RAILROAD ACCIDENT REPORT

DERAILMENT OF AMTRAK TRAIN NO. 1 WHILE OPERATING ON THE ILLINOIS CENTRAL RAILROAD NEAR SALEM, ILLINOIS

June 10, 1971

TRANSPORTATION SAFETY BOARD

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

REPORT NUMBER. NTSB-RAR-72-5

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ADOPTED AUGUST 30, 1972

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16. Abstract

Amtrak train No. 1, a southbound passenger train operating on the tracks of the Illinois Central Railroad between Chicago, Illinois, and New Orleans, Louisiana, derailed near Salem, Illinois, on June 10, 1971. Two locomotive units and the first seven cars were turned over on their sides. The derailment resulted in 11 fatalities and 163 injuries.

The National Transportation Safety Board determines that the probable cause of this accident was the displacement of the east stock rail of the southward main track by the false flange on the left-hand wheel on the leading axle of the rear truck of locomotive unit 4031. This wheel slid flat when the traction-motor armature bearings failed and locked the driving wheels. Failure to detect the sliding wheels was caused by an inoperative wheel-slip indicator.

The cause of six of the eleven fatalities was the ejection of passengers through the large side windows which broke when the cars overturned. The other fatalities were caused by passengers being ejected from the end of the car, being struck by a cross tie, and being hurled around the inside of the car. A total of 163 passengers and employees were injured when impacted against injury-producing surfaces inside the cars.

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FOREWORD

This iepoit of facts and ciicumstances and deteimination of probable cause by the National Transpoitation Safety Board is based upon infoima-tion developed in a field investigation and a public hearing The field investigation was conducted by the Safety Board in cooperation with the Fedeial Railioad Administration (FRA) and the Civil Aeromedical Institute (CAMI) of the Fedeial Aviation Administiation Much of the infoimation obtained concerning the injuries and the ciash-woithiness of the passengei cars is the result of CAMI's investigation and is contained in the Institute's final report of theii investigation of the accident, titled "Application of Commeicial Aiiciaft Accident Investigation Techniques to a Railioad Deiailment." The public heaiing was conducted by the Safety Board in St Louis, Missouii, on July 13, 14 and 15, 1971

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RAILROAD ACCIDENT REPORT

Adopted: August 30, 1972

DERAILMENT OF AMTRAK TRAIN NO 1 WHILE OPERATING ON THE ILLINOIS CENTRAL RAILROAD NEAR SALEM, ILLINOIS JUNE 10, 1971

I. SYNOPSIS

Amtrak train No. 1, consisting of 14 passenger cars and an Illinois Central Railroad Company (ICRR) four-unit diesel electric locomotive, while operating southward from Chicago, Illinois, to New Orleans, Louisiana, over the tracks of ICRR, derailed near Salem, Illinois, on June 10, 1971. The first two locomotive units and the first seven cars were turned over on their sides. The accident resulted in 11 fatalities and injuries to 163 people

The National Transportation Safety Board determines that the probable cause of this accident was the displacement of the east stock rail of the southward main track by the false flange on the left-hand wheel on the leading axle of the rear truck of locomotive unit 4031 This wheel slid flat when the traction-motor armature bearings failed and locked the driving wheels Failure to detect the sliding wheels was caused by the dispatch of the locomotive with an inoperative wheel-slip indicator

The cause of six of the eleven fatalities was the ejection of passengers through the large side windows which broke when the cars overturned. The other fatalities were caused by passengers being ejected from the end of the car, or being struck by a cross tie, or being hurled against the inside of the car. A total of 163 passengers and employees were injured when impacted against injury-producing surfaces inside the cars.

II. FACTS

A Location of Accident

This accident occurred at Tonti, Illinois, 111.2 miles south of Champaign, Illinois, in the Champaign District of the Illinois Central Railroad (ICRR), which extends 122.2 miles southward from Champaign to Branch Junction. Tonti, about 1.5 miles north of Salem, Illinois, is only a station point on the railroad.

In the vicinity of the accident, the two main tracks run north and south The west track is designated for southward movements and the east track for northward movements. The tracks are straight for a considerable distance to the point of the accident and the grade for southward trains varies from slightly descending to level.

A trailing-point crossover for the designated movements connects the two main tracks The south switch on the southward main track is 983 feet north of the Tonti station sign. A siding, designated as the business track, parallels the southward main track on the west. The north switch of the siding is located 29 feet south of the south switch

The derailment occurred on the southward main track, 12 feet south of the point of switch of the trailing-point crossover.

State highways, county roads, and buildings in the vicinity are shown in Figure 1

