INTERSTATE COMMERCE COMMISSION

REPORT OF THE DIRECTOR BUREAU OF SAFETY

ACCIDENT ON THE SOUTHERN PACIFIC RAILROAD

HARNEY, NEV

AUGUST 12, 1939

INVESTIGATION NO 2375

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON 1939

For sale by the Superintendent of Documents, Washington D C Price 10 cents

SUMMARY

Inv–2375

Railroad	Southern Pacific
Date	August 12, 1939
Location	Harney, Nev
Kind of accident	Derailment
Train involved	Passenger
Train number	101
Engine numbers	Diesel power units S P 1, 2, and 3
Consist	14 car units
Speed	60 m p h
Operation	Timetable, train orders, and automatic block system
Track	Single, 3° curve, 0.30 percent descending westward
Weather	Clear
Time	9 33 p m
Casualties	24 killed, and 115 injured
Cause	Malicious tampering with track

NOVEMBER 13, 1939

TO THE COMMISSION

On August 12, 1939, there was a derailment of a passenger train on the Southern Pacific Railroad near Harney, Nev., which resulted in the death of 9 passengers and 15 dining-car employees, and the injury of 99 passengers, 1 train-service employee, 1 stewardess, 11 dining-car employees, and 3 train porters. This investigation was made in conjunction with the Nevada State Public Service Commission.

LOCATION AND METHOD OF OPERATION

In the vicinity of the point of accident this is a paired-track line jointly operated by the Western Pacific Railroad and the Southern Pacific Railroad. East-bound trains of both lines use the Western Pacific track and west-bound trains of both lines use the Southern Pacific track. The accident occurred on the line of the Southern Pacific on that part of the Salt Lake Division designated as the Winnemucca Sub-division which extends between Imlay and Carlin, Nev., a distance of 150.4 miles. Trains are operated by timetable, train orders, and an automatic block system. The accident occurred at a point approximately 1.55 miles east of the station at Harney and 169.5 feet east of bridge 518.54. Approaching from the east there is a tangent 437 feet in length followed by a 3° curve to the right extending 875 feet to the point of derailment and 1,215 feet beyond. The grade varies between 0.163 and 0.47 percent, descending westward, a distance of 2,327 feet to the point of accident and some distance beyond, being 0.30 percent at the point of accident.

The track structure consists of 130-pound rail, P. S. section, height 6⅝ inches, base width 5½ inches, 39 feet in length, laid new in 1931 on 24 treated fir ties to the rail length, it is fully tie-plated with Lundie canted tie-plates, which are corrugated on the bottom surface for secure grip on the ties, the intermediate plates are 8¾ inches by 10½ inches and have spike holes spaced 3½ inches between centers, the joint plates are 8¾ inches by 11 inches and have offset spike holes spaced 3½ inches between centers. On the curve involved there are 4 spikes per tie-plate, 2 being inside and 2 outside of the rail. Angle bars are 24 inches in length and have 4 holes each. The angle-bar bolts are secured by nuts and lock washers. The rail joints are bonded for signal circuits with two No. 8 galvanized wires, 52 inches in length, looped at each end, housed behind the angle bars, and secured to each rail by channel pins which are

spaced 28 inches apart The superelevation at the point of accident is 4⅛ inches The track is laid on 12 inches of crushed rock ballast, and is well maintained

Approaching bridge 518 54 from the east the track is laid on a fill about 500 feet long and 30 feet at its maximum height At the west end of the bridge there is a fill about 440 feet long, the maximum height of which is 27 feet

Bridge 518 54 was a through-riveted Warren truss span, 120 feet in length, laid on concrete abutments founded on boulder base 41 feet below the base of the rail The bridge, which was fabricated in 1902, had recently been strengthened by lateral reinforcements, and was capable of sustaining a rolling load equal to the specifications of Coopers E–50 Its horizontal clearance between trusses was 16 feet, its vertical clearance was 21 feet 5 inches above the top of the rails The top surface of the rails was 33 feet above the river bed The bridge was equipped with guard rails, which were 90-pound, second-hand rails, laid parallel to and 8 inches inside the running rails The guard rails extended about 78 feet east of the east end of the bridge

Signals Nos 5213 and 5195, governing westward movements, are located 14,069 and 4,963 feet, respectively, east of the point of accident

In the vicinity of the point of accident the maximum authorized speed for streamline trains is 60 miles per hour

The weather was clear and it was dark at the time of the accident, which occurred at 9 33 p m

DESCRIPTION

No 101, a west-bound streamline passenger train, known as "The City of San Francisco," consisted of 3 power units, an auxiliary power and dormitory unit, 2 chair units, 2 kitchen-diner units, 1 dormitory-club unit, 7 Pullman sleeping units, and 1 lounge unit, in the order named, and was in charge of Conductor Edwards and Engineman Hecox The three power units were of steel-frame construction, the bodies were of ⅜ inch plywood covered with 27-gage galvanized iron The remainder of the units were of aluminum alloy with steel end-sills, body bolsters, and cross bearers This train departed from Carlin, 16 0 miles east of the point of accident, at 9 15 p m, according to the train sheet, 29 minutes late, and 18 minutes later became derailed 169 5 feet east of bridge 518 54 while moving at a speed of 60 miles per hour The three power units and the following two units, remaining coupled, became derailed, passed over the bridge on the ties, and stopped with the front end about 907 feet west of the point of derailment Power unit No 1, slightly

