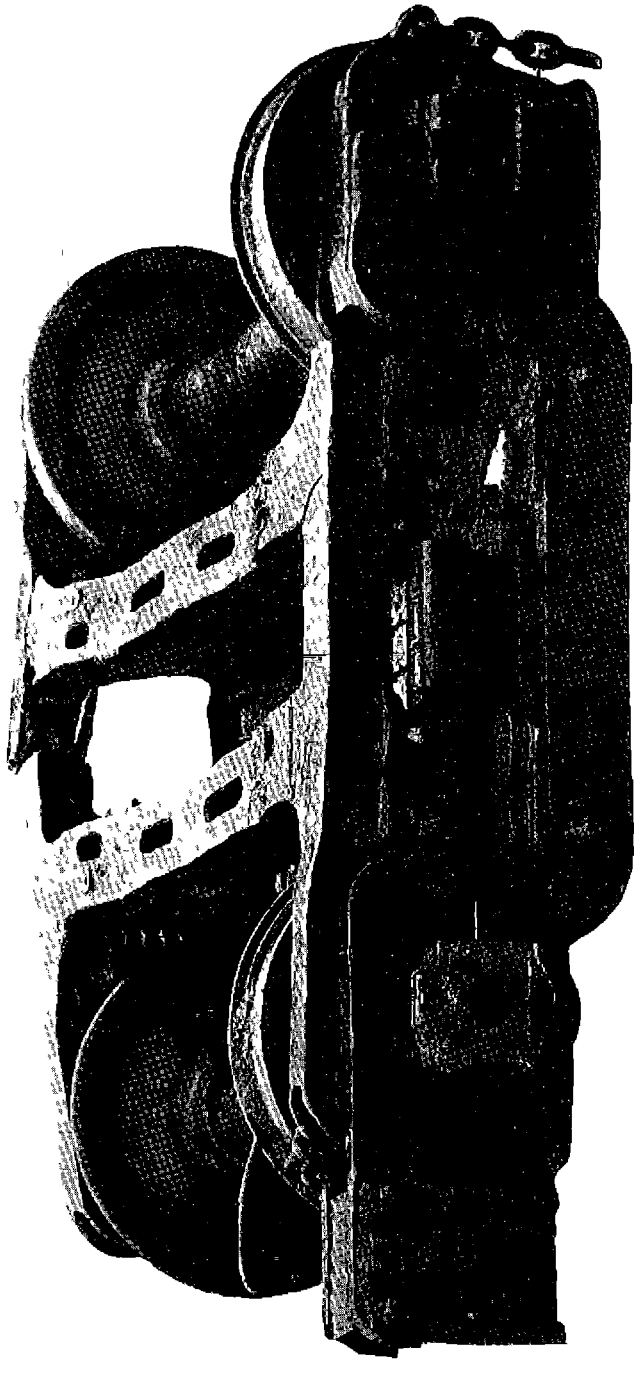

FIGURE 6.—Forward tender truck. Parts reassembled after the derailment. View of right side.