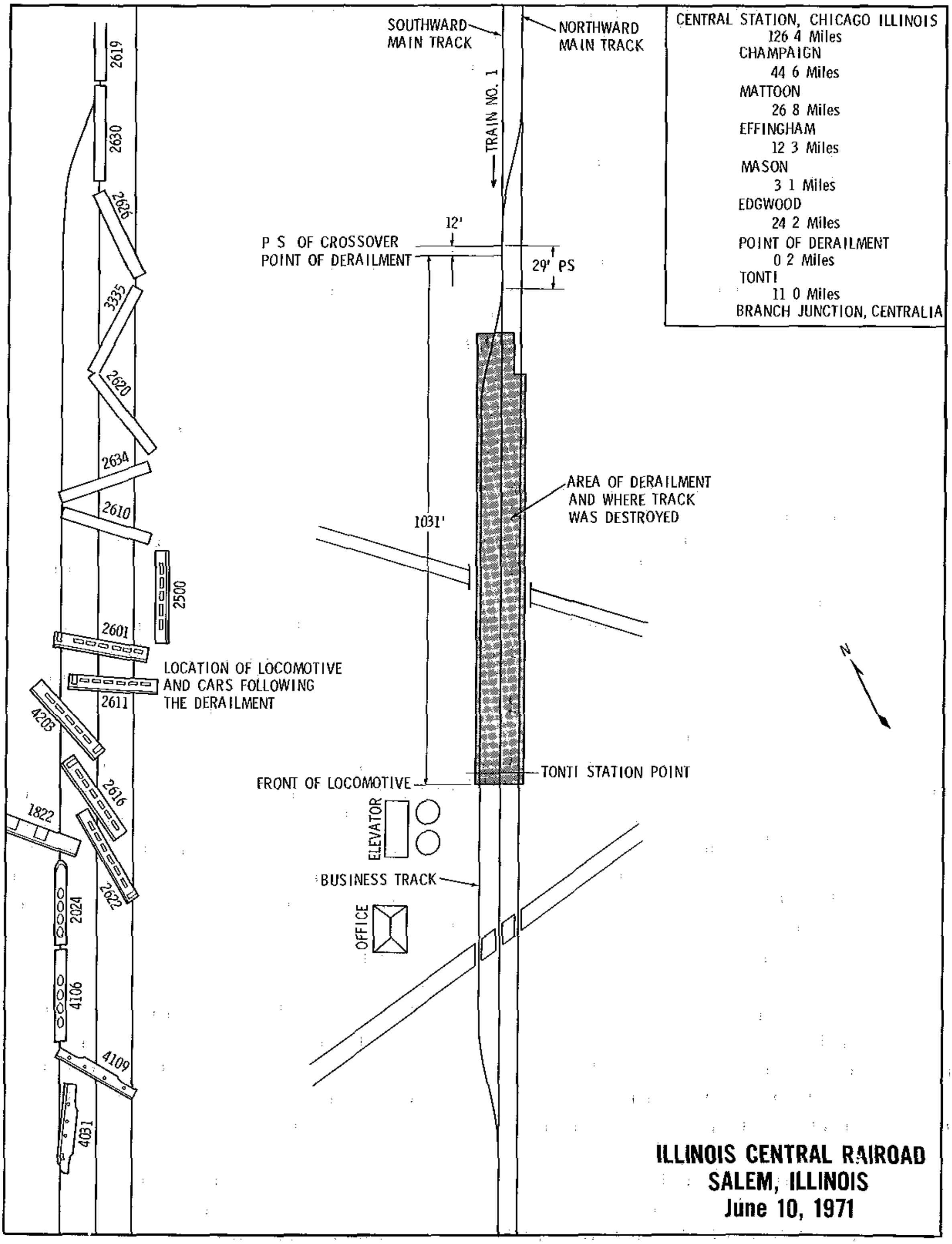
CENTRAL STATION, CHICAGO ILLINOIS
126 4 Miles
CHAMPAIGN
44 6 Miles
MATTOON
26 8 Miles
EFFINGHAM
12 3 Miles
MASON
3 1 Miles
EDGWOOD
24 2 Miles
POINT OF DERAILMENT
0 2 Miles
TONTI
11 0 Miles
BRANCH JUNCTION, CENTRALIA
SOUTHWARD MAIN TRACK
NORTHWARD MAIN TRACK
TRAIN NO. 1
12'
P S OF CROSSOVER
POINT OF DERAILMENT
29' PS
1031'
AREA OF DERAILMENT AND WHERE TRACK WAS DESTROYED
TONTI STATION POINT
FRONT OF LOCOMOTIVE
ELEVATOR
BUSINESS TRACK
OFFICE
LOCATION OF LOCOMOTIVE AND CARS FOLLOWING THE DERAILMENT
2619
2630
2626
3335
2620
2634
2610
2500
2601
2611
4203
2616
1822
2622
2024
4106
4109
4031
N
ILLINOIS CENTRAL RAIROAD
SALEM, ILLINOIS
June 10, 1971

Fig ıre 1.

B. Method of Operation

Trains moving with the current of traffic are operated by timetable, by train orders, and by cab signals of an automatic, continuous, inductive train-stop system Wayside signals are not used The cab signals can indicate only proceed (green) or proceed at restricted speed (red)

The rules and regulations of the ICRR's operating department require all train crewmembers to inspect the train as frequently as possible, giving special attention to sliding wheels and other defective conditions which might endanger the movement of the train Station employees, including operators, are required to be out of buildings and on the ground or station platforms when trains are passing, in order to inspect for defects. The station employees are required further to convey the results of their inspections to the traincrew by signals.[1]

In addition to the rules of the operating department, engineers on the ICRR are required to be familiar with the contents of booklets furnished by the Electro-Motive Division (EMD) of the General Motors Corporation on the operation of various designs of EMD-built locomotive units The following requirements are contained in one of these booklets which is titled "Engineman's Operating Manual Model E8":

"*Wheel Slip Relay* The wheel slip relay is located in the electrical control cabinet, behind the power contactors If one pair of wheels should slip while locomotive is under power, this relay will pick up, lighting the wheel slip light intermittently to warn engineman as the wheels slip, stop slipping and slip again. The throttle should be reduced to stop slipping, and sand applied to prevent slipping when throttle is reopened.

"*Alarm Indications For One Pair of Wheels Sliding* If one pair of wheels should slide when starting a train, the wheel slip light will flash on and off intermittently, but as the train speed increases, the light will stay on more or less continuously, and will not go out when the throttle is reduced and sand applied The light will go out when throttle is closed to idle.

Under this conditon, the engine crew should make an immediate investigation to determine the cause The wheels may be sliding due to a locked brake, a broken gear tooth wedged between the pinion and ring gear, or a motor bearing may have seized

* * * * *

IF A POWER PLANT IS ISOLATED BECAUSE OF REPEATED WHEEL SLIP * * * THAT UNIT SHOULD NOT BE ALLOWED TO REMAIN IN THE LOCOMOTIVE CONSIST UNLESS IT IS CERTAIN THAT ALL OF ITS WHEELS ROTATE FREELY."