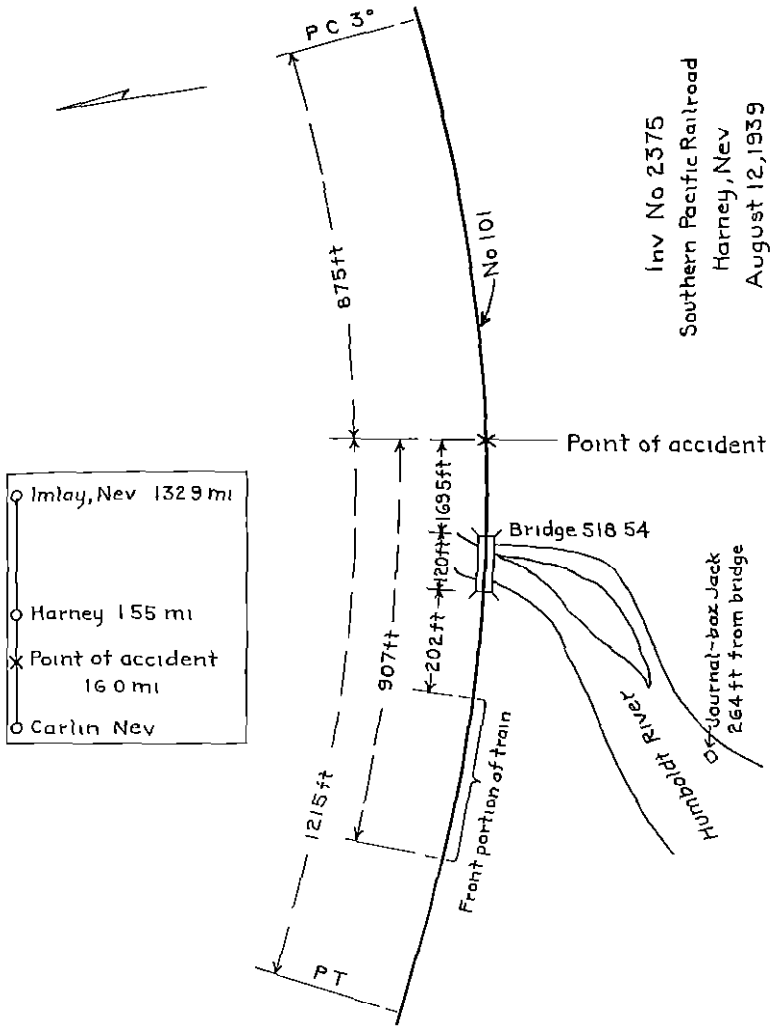

FIGURE 1.—Track lay out in vicinity of point of accident

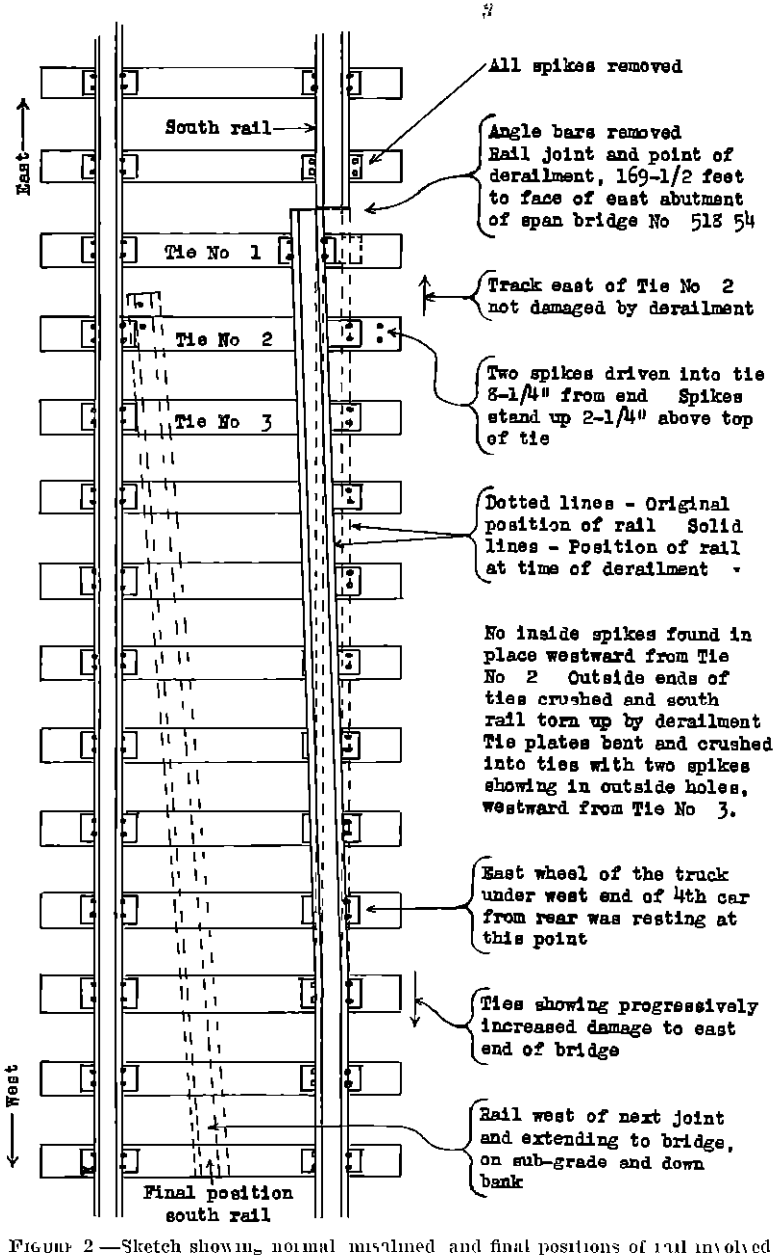

FIGURE 2.—Sketch showing normal, misaligned and final positions of rail involved

damaged, stopped upright on the ties and approximately 11 inches to the left of the line of track Power unit No 2, slightly damaged and inclined at an angle of 15° to the left, stopped with its front truck on the ties, about 12 inches to the left of the line of track, and its rear truck on the ballast Power unit No 3, inclined to the left at an angle of 45°, stopped with its front end on the fill and its rear end down the embankment, the left eave of this unit bore indications of having struck the bridge truss, the front truck was damaged considerably Unit No 4 stopped on its left side down the embankment to the south of the track, its side sheets were raked and broken through by the ballast, it bore marks indicating that it had struck the south bridge-truss Unit No 5 stopped on its left side down the embankment to the south of the track, with the rear end 200 feet west of the west bridge-abutment, its side sheets were sheared in numerous places and it was crushed inward along the window belt-rail, its left front corner bore marks indicating that it had struck the left bridge-truss, the tight-lock coupler at the rear was broken through the shank Unit No 6, a diner-kitchen car, the front section of an articulated two-unit car, became derailed and struck the bridge truss, causing the bridge to collapse, it broke loose from the preceding unit, struck the west bridge-abutment with such force that the impact moved the abutment 1½ inches out of line, passed over the abutment, overturned to the left down the embankment west of the bridge, stopped upside down, and was practically demolished, the steel end-sill was broken loose from the aluminum alloy center-sills which were broken about the middle of the car and were badly bent in other places, all the occupants of this unit were killed Unit No 7, a dining car, became derailed and was deflected to the left by the impact with the preceding car, it turned at an angle of 45° and stopped about 90 feet south of the track in the river bed, the body of the car was demolished and the frame badly distorted, the center-sills were broken just back of the bolster Of the 24 persons killed, 21 were occupants of units Nos 6 and 7 Unit No 8, a dormitory-club car, became derailed, was whirled by the deflecting motion of the preceding unit, and, using the bridge frame as a fulcrum, struck the left bridge-truss with an impact sufficient to demolish the truss, the center-sills were broken at the rear bolster, at the needle beams, and at the rear end-sill, the body above the floor line was badly crushed and twisted, unit No 9, dragging heavily as the whirling motion was being executed, caused the center-sills of unit No 8 to be broken through at the rear end, unit No 8 fell to the river bed and stopped upright but off its trucks, it was crushed badly at both ends Unit No 9, a Pullman sleeping car, articulated with unit No 10, became derailed and dropped through the bridge

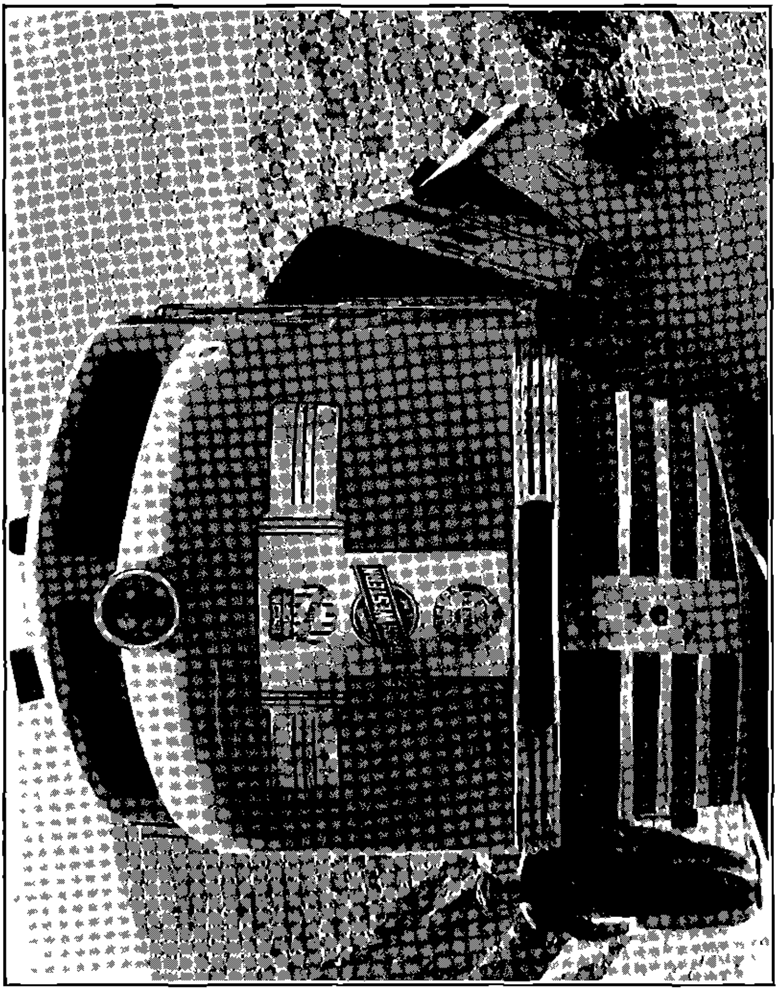

FIGURE 3.—View of the three power units, showing derailed condition of all units

FIGURE 4.—View of third to twelfth units inclusive

opening to the river bed, stopping upright, south of and at an angle of 30° to the track, its rear end was crushed inward as far as the cross-bearer or about 15 feet from the articulated joint, the rear coupler-head was broken off, and the center-sills were broken through, the roof was crushed inward by unit No 10 falling across it, unit No 9 was demolished, two passengers and one porter in this car were killed Unit No 10, a Pullman sleeping car, became derailed, fell through the bridge opening, and stopped on the roofs of units Nos 8 and 9, and on the overturned floor structure of the bridge, one end was pointed upward, this car was crushed and badly distorted These three cars, units Nos 8, 9, and 10, were entangled with the demolished bridge structure Unit No 11, a Pullman sleeping car, articulated with unit No 12, became derailed to the south at an angle of 25° to the track and stopped upright in the river bed with its front end badly damaged and its rear end suspended upon the east bridge-abutment Unit No 12, a Pullman sleeping car, became derailed, but remained coupled to unit No 11 and stopped upright on the embankment east of the bridge opening, one end was damaged slightly Unit No 13, a Pullman sleeping car, articulated with unit No 14, became derailed but remained coupled to the units at each end and stopped upright, slightly damaged, with its front truck on the embankment and its rear truck on the ties Unit No 14, a Pullman sleeping car, became derailed at the front end only and remained coupled at each end Units Nos 15, 16, and 17 were not derailed and sustained but slight damage