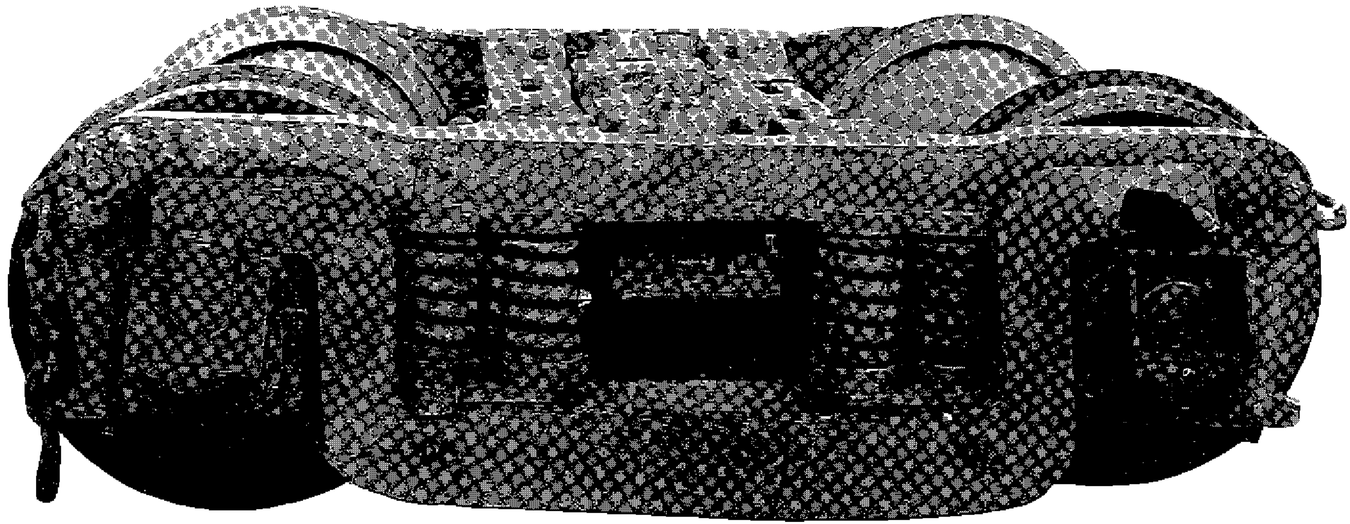

FIGURE 7.—Rear tender truck in the condition recovered after the derailment Crack in side rail at rear of seats of helical springs

Figure No 8 is a photomicrograph of the structure of the metal, near the initial point of fracture of the rail, west side, at a magnification of 100 diameters

The General Steel Castings Corporation furnish low-carbon steel in their castings and without annealing They are expected to have an elastic limit of 30,000 pounds per square inch, tensile strength 63,000 pounds per square inch, contraction of area, from 40 to 50 per cent Through skill in molding, castings of great length and weight are fabricated

Steel castings are expected to contain internal strains of some degree If the castings are annealed and strains relieved they are

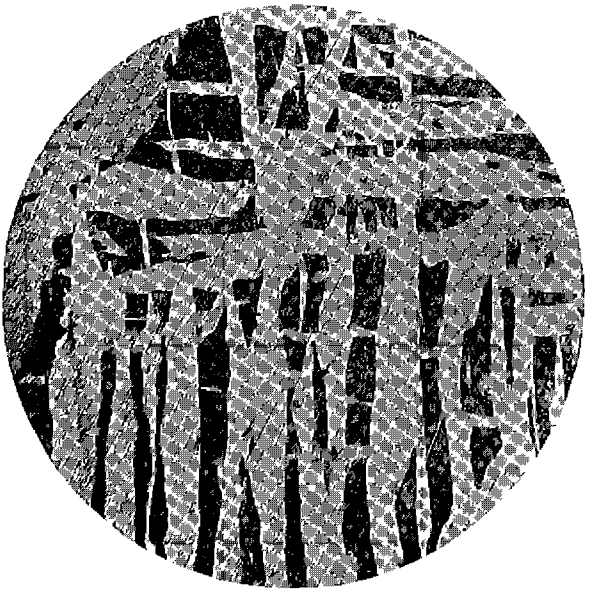

FIGURE 8.—Photomicrograph of structure of metal of forward truck frame Magnification 100 diameters

likely to become warped by the operation of annealing, requiring straightening, which in turn reintroduces internal strains Cold straightening leaves the metal in a state of unstable equilibrium, subject to overstrain locally and the introduction of permanent sets when external forces are received The success of the General Steel Castings Corporation in the production of castings of complicated shapes and of great weights and lengths appears to justify their practice of furnishing soft steel castings unannealed

The incipient fractures exhibited by these truck frames were undoubtedly caused by sudden blows or shocks, to which they could not be subjected if the trucks had been in normal positions on the

rails Violent vertical oscillations of the tender would be insufficient and would be taken up by the equalizer bars and transmitted to the journal boxes without straining the side rails of the cast frames at the points where the initial fractures occurred Brake-shoe pressures as influences would be insignificant in comparison to the strength of the side rails, 7,000 or 8,000 pounds braking pressure as against an estimated horizontal force of 130,000 necessary to fracture the side rails at their places of inception The several fractures of the tender truck frames are attributed to conditions experienced immediately succeeding the derailment of the engine

Figure No 9 is a simplified diagram of the tracks at the scene of the derailment, showing the positions of the overturned rail, where truck springs were found, the impress made by the tender on the embankment, and the places where the engine and tender came to rest after the derailment The distance from the overturned rail to the engine was about 335 feet horizontal, with a drop of 20 feet vertical The track was torn up from the overturned rail to a point abreast that which the engine reached Marks on the ties were found south of the overturned rail It has not been possible to establish a relation between these marks and the events which transpired during the early stages of the accident

Concerning the cause of the accident, a consideration of the details of what undoubtedly took place leads to the conclusion that high speed was the responsible cause The track was doubtless in good condition Nothing pertaining to the engine, tender, or rolling stock furnished evidence that any factor from those sources had a contributing influence Not only does it appear that high speed precipitated the accident, but the known circumstances, as exhibited in the results, present no discordant features