Further, trip or daily inspection is required of all locomotive units by the Code of Federal Regulations (CFR), Title 49, Section 230.203.[2]

C Description of Locomotive Unit 4031

Diesel electric unit 4031 was an EMD, E-8A, car-body type, rated at 2,250 horsepower and built in June 1952. Its total weight was 323,320 pounds The control compartment, located in the forward section, had a rounded nose in front of and below it. The unit had two six-wheeled roller-bearing trucks. (See Figure 2.) Each of the two outside pairs of wheels of each truck was propelled by a traction motor mounted between the axle of the wheels and a crossmember of the truck The motor, which was supported on the axle by two friction type suspension bearings and on the truck frame by a rubber nose suspension pack, drove the wheels by means of a direct connection between a 25-tooth pinion gear mounted on the traction motor and a 52-tooth ring gear mounted on the axle (See

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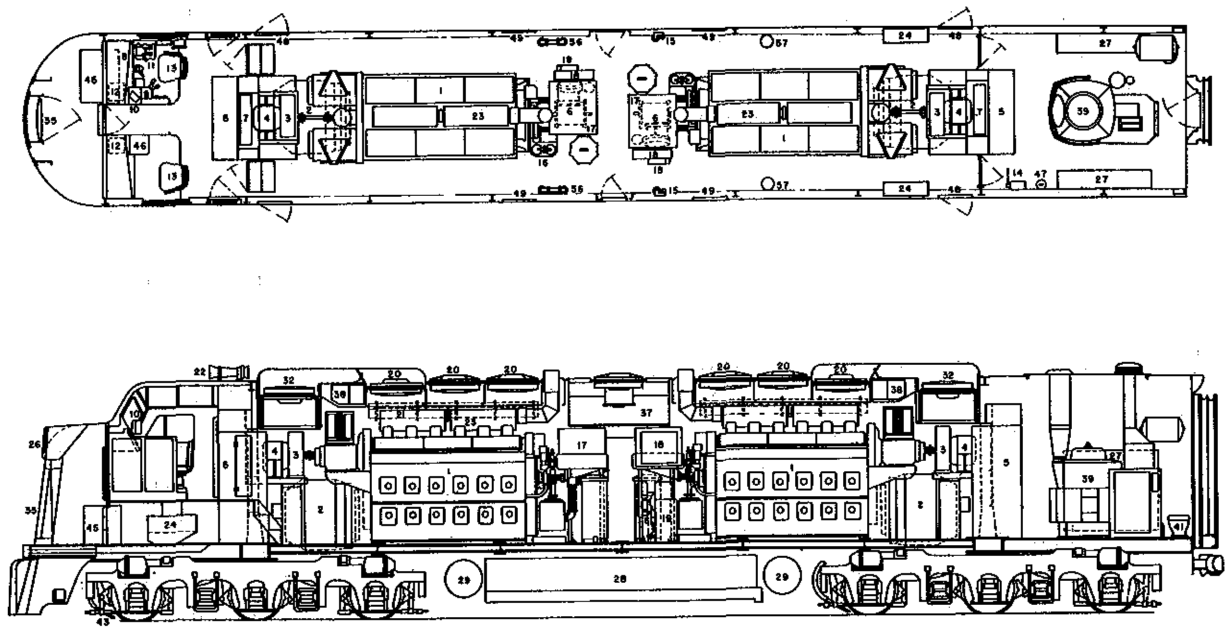
[1] Appendix A contains excerpts from ICRR Rules and Regulations of the Operating Department

[2] Appendix B contains excerpts from 49 CFR 230



1 Engine EMD Model 12-567B
2. Main Generator & Alternator
3 Generator Blower
4 Auxiliary Generator
5 Control Cabinet
6 Air Compressor
7 Traction Motor Blower
8 Instrument Panel
9. Controller
10 Speedometer Recorder
11 Air Brake Stand
12 Cab Heater
13 Seat
14 Hand Brake
15. Fuel Tank Vent With Flame Arrestor
16 Lube Oil Filler
17 Engine Water Tank & Lube Oil Cooler
18 Engine Control & Instrument Panel
19 Load Regulator
20 34" Fan & Motor
21 Radiator
22 Horn
23 Exhaust Manifold
24 Sand Box
25 Fuel Filler
26 Head Light
27 Batteries
28 Fuel (1200 Gal) & Water (1350 Gal) Tank
29 Main Air Reservoir
30 Air Intake & Shutters
31 Boiler Water Filler
32 Engine Room Ventilating Fan
33 Air Intake For Grids
34 Fuel Tank Gauge
35 Door (Plain)
36 Emergency Fuel Cut-Off
37 Dynamic Brake Hatch
38 "AC" Contactor Cabinet
39 Boiler
40 Air Compressor Aftercooler
41 Toilet
42 Battery Charging Receptacle
43 Sanding Nozzles
44 Blue Flag Bracket
45 Air Brake Rack
46 Water Cooler
47 Fire Extinguisher
48 Hinged Sash
49 Fixed Sash
50 Sand Box Filler
51 Boiler Room Shutters
52 Number Box
53 Boiler Air Intake
54 Boiler Stack
55 Battery Box Vents
56 Water Tank Vent
57 M R Pipeline Filter