The train-service employee injured was the conductor

SUMMARY OF EVIDENCE

Engineman Hecox stated that when approaching the point of accident the train was moving, as indicated by the speedometer, at a speed of 60 miles per hour and the power unit was riding smoothly The automatic block signals displayed proceed indications The headlight was focused properly and was burning brightly As the train entered the curve at the point of accident, he saw an object, which later he found to be a green tumbleweed, lying on the rail at a distance of about 300 feet Upon reaching that point his power unit became derailed and his first thought was that his train had struck a rock He shut off power and applied the [redacted] brakes in full-service application, the train stopped in a distance of about 900 feet It was clear and dark at the time of the accident, which occurred at 9 33 p m He stated that the track was in excellent condition After stopping he examined the pilot but found there were no marks indicating that it had struck a rock Power unit No 1 was upright but the left wheels were outside the left rail

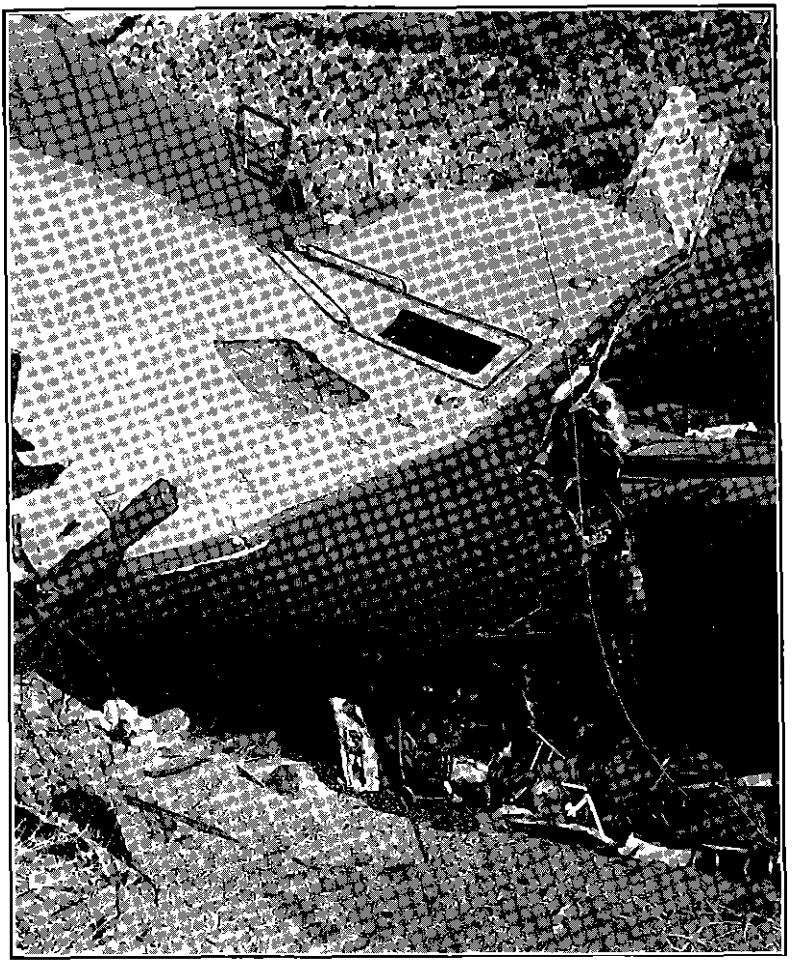

FIGURE 5.—View of "Presidio," sixth unit showing damaged condition of roof

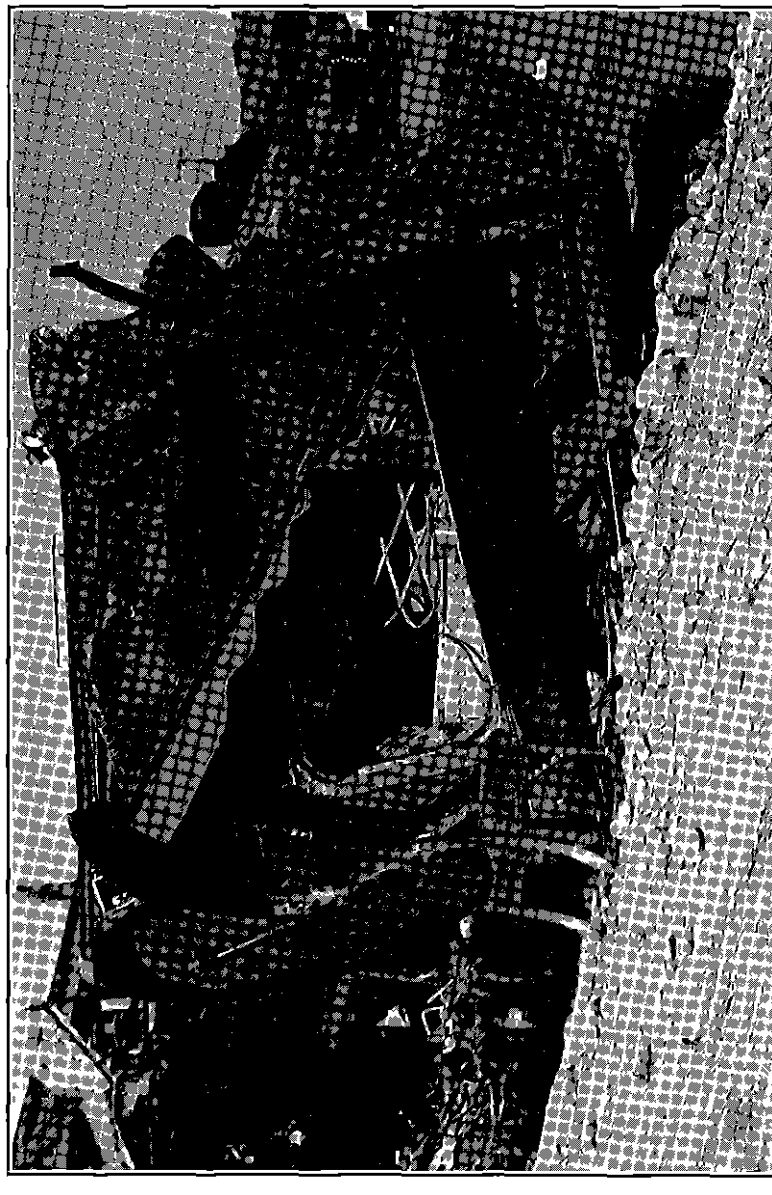

FIGURE 6.—View of Mission Dolores," seventh unit, showing damaged condition of end frame

and the right wheels inside the right rail The unit had been supported upon the rails and was prevented from overturning by the motor housings and spring planks He proceeded to Harney on foot, ordered relief trains, and about 11 p m returned to the scene of the accident He examined the track for some distance to the rear of the train and no marks were found on the ties or rails east of the point of derailment The green tumbleweed, which had been pushed aside by the trucks, was found lying near the fourteenth unit of the train and he threw it over the embankment About 8 feet down the embankment there was a track clawbar Looking under the fourteenth unit he observed that a rail-joint had been disconnected on the high or south rail at a point about 160 feet east of bridge 518 54 The angle-bars had been removed and, on the first tie west of this joint, a tie plate was secured inward about 4 or 6 inches from the normal position for a tie plate, the two outside spikes were fully driven, but the two inside spikes were driven only part way There were about 20 loose spikes lying adjacent to the disconnected joint Two spikes, driven halfway, were at the south end of the second tie west of the joint and about 6 inches distant from the tie plate, which was in normal position A drift pin was lying near the joint The disconnected rail was lying on its side with its base toward the north and its receiving end near the north companion rail The two bond wires were straightened out, stretched in a northwesterly direction, and torn loose from the receiving end of the disconnected rail, but still attached to the leaving rail The ties were in their original positions in the ballast A close-up photograph taken under the fourteenth unit shortly after the occurrence of the accident was shown to Engineman Hecox This photograph reveals that angle-bars had been removed at a rail joint, track bolts, nuts, and tight-lock washers were lying adjacent to this joint Track spikes had been drawn from the undisturbed tie plate at the west end of the leaving rail, all track spikes and the tie plate had been removed from the south end of the first tie west of the disconnected joint A tie plate was placed inward about 4 or 5 inches from the normal alinement for a tie plate, there were two spikes fully driven in the two outer holes of this tie plate and in the two inside holes there were two spikes with their heads about 3 inches above the top of the tie, the shanks of the latter spikes were slightly bent and abraded, which indicated that they had been partially withdrawn Several loose spikes were lying on the ballast near the south end of the ties The ties were in alinement at their ends and were tightly secured by the ballast The two bond wires were still attached to the west end of the leaving rail at the disconnected joint, they were straightened out and extended diagonally