The engine overturned the high rail of the 5° 15′ curve and was itself overturned by centrifugal force On this curve, having a superelevation of 7 inches, less 1½ inches allowance for the overturned rail, the horizontal force required to overturn the engine of 300,000 pounds weight, applied at its center of gravity, would be about 147,000 pounds This centrifugal force calls for a speed in excess of 88 miles per hour

The trajectory of the engine, 335 feet with a drop of 20 feet, if made in mid-air would call for a still higher speed Some portion of the flight probably partook of a ricochet movement, since the top of the engine was stripped of accessories

A rotary motion, about its longitudinal axis, was imparted to the engine, and during its flight it made one and one-quarter rotations This extraordinary movement is explained by the influence of the high rail of the curve acting as a land in the lifting of a gigantic

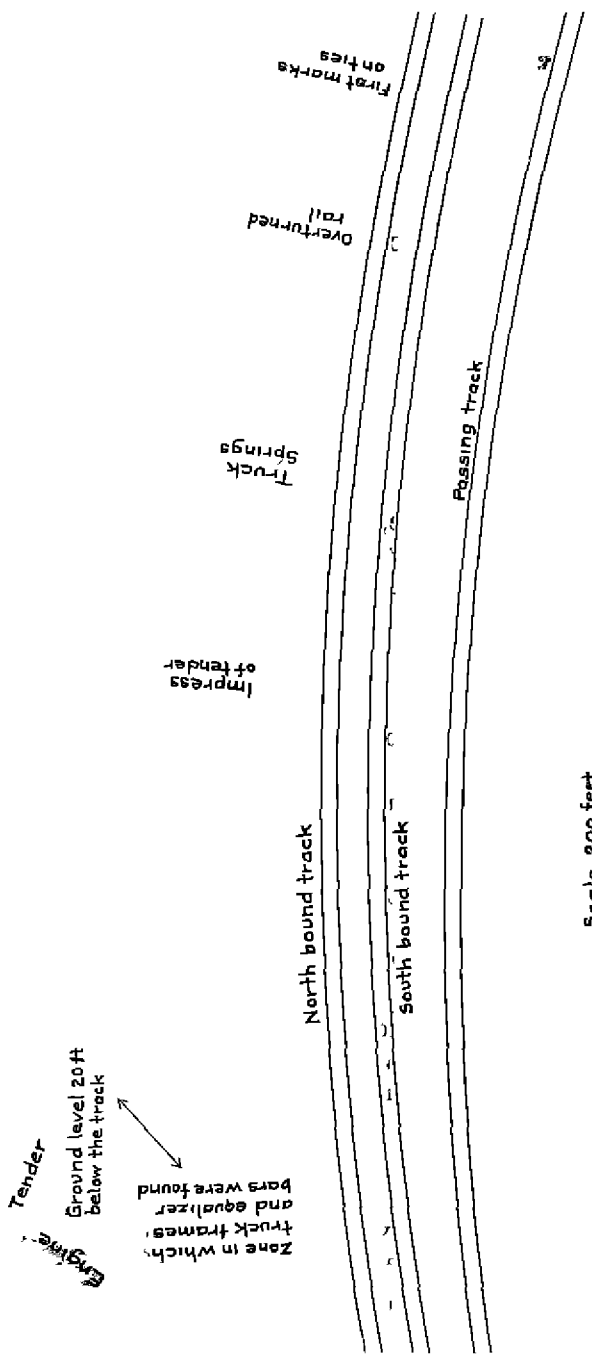

FIGURE 9.—Diagram showing positions of engine, tender, truck frames and fragments with reference to location of overturned rail

piece of ordnance While in the act of overturning and with the outer driving wheels still in contact with the high rail the curvature of the rail would impart a rotary motion to the engine as the latter took a tangent course The engine was projected into space in precisely the same manner as a projectile leaves the muzzle of a gun

Figure No 10 illustrates the twisted and fractured drawbar which connected the engine with the tender Its dimensions were 78¾ inches long, 5½ inches wide, and 3 inches thick It was twisted through an angle of nearly 360° before separation The safety bar was likewise twisted but remained unbroken No further evidence is needed to establish the remarkable fact that the engine rotated through an angle of 450° after it left the track and before it finally came to rest