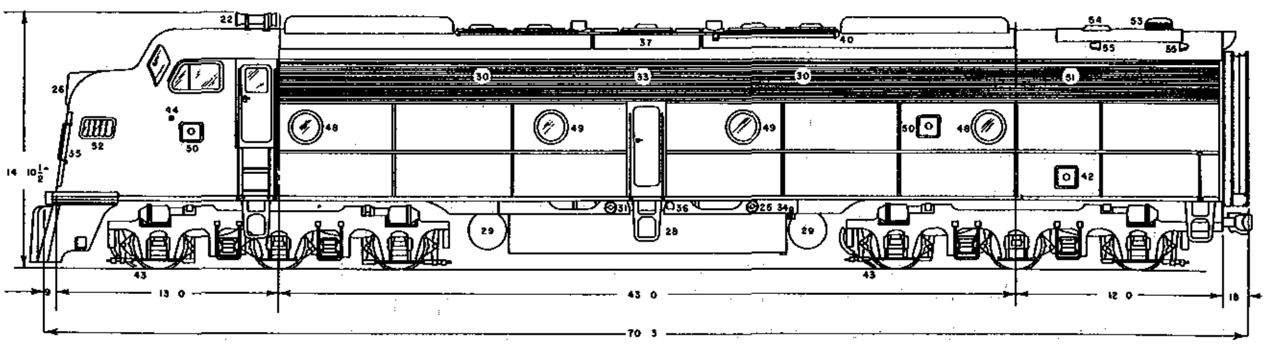
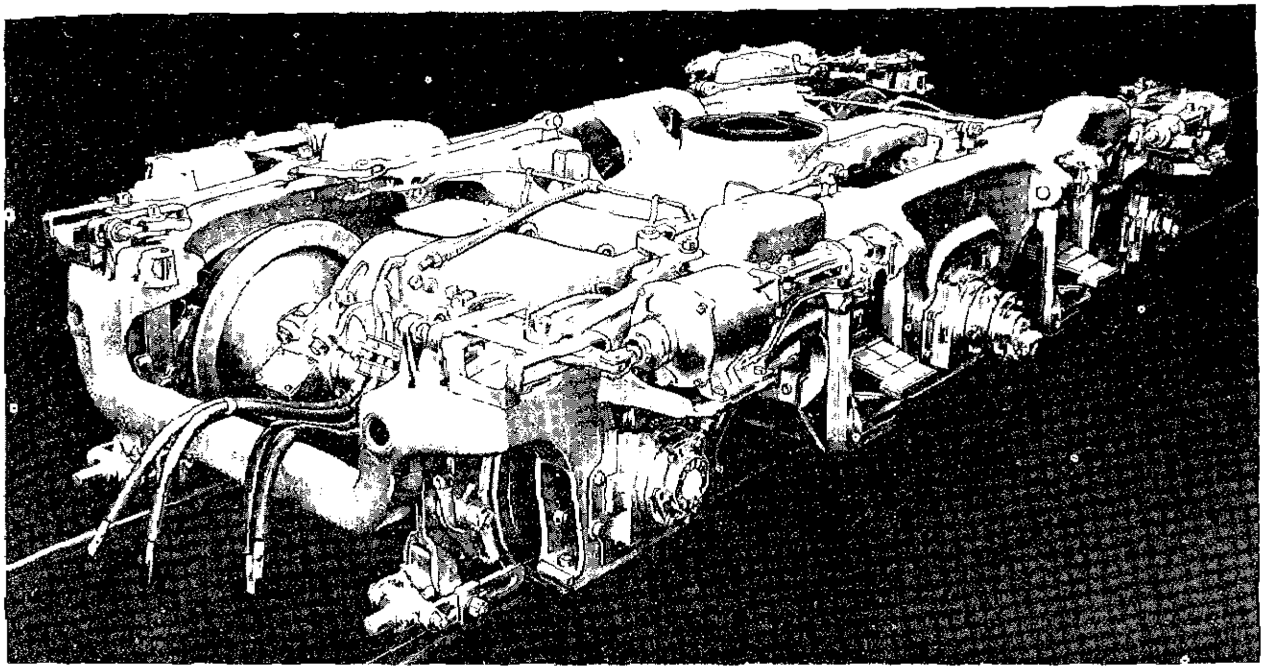


Figure 2.—Arrangement of EMD E-8 Passenger Locomotive Unit.



A Six Wheel Truck

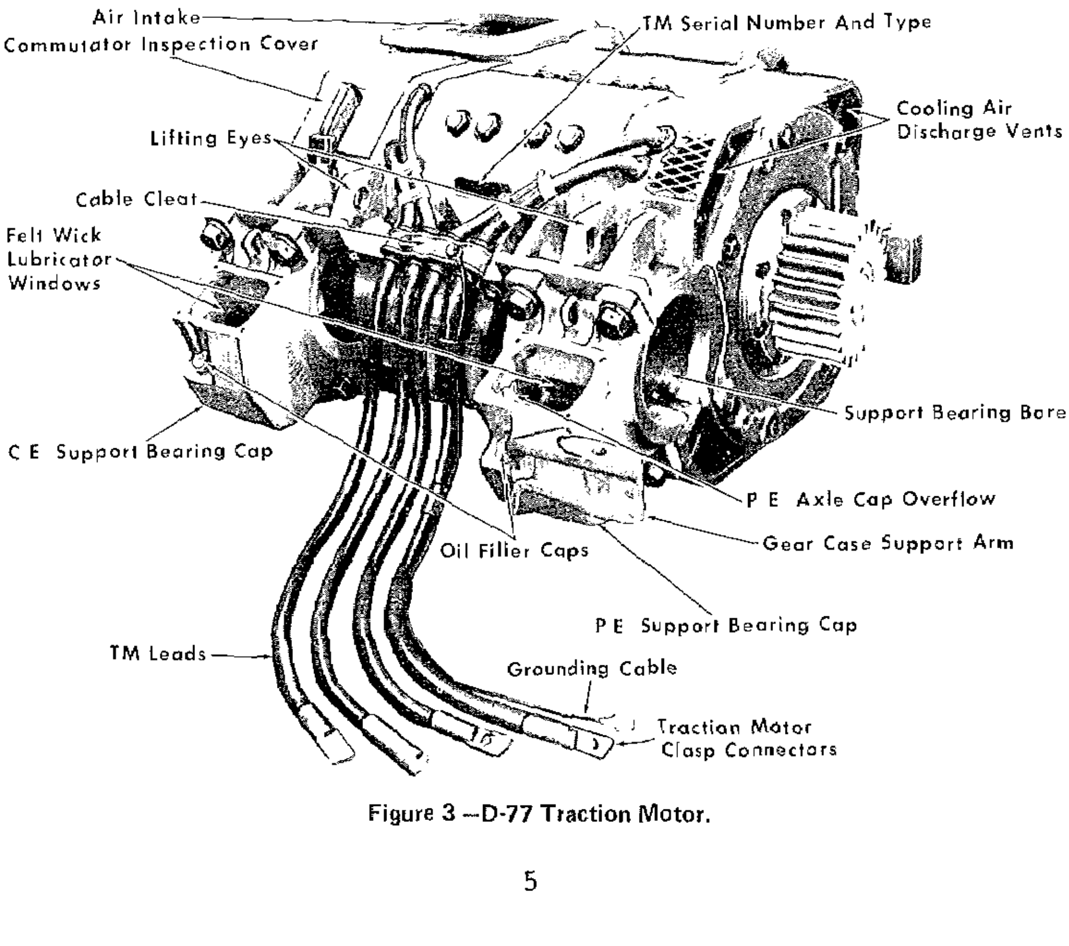


Figure 3 —D-77 Traction Motor.