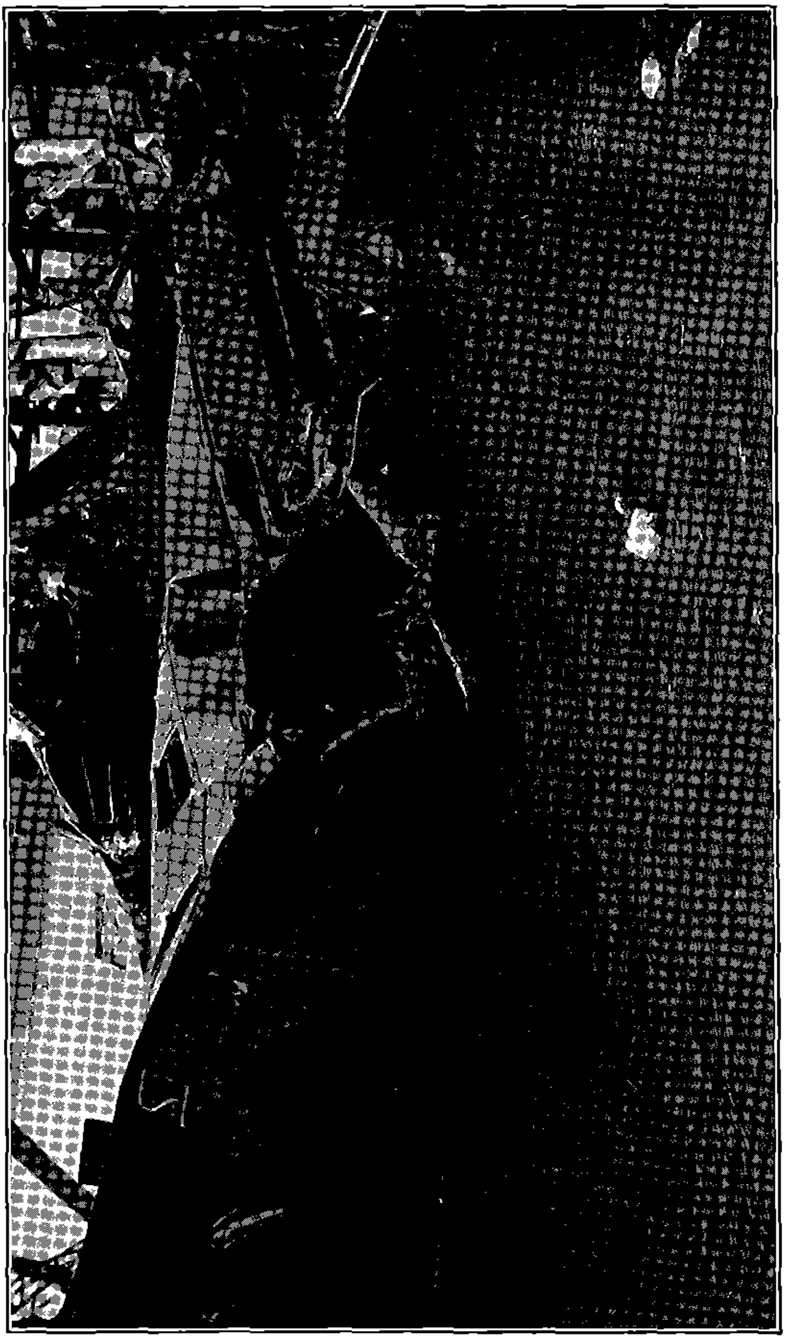

FIGURE 7.—View of 'Mission Dolores,' seventh unit, showing distorted condition of frame

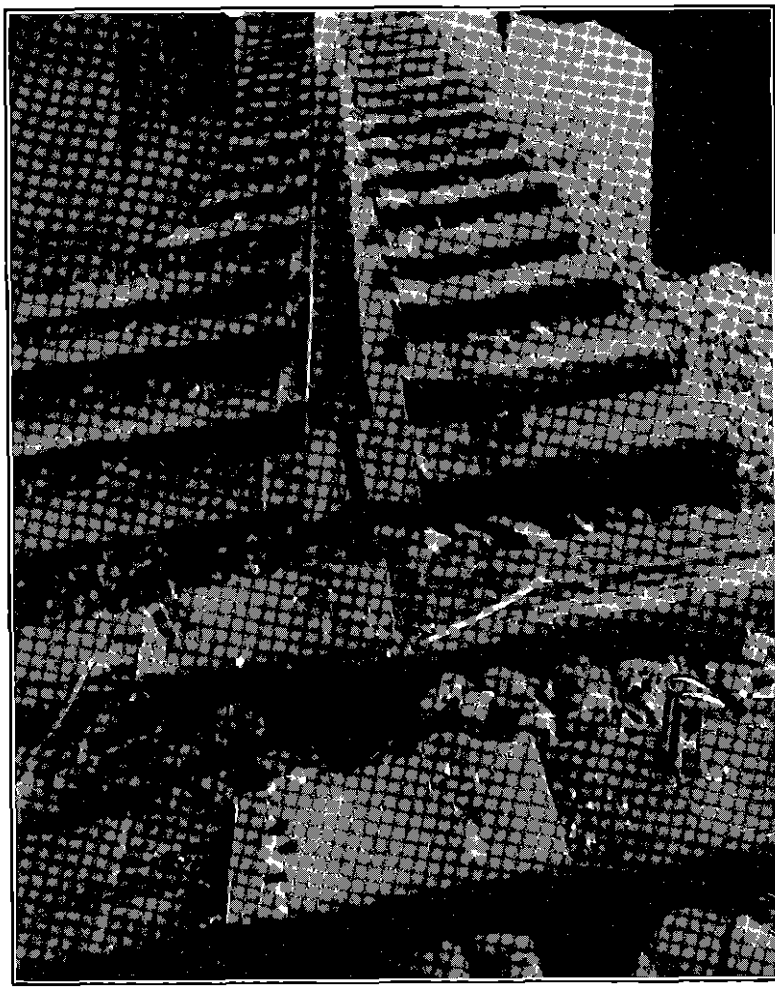

FIGURE 8.—View of ties Nos 1 and 2, misaligned tie plate bond wires, nuts, washers, and fulcrum spikes in tie No 2

across the line of the track Engineman Hecox identified this photograph as portraying conditions in the immediate vicinity of the disconnected rail joint exactly as he saw them

Firemen Kelley stated that, approaching the point of accident, he and the electrician were in the forward end of power unit No 2 endeavoring to start the motor when he felt a settling and skidding sensation, which indicated that the train had become derailed After the accident he was engaged for some time in rescue work It was about 3 a m when he first had an opportunity to observe track conditions at the point of derailment He corroborated Engineman Hecox's statement in all essential details It was his opinion that during the derailment some force exerting pressure against the outside of the rail had moved the displaced rail toward the north rail, from the point where it had been respiked, and that the rail in question had been arranged to form a derailer

District Road Foreman of Engines Fogus stated that he was in power unit No 2 at the time of the accident In response to a signal indicating motor trouble in power unit No 2 he had left the control cab of power unit No 1 about 1 minute before the accident occurred He had observed that the train was riding normally and was moving, as indicated by the speedometer, at a speed of 60 miles per hour The accident occurred about 9 33 p m It was his opinion that the wheels of power unit No 2 were striking the ties as the rough-riding action was quite noticeable The unit listed considerably to the left from the point of derailment to the point where it stopped After the train stopped he examined the equipment and found that the wheels of power unit No 2 had been in contact with the ties The pilot was nicked and loosened on the left front portion There were marks on the first pair of wheels of power unit No 1, indicating that they had been in contact with numerous objects The motors, gear housings, and pedestal binder-bolts had been in contact with the rails and, acting as guides, prevented power units Nos 1 and 2 from leaving the track The right and the left wheels were about 10 inches to the left of their respective rails Power units Nos 1 and 2 were not greatly damaged and after being re-railed were able to proceed under their own power Power unit No 3 became derailed and, inclining at an angle to the left, stopped with its front end about 3 or 4 feet above the top of the rail and its rear end down the bank All three power units had been sliding on the rails About 11 p m he proceeded toward the rear of the train and discovered that bridge 518 54 had been destroyed The last three cars in the train remained on the rails, the fourth car from the rear, or the fourteenth unit, was upright but its forward truck was derailed The track beneath this car was observed to be as described by Engineman Hecox There

were several marks on the displaced rail, caused by its being struck by some blunt object There were several loose spikes, which appeared to have been freshly removed from the ties, lying near the opening made by the rail being misaligned

Electrician Baumann stated that his duties as electrician in charge of the motors required him to ride No 101 regularly Approaching the point of accident he was in power unit No 2 endeavoring to start a motor which was giving trouble Just prior to the derailment the train was riding normally He said that he felt the unit leave the rail and then felt a skidding sensation combined with a wobbling action After the train stopped he found that the power units were derailed but there were no marks on the pilot which indicated it had struck rocks or other objects Sometime later he proceeded to the rear of the train and found conditions under the fourteenth unit to be as described by Engineman Hecox He observed that the bond wires were stretched diagonally across the track at an angle to the running rail The ballast adjacent to the displaced rail was not disturbed He found marks on the truck binder bolts and motor housings, which indicated that they had been in contact with the rails The binder bolts and motor housings served as guides and prevented the power units leaving the roadbed after derailment occurred It was his opinion that the rail in question had been moved inward and secured in that position