Other circumstances attending the derailment gave conclusive proof that the ill-fated train was traveling at a terrific rate of speed The mail car which occupied a position next the tender took the same tangent course but was apparently turned end for end and thereby detached from the tender, while the combination car, next in the train, was cut out at each end and continued down the track, still remaining on the roadbed Three cars independently left the roadbed, while the next, the sixth of the train, took an oblique course and collided with the mail car, jamming the latter against the overturned engine No endwise damage appears to have been done the mail car, the combination car, nor the two cars which next followed The buckling of the middle part of the train caused endwise and sidewise damage to four cars

A reason must be looked for to account for the derailed train attaining the rate of speed with which it was evidently traveling Its speed was greater than a train could be expected to run in this territory The reputation of the engineman of the derailed train as a conservative, careful runner was beyond question One reasonable explanation, and one only, consistently accounts for the accident The engineman must have experienced a temporary lapse of consciousness at that fatal interval while the speed of the train was being accelerated on the 2 miles down grade which preceded the point of derailment

Acknowledgment is made to Mr J C Austin, general superintendent, Southern Railway, to Mr R L Ettinger, assistant to the vice president, Southern Railway, and to Mr Finch, of the computing division of the American Locomotive Co for the valuable assistance they extended in connection with the results arrived at in this report

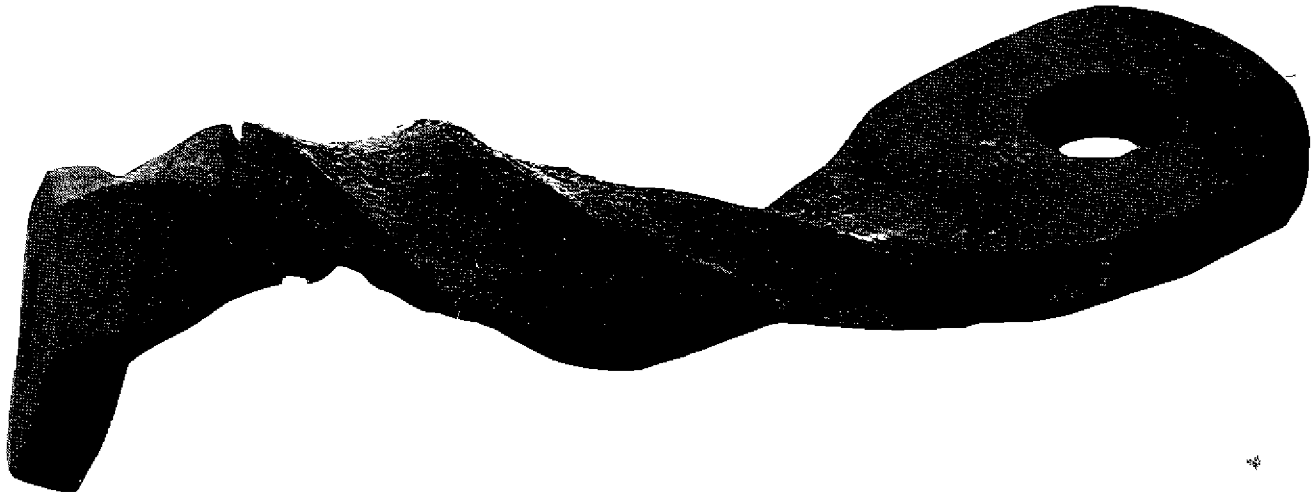

FIGURE 10.—Drawbar which connected engine and tender, shown as recovered after the derailment Twisted and broken during the flight of the engine

CONCLUSION

The engineer-physicist has presented the facts pertaining to this derailment as they were furnished by the testimony of those who examined the derailed cars immediately after the accident and as supplemented by a series of photographs which were supplied by the officials of the Southern Railway The sequence of events, which a review of these data admitted of following, appear to explain the cause of the accident The train was traveling at an excessive rate of speed The engine appeared to have overturned the high rail of a 5° 15′ curve, and was itself overturned in doing so by reason of the centrifugal force developed While still in contact with the high rail a rotary motion was imparted to the engine, the high rail acting in the same manner as a land in the rifling of a gigantic piece of ordnance The remarkable result followed, in which the engine rotated about its horizontal axis through an angle of 450° before coming to rest This was the main circumstance of the derailment

While it was clear that excessive speed was the cause of the accident, the engineer-physicist looked about for a reason for its display The engineman was a careful driver, whose reputation was second to none, while no such speed would be expected in any event in this territory As deduced, a temporary lapse of consciousness must have been experienced during the fatal interval which immediately preceded the accident

Respectfully submitted

W P Borland, *Director*

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