Figure 3.) The center pair of wheels of each truck was not powered. A gearcase, which enclosed the gears, carried the grease for their lubrication. Grease could be added, as needed, by means of a filler cap in the gearcase.

1. Powerplant

The unit was provided with two 12-cylinder diesel engines, each coupled directly to an electrical unit containing a 600-volt generator which provided power for the traction motors and an alternator which provided power for cooling and ventilating fans. Hereinafter, this electrical unit will be referred to as the generator. Each diesel engine and generator were mounted longitudinally in the engineroom with the generator of each engine positioned toward the end of the unit. The generator end is considered the rear of the engine. The forward engine and generator, referred to as No. 1, provided power for the two traction motors mounted on the front truck, while the rear engine and generator, referred to as No. 2, provided power for the two traction motors mounted on the rear truck.

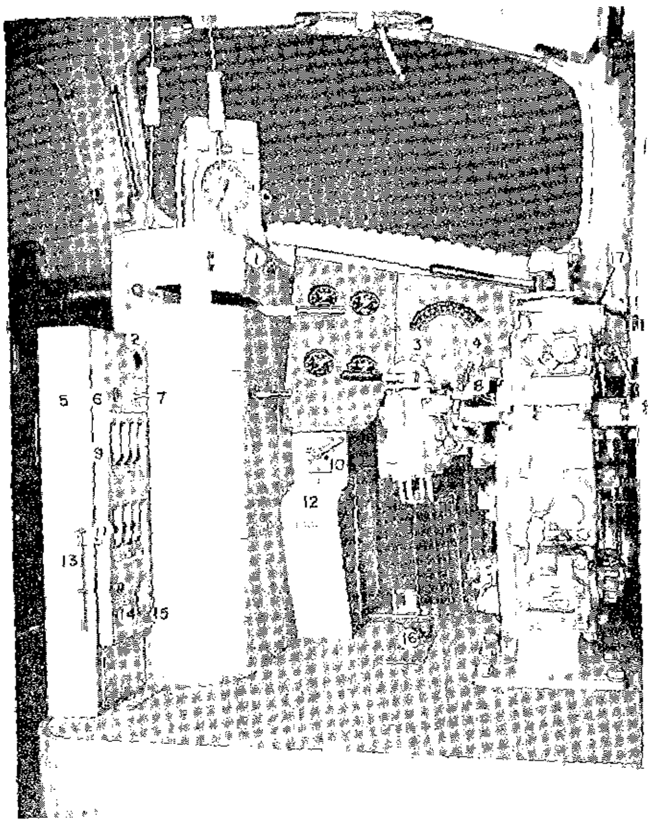
Electrical controls which governed the operation of the power or primary circuit of each engine and generator were contained in a cabinet mounted on the end walls of the engine room toward the rear of each engine. A power-operated reverser switch, remotely controlled, was used to change the direction of the flow of electrical current to the traction motors for forward and reverse movements of the locomotive unit. The reverser had three positions: forward, backward, and neutral. The reverser could be locked in the neutral position by placing a pin through a hole in the hub of the switch which aligned with a hole in the frame. Although power to the two traction motors in that circuit was cut off when the reverser was placed in the neutral position, the diesel engine and generator would respond to their controls.

In addition to the main generator, a 10-kw auxiliary generator, driven directly by each of the diesel engines, provided direct current at approximately 74 volts for lighting, control circuits, generator field excitation, fuel pumps, and charging of the batteries. This auxiliary generator was mounted above the main generator.

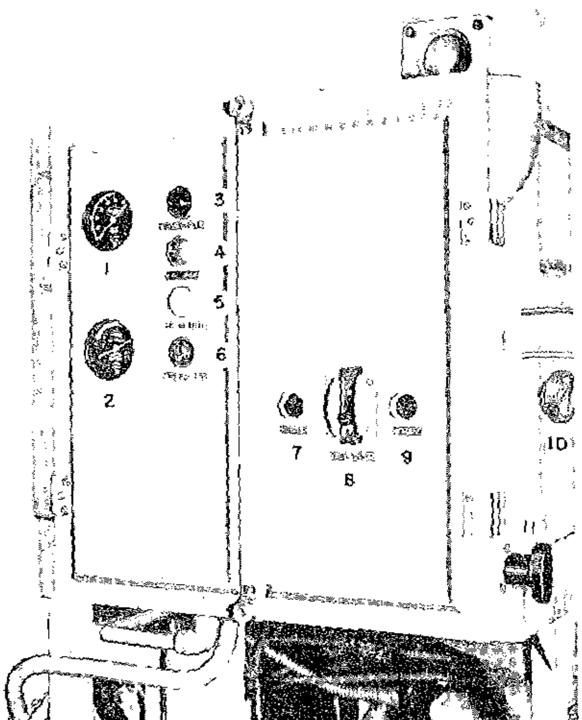
The armature of the traction motor was carried at each end by sealed, grease-lubricated roller bearings. The pinion gear is mounted on the end of the armature opposite the commutator end. The amount of lateral movement of the armature was controlled by the commutator-end bearing with an end plate secured to the end of the armature which bore against the H-ring of the roller-bearing assembly. The end plate was secured to the end of the armature shaft by a threaded projection screwed into a threaded cavity in the center of the armature end. Two locking screws which bore against the end of the armature shaft prevented the end plate from turning. Each bearing assembly was provided with oil throwers and seals to retain the lubricant.