Brakeman Thomas stated that when leaving Carlin an air-brake running test was made and the brakes functioned properly en route Approaching the point of accident he was in unit No 4 and it was riding smoothly The train was not exceeding the speed restrictions He had maintained a lookout around curves and there were no indications of defective equipment A heavy brake application was felt, followed by rough riding, after which the unit was overturned down the embankment and stopped on its side After the accident, being busy with relief work, he did not have an opportunity to examine either the track or the equipment for some time His observation as to the track condition existing under the fourteenth unit corroborated that given by Engineman Hecox He thought that the spikes had been removed from twelve ties under the receiving rail

Brakeman Webster stated that by means of an air gauge located between the sixteenth and the seventeenth units, an air-brake running test was observed when leaving Carlin He remained in this location, maintaining a lookout around curves, until the accident occurred There was no indication of defective equipment The train stopped abruptly and he went back immediately to afford flag protection

Assistant Superintendent Foley stated that he arrived at the scene of the accident about 11 30 p m, August 12 He examined the track and equipment in order to determine the cause In effect, he corroborated Engineman Hecox's statement as to the track conditions under the fourteenth unit He found that the bond wires, attached to the rail immediately east of the joint involved, were stretched diagonally in a northwesterly direction but were broken loose from the displaced rail in question The south tie plate on tie No 2 bore a mark similar to a flange mark There was an indentation on the ball of the receiving end of the overturned rail which appeared to have been made by a wheel flange striking the end of this rail A number of track spikes, slightly bent and lying loose between the rails, bore marks indicating that they had been drawn by a clawbar Spikes in the north end of the south tie plate on tie No 1 bore marks of abrasion The track ballast was undisturbed There was no indication of derailment east of the displaced rail

Assistant Division Engineer Lundy stated that he arrived at the scene of derailment on August 13 and examined the track and the equipment From the initial point of derailment to a point about 1,000 feet eastward he found no mark of derailment or indication of dragging equipment The derailment occurred on the south or high rail, at a point 169 5 feet east of bridge 518 54 A sketch, drawn to scale, showing track conditions was used to illustrate his statement The track was laid on a 3° curve with a superelevtion of 4⅛ inches on the south rail He observed that the angle bars had been removed from the joint at the point of derailment and thrown down the embankment, angle-bar bolts and nuts were lying adjacent to the track, none was broken or cut, which indicated that they had been removed by a wrench All track spikes at the west end of the leaving rail at this joint had been drawn, however, the leaving rail and tie-plate were undisturbed All spikes and the joint tie-plate at the south end of the first tie west of this joint, hereinafter referred to as tie No 1, had been removed, and an intermediate tie-plate was placed 4⅝ inches inward from the normal position of the tie-plate which had been removed, there were two spikes fully driven in the two outer holes of this tie-plate and in the two inside spike holes there were two spikes with the heads about 3¼ inches above the tie and with the shanks bent slightly to the north, the two latter spikes had the appearance of being partially drawn The position of the misplaced tie-plate and the condition of the spikes which secured it indicated to him that the receiving end of the rail at the point of derailment had been moved

and secured 4⅝ inches inward from its normal position All inside spikes were drawn from the following nine ties Two spikes were driven close to each other and equidistant from the normal position of the rail and 8¼ inches from the south end of the second tie west of the joint in question, hereinafter referred to as tie No 2, the heads were turned outward and protruded a distance of 2¼ inches above the top of the tie There were four blocks of wood, each of which was about 2 inches by 3 inches by 6 inches, lying near ties Nos 1 and 2 The rail immediately west of the joint in question was found lying on its side with its base toward the north and its receiving end 1⅝ inches from the north rail and pointing diagonally in a southwesterly direction across the track The next rail westward on the left side was along the edge of the ballast and down the embankment to the south These rails evidently had been moved by some force striking at an angle, as evidenced by marks on the receiving end of the first misplaced rail The north rails were undamaged and undisturbed Starting at the third tie west of the joint in question the south ends of all ties were crushed and damaged by wheels, the damage increasing progressively westward At the time of observation the fourteenth unit was standing with its west end 20 feet west of the joint involved

Chief Engineer Kirkbride stated that he arrived at the scene of accident at 1 p m , August 13 He found that the track conditions and the derailed equipment had remained undisturbed from the time of derailment because of waiting for his inspection As a result of his examination measurements were taken at the point of derailment and a sketch was prepared under his supervision, the description of the conditions at this point, made by Assistant Division Engineer Lundy, was based upon this sketch The two bond wires were straightened out and were reduced in section, which condition indicated tensile strain, the fiber denoted drawn conditions similar to that produced when metal is tested in tension All these conditions indicated that the bond wires were forcibly torn away from the receiving rail Detailed examination of the misaligned tie plate disclosed that the two outer spikes were fully driven, but the two inside spikes projected above the top of the tie plate, the heads of the eastward and the westward spikes were 3¼ inches and 3½ inches, respectively, above the tie plate It was possible to remove the westward spike by means of thumb and forefinger, the eastward spike was not touched It was his opinion that this condition of the spikes was caused by the left front wheel of power unit No 1, as it left the leaving rail, engaging the outside surface of the ball of the receiving, or misaligned rail, then dropping to the base and running

thereon a distance of 20 feet before leaving the rail This was indicated by the wheel marks starting outward in a gradual taper to a point where the marks left the rail The pressure downward on the outer edge of the ball of the rail tended to press the rail inward against the two inside spikes This force was resisted by the rail strength being arched against the direction of the force There was a tendency for the train to follow tangential direction with a centrifugal force in proportion to its speed of 60 miles per hour The misaligned rail, being engaged by the pilot casting sliding upon it, was curving in a direction divergent to that of the train, therefore, the rail could overturn in one direction only, that being outward The result was that the eastward end of the misaligned rail revolved on the tie plate under the heads of the two outside spikes while the rail flange was pulling the two inside spikes upward sufficiently to turn clear of them Simultaneously, the rail was moved westward because of the friction created by the pilot casting running in contact with the ball of the rail A movement of 10½ inches was sufficient for the rail end to clear the spikes Subsequent wheel blows kicked the rail inward to its final position near the north rail The west end of the misaligned rail, still attached to the succeeding rail, was pounded into the ballast and covered by debris and equipment The track was gaged at joints and centers a distance of 11 rail lengths eastward from the point of derailment The south rail had a superelevation varying between 4 and 4⅛ inches, being 4⅛ inches at the point of derailment The gage varied between 4 feet 8½ inches and 4 feet 8⅞ inches, being 4 feet 8¾ inches at the point of derailment A series of tests was conducted to determine the actual force necessary to move a rail inward in the manner in which it appeared to have been done on the date of the accident A replica of the track at the point of accident was constructed, with the exception that sand ballast was used, and a spring balance was attached to measure the energy necessary to move a rail the distance that the misaligned rail was moved at the point of accident, the energy expended was as follows

Number of ties with inside spikes pulled	Movement of rail inward	
	4 inches	4½ inches
	Pounds	*Pounds*
8	709 5	742 5
10	445 5	495
11	363	412 5
12	313 5	364

Using a 10-inch journal jack, this test was accomplished with such ease that the jack ratchet was operated without a bar A 10-inch

journal jack could readily be inserted between the spikes, which were 8¼ inches from the end of tie No 2, and the ball of the rail A test was made in which only 5 minutes were consumed in uncoupling the joint angle bars, pulling the inside spikes from eight ties, and moving the rail inward 4½ inches, in this test a track-lining bar was used to move the rail

Roadmaster Williamson stated that his last inspection of the track involved was on the morning of August 11, when he rode over it on a motor car, 10 days prior to the day of the accident a walking inspection had been made, in both instances the track at the curve involved was in excellent condition He arrived at the scene of the accident about 11 30 p m, August 12, and found that the south rail, at the initial point of derailment, had been loosened and moved inward He corroborated Assistant Division Engineer Lundy's statement in all essential details The bond wires extended diagonally across the track The ballast was undisturbed and there had been no authorized movement of ties at this place for 18 months past Loose spikes, slightly bent and lying adjacent to the normal location of the south rail, displayed claw-bar marks The top of the ball of the misplaced rail had been recently painted with dark paint, which was dry when he examined it

Section Foreman Bianchini stated that he had been over the track in the vicinity of the point of accident on August 11 and it was in excellent condition at that time The ballast and the track had been undisturbed for some time There were no tools missing from the complement assigned to his gang He arrived at the scene of the accident about 1 hour after its occurrence He found that the conditions were as stated by Assistant Division Engineer Lundy

Section Foreman Jones, of the Western Pacific Railroad, stated that about 5 a m, August 13, he observed the track condition at the point of derailment He confirmed the testimony of other witnesses regarding the various positions in which the members of the track structure lay

Bridge Foreman Stone stated that on August 5, 1939, he had completed the work of reinforcing bridge 518 54 and it was in excellent condition