2. Locomotive Controls

The controls for operating the lead unit and other units when they were coupled as a multiple-unit locomotive were located in the control compartment in the vicinity of the engineer's position. Included as part of the controls were the throttle, which controlled the speed of the diesel engine; a transition lever, which determined the power or dynamic braking aspect; a reverse lever, which determined direction; and two airbrake valves. The reverse lever was electrically connected to and controlled the position of the power reverser switches, previously described. In addition, a number of switches, gauges, and warning lights or indicators were provided. The dial of a speed recorder indicated the speed of the locomotive, however, tapes were not used to record the speed. A load meter indicated in amperes (from 0 to 1,500), the amount of current supplied to the traction motors in No. 1 circuit. Airbrake gauges were also provided. (See Figure 4.)



View of Engineer's Operating Controls in the Control Compartment.



View of the Engine Control and Instrument Panel Located in the Engine Room

1 Lube Oil Pressure
2 Lube Oil Suction
3 Red Light — Hot Engine
4 Yellow Light — Low Oil or High Suction
5 White Light — Ground Relay
6 Purple Light – No Power
7 Engine Stop Button
8 Fuel Pump Switch
9 Engine Start Button
10 Cooling Water Inlet Temperature Gauge
11 Isolation Switch

Figure 4

The following safety devices and warning systems are provided as part of the locomotive controls:

a. Safety Control (Dead-man) - provided a penalty application of the brakes in case the engineer becomes incapacitated.

b. Pneumatic Control Switch (PC) - automatically reduced power in response to a penalty application of the air brakes.

c. Ground Relay - detected an electrical ground in the primary circuit.

d Lube Oil Pressure Alarm - detected low oil or incorrect pressure in an engine

e No Power Alarm - was actuated when an engine is automatically shut down.

f. Hot Engine Alarm - warned of excessive engine heat.

Additional controls for the operation of each diesel engine were mounted on a panel near the front of each engine in the engine room. An isolation switch with two positions, "Start" and "Run", had to be placed in the "Run" position for the diesel engine to function. When the switch was placed in the "Start" position, the diesel engine was disconnected from the control circuit and was reduced to idle. Engine "Start" and "Stop" buttons as well as other switches and indicators were located on the panel. (See Figure 4)

3. Steam-Heat Generator

Each of the locomotive units involved in the accident was provided with an oil-fired steam generator which provided steam for use in the dining cars and for heating water in all cars. During periods of cold weather, the steam was also used for heating. The steam generator was located at the rear of each locomotive unit.

4. Wheel-Slip Protection Device

Locomotive units had been provided with a protective electrical circuit which warned the engineer when any pair of driving wheels of the locomotive slipped or slid. In unit 4031, this had been accomplished by the detection of a differential of current produced between the two traction motors in the circuit when either pair of driving wheels slipped or slid. The actuation of this circuit would have lit a wheel-slip indicator on the panel in front of the engineer which would have stayed lit until the current differential was corrected. There was no other alarm in this circuit.

If no current had been supplied to the traction motors, the wheel-slip protection device could not have functioned.

D. Operation of Locomotive Unit 4031 Prior to the Accident

On June 6, 1971, unit 4031 was dispatched as the lead unit of a three-unit locomotive consist in Amtrak's train No. 1 from Chicago, Illinois, to New Orleans, Louisiana Shortly after departing from Chicago, the No. 2 engine on the unit failed to supply electrical power, and it was isolated for the remainder of the trip by positioning the isolation switch at the "Start" position. Inspection of the unit in New Orleans revealed that the auxiliary generator in the No. 2 circuit was defective. It was decided to return the unit to Chicago with the No. 2 engine shut down so that repairs could be made by the ICRR at their Woodcrest shop, near Chicago.

The No. 2 engine was shut down in New Orleans and a yellow tag bearing the notation "Do Not Start" was attached to the isolation switch on the No. 2 engine control panel. This tag also carried a brief description of the defective condition. As an additional precaution, the power reverser for the No. 2 power circuit was placed in neutral position and a 3/8-inch diameter pin inserted to lock the reverser in this position for the movement to Chicago. The ICRR does not require that the power reverser be locked in neutral position when a diesel engine is shut down.

Unit 4031, with the conditions so described, was dispatched from New Orleans to Chicago as the middle unit of a three-unit consist. The engineers who prepared locomotive inspection reports at Canton and McComb, Mississippi, and at Centralia, Illinois, noted on their reports that the No. 2 engine of unit 4031 was shut down and tagged. The engineer making the locomotive inspection report at Champaign, Illinois, noted: "#2 Engine 4031 dead and tagged and has reverser blocked."[3]

After its arrival in Chicago, the locomotive was moved to Woodcrest shop for inspection, servicing, and repairs, and unit 4031 was placed in the repair shop. The auxiliary generator was replaced and the personnel responsible for making the repairs so noted and signed the locomotive inspection reports. The unit was then moved to the ready track where it was assembled as the fourth unit of a locomotive which consisted of units 2024, 4106, 4109, and 4031.

Tests were performed on the locomotive to ascertain whether it was suitable for service. A sequence test was made to determine if all motor circuits were functioning. The locomotive was considered ready for service and was assigned to Amtrak's train No. 1 for June 10, 1971.

E. Description of the Accident

1. The Train

Amtrak's train No. 1 was scheduled to depart from Central Station in Chicago at 8 a.m., and to operate on the tracks of the ICRR to New Orleans, arriving there at 1:30 a.m. the following day, having covered a distance of 921 miles. Stops were scheduled between Chicago and the vicinity of the accident as follows:

Stations	Mileage from Chicago	Time
Homewood	22	8:40 a.m.
Kankanee	55	9:08 a.m.
Champaign	127	10:20 a.m.
Mattoon	171	10:59 a.m.
Effingham	198	11:24 a.m.
Centralia	251	12:16 p.m.

[3] Appendix C contains a copy of the locomotive inspection report for unit 4031, June 7, 1971.

The engineer and fireman of train No. 1 reported for duty at the Woodcrest shop on June 10, 1971 and were assigned the locomotive consisting of units 2024, 4106, 4109, and 4031. A defective motor was found on the oscillating headlight of the lead unit 2024 while the crew was making the required inspections. The crew was instructed to turn the locomotive on a wye track which was located on the route to Central Station. This maneuver placed unit 4031 in the lead. On arrival at the station, the locomotive was coupled to 14 passenger cars arranged as follows: one baggage car, two coaches, one diner-counter, one lounge car, six coaches, one coach-food car, and three coaches. The airbrakes were tested and the train departed shortly after 8 a.m.

2. Description of the Passenger Cars

The passenger cars were of all-steel construction and were provided with tightlock couplers. The coaches and vestibules and steps at one end only but had end doors at each end that opened into the interior of the car. Toilet and lounges were provided at each end of the coaches. The upholstered reclining seats were provided with foot rests. The seats could be unlocked for rotation by pulling the double seat towards the center of the car. The cars were equipped with sealed, double-glazed picture windows, 28 inches high and 56 to 62 inches wide. The double pane of the window sash consisted of ¼-inch laminated safety glass on the inside and ¼-inch plate glass on the outside. The two panes were mounted in the metal sash frame with a rubber gasket. The sash was installed from inside the car and was secured by a retaining plate fastened to the inside of the car side by bolts or screws.

The dining car was divided into three areas: a kitchen, a serving bar, and an eating or lounge area which contained movable tables and chairs.

A number of the cars were equipped with air-conditioning systems powered by a propane-operated engine. The propane for the operation of these engines was stored in five compressed-gas tanks carried in a rack mounted under the car floor.

3. Operation of the Train Between Chicago *and the Point of Accident*

Shortly after the train departed from Chicago, the engine crew discovered that the locomotive was lacking power. The fireman checked the units and found that two engines in the center units and the No. 2 engine in unit 4031 were not loading. He made several adjustments on the engines and was then able to operate the two engines of the middle units but not the No. 2 engine on 4031. No additional trouble was experienced en route to Champaign, where the train arrived at 10:44 a.m., 34 minutes late.

Engine crews were changed at Champaign. The new crew was informed of the problems encountered between Chicago and Champaign, including the unsuccessful attempt to get No. 2 engine in unit 4031 to operate properly. While the new fireman was checking the No. 2 engine, the train departed from Champaign at 10:53 a.m., 33 minutes late. When he heard the No. 2 engine increase its speed in response to the engineer's operating the throttle and after he checked the governor and load regulator, the fireman concluded that the engine was operating. He then informed the engineer that all engines were operating.

The train made scheduled stops at Mattoon and Effingham. No inspections of the train were made during these stops. There were 211 passengers on the train when it departed from Effingham at 11:53 a.m. Train No. 1 passed Edgewood, the last open office, 24.4 miles north of the accident point, at 12:05 p.m. The station operator made an inspection of the east side of the train from his position on the platform. He observed no defects and signaled to the train crew accordingly. When train No. 1 passed a northbound freight train in the vicinity of Edgewood, the crew of the freight signaled to No. 1 that they had observed no defects. The crew of train No. 1 had looked over the train a number of times and had not observed any defects. The engineer stated that he had sufficient power to operate the train and that at no time was the wheel-slip light indicator lit or were any other warning signals received that would have indicated an abnormal operation of the locomotive.

4. Derailment of the Train

The train was moving at a speed of about 90 miles per hour on the southward main track as it approached the crossover between the main tracks at Tonti. The engineer was reducing speed in anticipation of a reduce-speed aspect at the next signal. The engine crew stated that the locomotive rode smoothly and that there was no indication of any defect. The engineer felt a bump as the locomotive moved over the south switch of the crossover and he then saw the locomotive derail. He immediately applied the brakes in emergency and braced himself as the first unit turned over on its right side. As the unit slid southward on its side about 390 feet, ballast and dirt were scooped into the cab partially covering the engineer. After the unit stopped, the fireman assisted the engineer and together they crawled through a window on the left side of the control compartment. After the crew got out, they observed that the second unit was on fire; and soon thereafter, the first unit caught fire.

As the train approached Tonti, the baggageman and the conductor were seated on opposite sides of the conductor's desk, which was located between two of the seats along the right side in the rear of the third car. The conductor was facing forward. The baggageman first noticed the impending derailment when the rear of the third car raised upwards and the car turned over on its right side. The conductor was hurled through a window as the car rolled over. The baggageman was thrown around the inside of the car, and, although he was injured, he was able to crawl out of the car after it came to a stop.

The flagman was seated at the rear of the last car. His first knowledge of the accident was when the brakes were applied in emergency and the car derailed.

5. Postition of the Locomotive and Cars

The first two locomotive units stopped west of the siding with the front end of the first unit 1,031 feet south of the point of derailment. The third and fourth locomotive units stopped upright on the siding and to the rear of the second unit. The first seven cars jackknifed, turned on their sides, and stopped in various positions, as shown in Figures 1 and 5 The next five cars jackknifed but stopped upright across the main tracks The remaining two cars derailed and stopped in line with the southward main track.

F Results of the Accident

1 Damage to the Locomotive and Cars

The first locomotive unit, No 4031, was heavily damaged and the second unit, No. 4109 was destroyed by the accident and the ensuing fire. The third and fourth units were not damaged so extensively as the other two

The first six cars were demolished. Their sides were bent and torn, their underframes were damaged, and the roofs of several of the cars were smashed downwards. Most of the windows on the sides of the cars which were in contact with the ground were smashed Many of the seats in the coaches had rotated and some were torn loose from the floor. Unsecured furniture in the coaches, particularly in the dining cars, was thrown around the interior of the cars. Broken rails from the track penetrated several cars In one case, a rail was driven up through the floor in the seat area and in another case a rail penetrated the toilet area. (See Figure 6) Propane tanks on some cars were torn loose and were scattered on the ground, whereas the fittings of others were torn loose The propane, however, did not ignite.

The next four cars were extensively damaged, and the rear four cars were damaged to a lesser degree

2. Casualties

Six persons riding in the head coaches, were ejected through the windows and killed when the cars turned over. Three other passengers were either crushed in the end of a car or were ejected from the end of the car One person was struck by a crosstie which was thrust through a window and one person apparently was fatally injured when he was thrown around and struck objects inside the car.