Signal Maintainer Grotegut stated that he arrived at the scene of the accident about 11 45 p m, August 12 His testimony corroborated that of other witnesses as to the condition of the track and the equipment He stated that about daylight, August 13, his attention was called to the fact that there was paint on the ball of the misplaced rail

Signal Maintainer Burg, who arrived at the scene of the accident about 2 hours after its occurrence, stated that the track conditions at the scene of the accident indicated deliberate sabotage

Signal Maintainer Hutchins stated that he arrived at the scene of the accident at 5 45 a m, August 13 He examined the signal apparatus to the rear of the train and found that it functioned properly About 6 10 a m he crawled under the fourteenth unit and photographed the displaced rail, ties Nos 1 and 2, and the tie plate which had been spiked inward from the normal position for a tie plate, all pictures were taken in natural light At this time he observed that the ballast was undisturbed and the bond wires were attached to the leaving rail but were broken loose from the receiving rail It was his opinion that after the angle bars were removed a rail could be moved inward 16 inches from its normal position before the bond wire would be broken

Signal Maintainer Gavey, of the Western Pacific Railroad, stated that about 8 a m photographs of the track conditions under the fourteenth unit were taken by him His testimony as to the positions in which various track structure members lay corroborated that of other witnesses

Herschel Smythe, a resident of Beowawe, Nev, stated that as a member of the coroner's jury he viewed the derailed equipment and damaged track at 6 a m, August 13 He observed that the fourteenth unit was derailed at its front end only, and there was a clearance of about 20 inches between the track and the bottom of the car He crawled under the car that he might distinctly see the condition of the track The angle bars had been removed at a joint of the south rail at a point about 167 feet east of a bridge over the Humboldt River The leaving rail was in its normal position but the receiving rail was lying on its side near the north companion rail and the ball was toward the south On the south side of the top of the ball of the rail at the receiving end there was a mark which had the appearance of having been caused by a wheel flange striking downward On the south end of the first tie west of the leaving rail at the disconnected joint, a tie plate was secured inward about 4 inches from the original position The two outside spikes in this plate were fully driven but the two inside spikes protruded about half the length above the tie and apparently had been partially drawn by the revolving action of the misplaced rail during the progress of overturning There were two spikes, driven about half their length and at an angle outward, a short distance from the normal position for a tie plate, he believed that these latter spikes had been used as a fulcrum in the process of prying the misplaced

rail over a distance of 4 inches A track-bolt nut lying near the disconnected joint bore indications of having been recently removed by a wrench There were several small blocks of wood about 7 inches long adjacent to the track at that point The tie plates and outside spikes on the south ends of a number of ties westward from the disconnected joint were still in place, but nearly all the inside spikes on these ties were drawn, of the spikes which were lying adjacent to the track none was sheared or broken, they bore indications of having been drawn by a clawbar, being slightly bent and the bottom surface of the heads being freshly scarred The bond wires, still connected to the leaving rail but broken loose from the receiving rail, were stretched out and extended diagonally across the track It was his opinion that the rail joint was disconnected, the inside spikes drawn, and the receiving rail moved inward about 4 inches and secured on another tie plate as a derailer When the train reached this point the first wheel flange struck the end of the receiving rail, revolved it, and then kicked it to its final position near the north rail His opinion, based on the evidence, was that some person had deliberately arranged the track at the point of accident and that it was an act of sabotage

P E Graf, chief engineer, Elko Power Co, Elko, Nev, stated that he took a number of photographs under unit No 14 at 11 45 a m, August 13 He corroborated the statement of Assistant Division Engineer Lundy regarding the position of the various parts of the track structure

Warren Monroe, newspaper publisher, of Elko, stated that he took photographs of track conditions under the fourteenth unit at 9 30 a m, August 13 He substantiated, in effect, the testimony of other witnesses

William VanVolkenburg, a resident of Elko, stated that at 11 45 p m, August 12, he observed the track conditions under the fourteenth unit He corroborated the testimony of Assistant Division Engineer Lundy regarding the positions of various track structure members, and the marks which were sustained by them

According to data furnished by the Federal Bureau of Investigation, the spike holes at the inside of the misaligned tie plate extended into the tie 4 6 and 4 95 inches, respectively The heads of the eastward and the westward spikes were 3 1 and 2 88 inches, respectively, above the surface of the tie plate

According to the train sheet, the last train which passed the point of derailment prior to No 101 was a west-bound freight train, which passed shortly after 6 p m, or about 3 hours 30 minutes before the accident occurred

According to data submitted by the carrier, a rail detector-car was last operated over the track involved on June 19, 1939, the last prior inspection was on October 8, 1938, there being an interval of 8 months 11 days between these inspections There were no rail defects recorded in the vicinity of the point of accident

Shortly after the accident a 25-ton Buda ratchet jack was found in the bed of the river a distance of 264 feet downstream from the railroad bridge It was greasy and there were no indications of rust The plunger was extended 4½ inches, a distance which would fit readily between a rail moved inward about 4 inches and spikes located the same distance from the end of a tie as was the case on tie No 2

The streamline train, "City of San Francisco," was owned jointly as follows C & N W, 21 63 percent, S P, 34 19 percent, and U P, 43 88 percent

The center of gravity of the Diesel-powered units on this train was 57 inches above the top of the rail The overturning speed on a 3° curve, with superelevation of 4 inches, is 124 5 miles per hour, and a speed of 60 miles per hour is well within the limits of safe practice as recommended by the American Railway Engineering Association

The 3 power units were constructed by the Electro-Motive Corporation according to the carriers' specifications, the frames were of molybdenum steel, in rolled sections, the sides of 27-gage galvanized iron over ⅜-inch plywood, and the trucks were 6-wheel type with motors mounted on the leading and trailing axles of each truck The cars were constructed by the Pullman-Standard Car Co according to the carriers' specifications, the end sills, bolsters, and needle beams were of high tensile Cor-Ten steel, of welded construction, the yield point being a minimum of 50,000 pounds per square inch and the ultimate strength a minimum of 70,000 pounds per square inch The center sills, side sills, posts, carlines, sheathing, roof, and all other framing were of aluminum alloy, the properties of which were as follows

Material	Dimension	Minimum tensile strength per square inch	Minimum yield strength (at 2% offset) per square inch	Minimum elongation in 2 inches
	Inches	*Pounds*	*Pounds*	*Percent*
17S–T Sheet and plate	0 041–0 128	55 000	32 000	16
	129– 258	55 000	32 000	15
	259– 500	55 000	32, 000	12
17S–T Rolled shapes		50 000	30 000	16
Extruded shapes		50 000	35 000	12
A17S–T Extruded shapes		35, 000	20, 000	18
18S½H sheet	051–0 113	30 000	[1] 24 000	5
	114– 203	30 000	[1] 24 000	6

[1] Approximate

Typical shear strengths were as follows

	Pounds per square inch
17S–T	36,000
A17S–T	26,000
53S–T	24,000
4S–½H	18,000

The specifications provided for a buffing stress of 400,000 pounds at draft gear without the use of buffers All couplers were improved tight-lock, EMC design, rubber-cushioned draft gears The construction of this train was completed December 27, 1937, and it was placed in service January 2, 1938 The builder's records indicate that this equipment was built according to Post Office Department specifications of 400,000 pounds buffing stress, with a safety factor of two, which fixes the minimum for actual failure at 800,000 pounds

The records of the Pullman Car Company indicate that a test was conducted February 16, 1937, using a 7-foot 10-inch section of the underframe taken from the center of a car, and containing the center-sill, side-sills, floor-stringers, one steel cross bearer, and three aluminum floor supports This section withstood a compression load of 880,000 pounds before any permanent deformation resulted On September 17, 1939, a test was made on a section of the center-sill cut out of the frame of the car "Twin Peaks," which was the ninth unit in the derailed train The results of this test were as follows

Item		No 1	No 2	Specification minimum
Yield point	pounds	45,000	34 000	39,000
Tensile strength	do	55 830	55 500	50 000
Elongation 8 inches	percent	20 7	20 3	
Reduction of area	do	28 0	26 0	

On October 3, 1939, the Aluminum Co of America, at its research laboratories, New Kensington, Pa , tested for tensile properties a portion of the web, the bottom flange of one channel, and the bottom angle of the center-sill of the ninth unit, the results of these tests being as follows

Location	Tensile strength	Yield strength set—0 2 percent per square inch	Elongation in 2 inches	Reduction of area
	Pounds	*Pounds*	*Percent*	*Percent*
Angle	56, 320	37 500	25 0	38 9
Channel web	56 030	34 700	24 0	34 3
Channel toe	56, 770	37, 100	24 5	35 7
Channel heel	56, 750	39, 100	24 0	40 8
Average	56, 470	37, 100	24 4	37 4
Specified minimum	50 000	30 000	16 0	

The following is a statement of damage, as formulated by the carriers and the Pullman Co

Position in train	Name	Damage
Unit No 1	S F 1 Power unit	$11,000 00
Unit No 2	S F 2 Power unit	11,500 00
Unit No 3	S F 3 Power unit	14 000 00
Unit No 4	S F 101 Baggage dormitory	43 500 00
Unit No 5	S F 401 Market Street	45 000 00
Unit No 6	S F 601 Presidio	[1] 117,073 29
Unit No 7	S F 602 Mission Dolores	[1] 103,199 37
Unit No 8	S F 701 Embarcadero	[1] 118,337 90
Unit No 9	N-120 Twin Peaks	[1] 90 658 30
Unit No 10	N-121 Chinatown	[1] 86,446 28
Unit No 11	N-122 Fisherman s Wharf	18,500 00
Unit No 12	N-123 Golden Gate Park	8,500 00
Unit No 17	S F Nob Hill	2,600 00
Total		670,315 20

[1] Demolished

OBSERVATIONS OF COMMISSION'S INSPECTORS

The Commission's inspectors examined the track a distance of one-half mile east of the point of derailment and found it to be maintained in excellent condition, no indication was found of wheel marks or dragging equipment east of a point 169 5 feet east of bridge 518 54 At this point the indications were that the joint on the high rail had been disconnected, the angle bars removed, and the east end of the receiving rail moved inward about 4⅝ inches on the tie The tie itself gave evidence that the tie plate was misplaced, as the outline of the original plate seat was clearly defined and the condition of the spike holes indicated fresh and recent disturbance of the wood fiber which would result from drawing a spike A dent in the receiving end of the misaligned rail at the top of the ball on the south side indicated that the rail had been struck by some heavy object, this dent was so located that if the receiving rail were moved inward about 4½ inches the flange of a wheel would strike the end at that point There were flange marks on the outside portion of the base of this rail There were no indications that this rail was curve-worn The wheels of power unit No 1 were examined at Carlin, there was a deep cut on the back of the flange of the left front wheel, this cut was ¾ inch in diameter and 3/16 inch deep, the flange, gaged ⅝ inch above the tread, was 1 31/32 inches thick There were several horseshoe-shaped abrasions on the back of the flange, a rolling test disclosed that these abrasions probably were caused by this wheel being in contact with angle-bar bolts The trucks of the power units were examined, and it was observed that the motor housings and the pedestal binder-bolts showed considerable wear, indicating abrasive action obviously sustained by sliding on the top of the rails Grooves on the left side of the motor housings of power units Nos 1, 2 and 3 indicated contact with the top

FIGURE 9.—View of receiving end of misaligned rail showing flange mark on outer corner of bolt

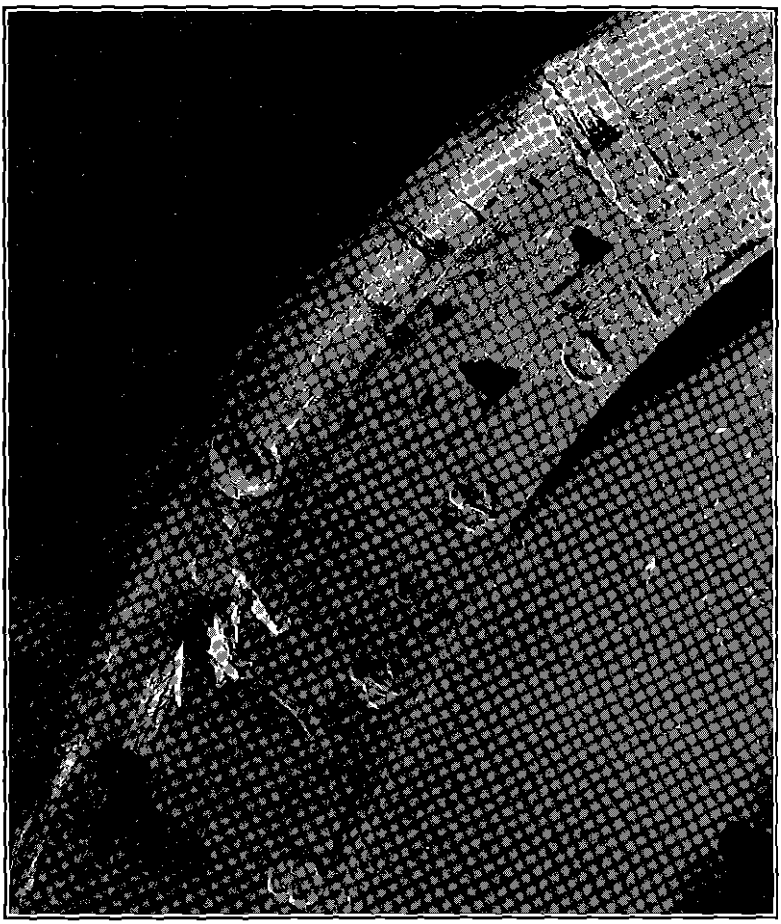

FIGURE 10.—View of back of flange of left No. 1 wheel of No. 1 power unit, showing mark caused by striking end of rail

of the rails, on all motor housings the grooves were worn to a depth which varied between 3/32 and 7/16 inch These marks were blue in color, which indicated friction burning Holes in the motor housings indicated probable contact with the bridge guardrail The inner faces of the right-pedestal binder-bolt nuts, which were 1-inch hexagonal nuts, were severely abraded and burned because of contact with the outside of the ball of the north rail, except one nut at the right No 2 wheel of truck No 1 of power unit No 1, which was worn to less than half its thickness, it was fused to its bolt, evidently due to sliding on top of the rail head There was somewhat greater wear on the motor housings and the pedestal binder-bolts on unit No 1 than on the two following units

The inspectors observed that the cars withstood impact shock up to a certain degree, after which some of them collapsed An absence of intermediate stages of damage was noticeable, in cases of badly damaged material the state of damage was total collapse One underframe indicated compression failure There was but little damage in cases where the tight-lock couplers and articulated joints held The only instance of telescoping was at the ninth unit, it became separated at its articulated joint and the shank of the tight-lock coupler at the opposite end failed The greatest damage sustained by the cars collectively consisted of failure of the superstructures The aluminum alloy metal in many cases tore loose from the rivets and was cut through in places where it had been dragged on the ballast, very few steel rivets were sheared off There was no indication of dispersion of strain, in many instances a badly torn section was adjacent to a section which had not buckled in the slightest degree In many instances the tie straps between center-sill flanges were buckled

DISCUSSION

According to the evidence, No 101 was not moving in excess of the maximum authorized speed of 60 miles per hour when it became derailed The train was riding smoothly and there was no indication of defective equipment Prior to arrival at the point of derailment the track was structurally sound, maintained in excellent condition, and the automatic block signals were displaying proceed indications Upon entering the curve on which the accident occurred, the engineman saw an object about 300 feet distant, which later was found to be a tumble weed, lying on the south or high rail of the curve When the train reached that point the front truck became derailed and the engineman thought that a rock had been struck Subsequent examination of the track disclosed that on the south rail the angle bars had been removed from a joint located 169 5 feet east of bridge 518 54, and the angle bars, bolts, nuts, and tight-lock washers were

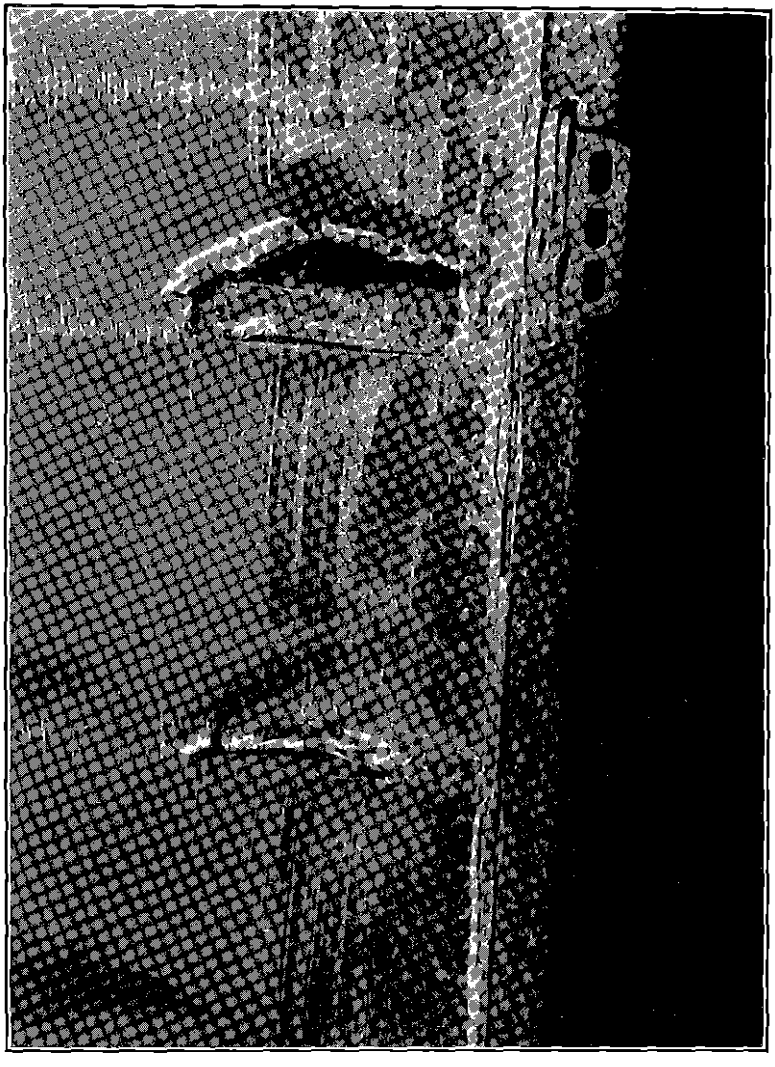

FIGURE 11.—View of fourth unit, showing results of sliding on rock ballast

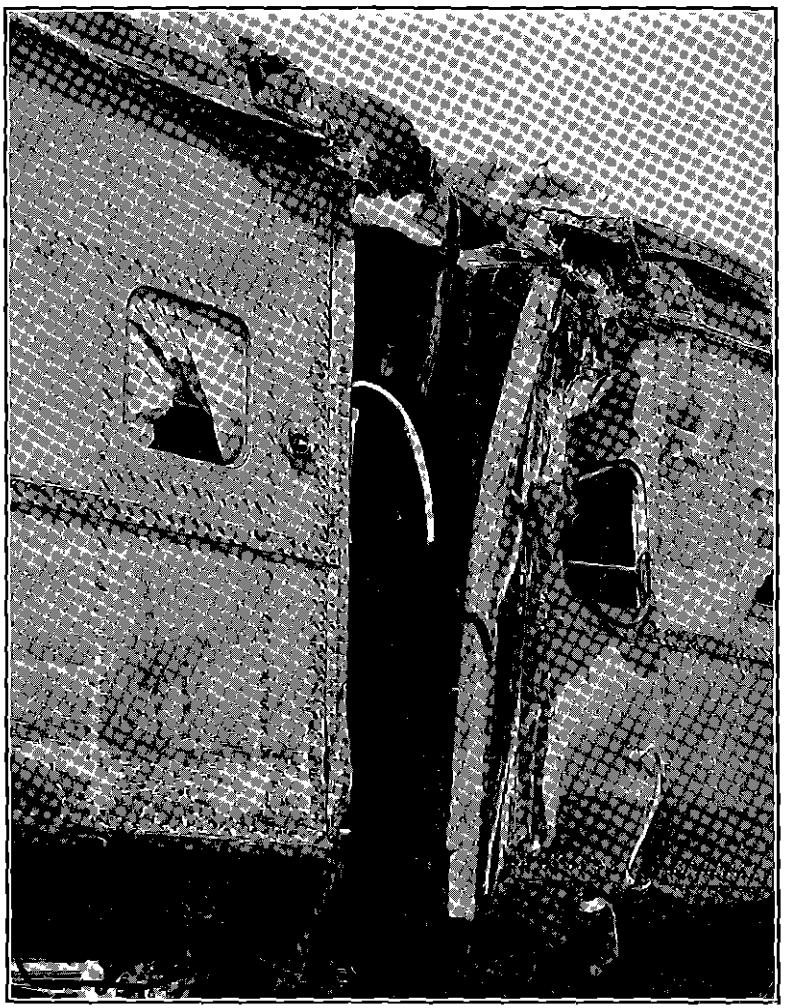

FIGURE 12.—View of fourth and fifth units showing results of striking bridge truss

lying adjacent to the disconnected rail Apparently a wrench had been used to remove the nuts, as none of the bolts was cut or broken The joint tie plate on the first tie beneath the receiving end of the disconnected rail had been removed and an intermediate tie plate had been placed 4⅝ inches inward from the alinement of the south rail and fully spiked with four spikes The position of this plate was not a result of the tie moving laterally under impact resulting from the derailment, as there was no indication in the ballast of any tie being moved from its original position The tie plate had been misplaced, as the outline of the original plate seat on the tie was clearly defined, and the spike holes indicated fresh and recent disturbance of the wood fiber such as would follow the action of withdrawing a spike Of the four spikes holding the misalined tie plate, the two outside spikes were fully driven while the two inside spikes were found withdrawn a distance of 2 88 and 3 1 inches, respectively, above the plate, this indicated a revolving lateral motion of the receiving rail which caused the inside spikes to be drawn sufficiently to permit the rail to roll free The rail at the same time was being pushed westward because of the friction imparted to it by the pilot casting, a longitudinal movement of 10½ inches being sufficient to clear the spikes in order that the rail could be pushed laterally toward the north rail The receiving rail having been moved inward 4⅝ inches provided a gap approximately 1⅝ inches, as the ball of the rail was 3 inches in width The front wheel flange being 1$\frac{5}{32}$ inches in thickness could readily fit into the gap As the misalined rail was on the high side of a 3° curve the centrifugal force of 60 miles per hour would throw the wheel flange tightly against the ball of the leaving rail, and prevent the flange from riding over the ball of the receiving rail Further observation disclosed that all four spikes in the plate at the end of the leaving rail had been drawn without disturbing the position of the rail or tie plate All inside spikes on the south ends of at least nine ties following the point of derailment had been drawn A dent on the end of the receiving rail at the top and on the south side of the ball indicated that the flange of a wheel had struck the end of this rail There was a corresponding mark on the back of the flange of the left front wheel of power unit No 1 There were no damaged angle bars or bolts, which would have been the case had the rail been in proper alinement when the train approached The evidence is conclusive that this rail had been misalined before the accident occurred

The investigation developed that the receiving rail, after being freed by the removal of the angle bars and spikes, was pushed over by means of either a journal jack or track bar, it is probable that the former was used, as a jack was recovered from the river bed near

the scene of the accident After the accident an unusual spike arrangement was found on tie No 2, which would permit a journal jack to be placed between the spikes, driven 8¾ inches from the end of the tie and the web of a rail in normal position With the angle bars removed there would be sufficient slack in the signal bond wires at the rail joint to permit a rail to be moved inward about 16 inches before the bond wires would be broken, and a movement of only 4⅝ inches would be insufficient to disturb the circuit in such manner as to cause the block signals immediately east of the point of accident to display restrictive indications

The ball of the misaligned rail had been painted and a tumbleweed placed over the disconnected joint As any irregularities of track alinement are clearly defined by the reflection of a headlight on the shining surface of the rails, it is reasonable to assume that these measures were taken so that the engineman of an approaching train would be unable to detect the damaged track condition

About 3 hours intervened between the passage of the last prior train and No 101 It was developed by tests that only a comparatively short time was required to disconnect a rail joint, draw the spikes, and realine a rail as had been done in this case

When the power units became derailed on the curve, the first power unit traveled to the left a few inches, because of following a tangential line, however, the motor housings and the pedestal binder bolts prevented the power unit from leaving the roadbed

The cars involved in this accident were constructed, for the most part, of aluminum alloy As shown by the records, these cars were designed and constructed in accordance with the requirements of the Post Office Department specifications for railway mail cars, the underframes were designed to withstand a buffing stress of 400,000 pounds The Postal Department specifications require a safety factor of two in the calculation of buffing stresses, fixing the minimum for actual failure because of buffing shock at 800,000 pounds To determine that the requirements of these specifications were complied with, the manufacturer apparently relied upon calculations and results of tests of a section of underframe similar to that of the cars in the "City of San Francisco" This section was 7 feet 10 inches in length and withstood a compression test of 880,000 pounds before permanent deformation occurred After the accident, on September 17, 1939, similar tests were made at the Pullman Car Co laboratory, a section of frame removed from the car "Twin Peaks" was used and the results indicated that the material was in accordance with the specifications

On October 3, 1939, The Aluminum Co of America, at its laboratory, conducted tests on a portion of the center-sill removed from

the car "Twin Peaks," the ninth unit, using a piece near the point where a fracture had occurred The results of this test demonstrated that the material was well above the minimum requirements

These cars withstood impact shock up to a certain degree, beyond which there was practically a total collapse, there appeared to be no intermediate stage of damage A great amount of damage to the superstructures was sustained by the cars involved in this accident, especially those where the most fatalities occurred The aluminum alloy sheathing, which forms a part of the girder construction of the car sides, manifested a tearing characteristic, in that the metal readily tore loose from the rivets, also it was cut and torn badly because of being dragged on the ballast There was but little indication of dispersion of strain, in many instances a badly torn section was adjacent to one that did not buckle in the slightest degree

Any attempt to draw conclusions as to what might have occurred had standard all-steel passenger cars been involved in this accident, would be purely conjectural and speculative

CONCLUSION

This accident was caused by malicious tampering with the track

Respectfully submitted

S N MILLS, *Director*

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