Some passengers in the coaches were injured by the rotating seats, some by being thrown against objects or by falling baggage, and others by the crushing of the car's superstructures Some passengers and employees in the dining car were injured when struck by loose furniture. In addition to the 11 fatalities, 163 passengers and employees were injured.

G Post-Accident Activities

The population of Salem, Illinois, according to the 1970 census, is 6,089 The hospital, with only 37 beds, is provided with limited facilities appropriate to its size and requirements Ambulance service is provided by three funeral homes in Salem The fire department, manned by volunteers, has two fire engines and one emergency vehicle

Prior to being elected, the Mayor of Salem was associated with the fire department in various capacities and was County Civil Defense Administrator, and, he was instrumental in formulating plans to cope with a catastrophe resulting from any source. Many of these plans were adopted by Salem Although there had been little opportunity to use any of the Civil Defense plans, the officials and people of Salem continued to practice and to improve the system. Salem has a modern system of emergency communications both for notifying a

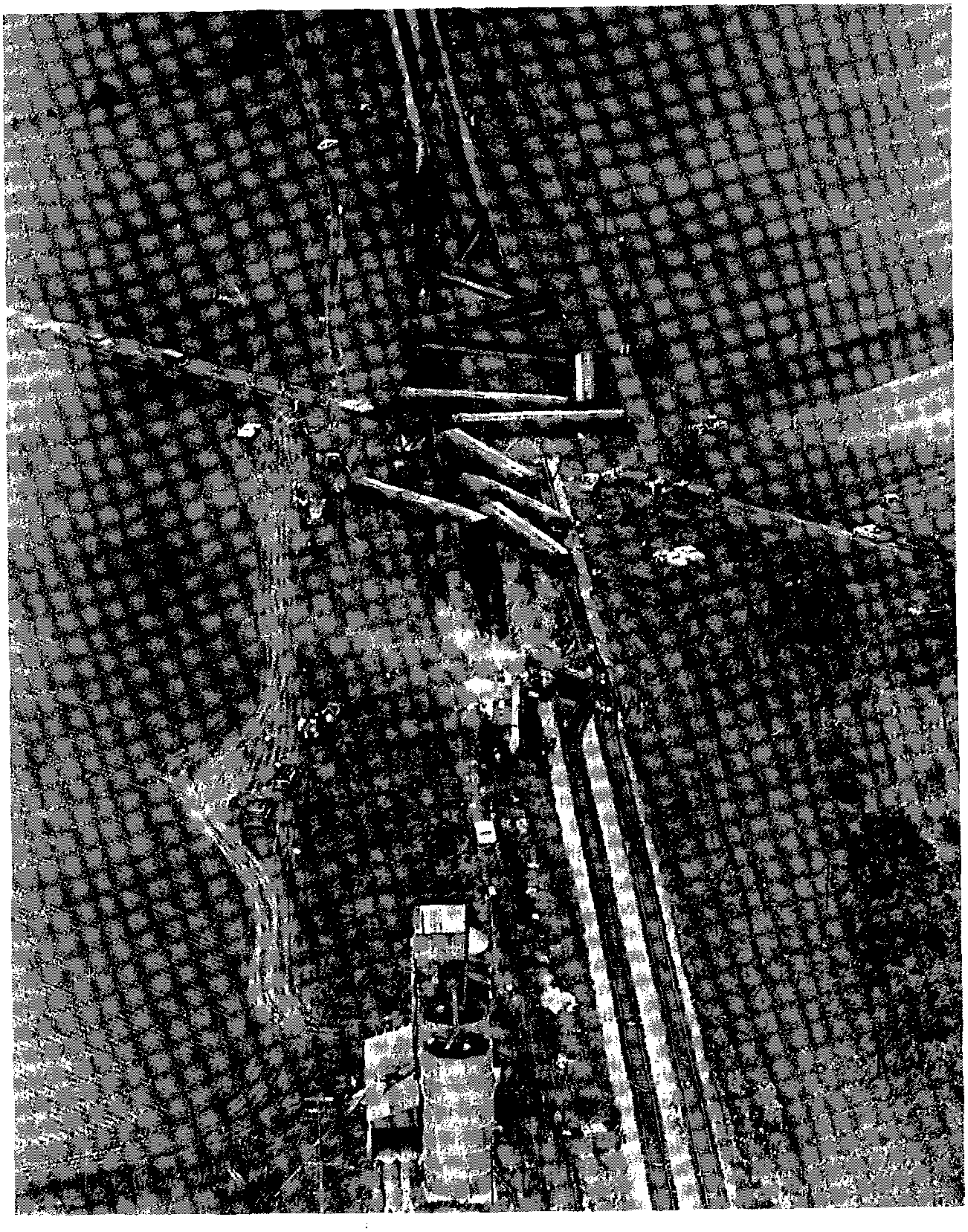


Figure 5 —The Location of the Locomotive and Cars After Derailment

Figure 6 —Rail Penetrated Interior of Car

central dispatcher of trouble and for notifying the responsible agency's personnel of an emergency.

At about 12:27 p.m. on June 10, 1971, information was received and relayed over the town's communications system that a catastrophic accident had occurred on the ICRR near the boundaries of Salem. Almost instantly, emergency personnel and vehicles were dispatched to the scene and the surrounding communities were alerted and requested to provide assistance. The hospital staff was alerted and they prepared to care for the injured. Doctors, including a dentist and a veterinarian, proceeded to the scene to provide first aid and to dispatch the most seriously injured promptly to the hospital.

A portable field hospital unit in Salem was made available and moved to the high school which was opened as an emergency station. Many of the less seriously injured passengers were treated at the high school, while some of the more seriously injured were first treated there and then moved to hospitals in the surrounding area. When the Salem hospital became filled, the injured were moved promptly to other hospitals Many of the uninjured passengers were brought to the high school and were cared for until arrangements could be made for them to continue their journey.

The State Police were notified immediately of the accident and two troopers were dispatched to the scene. It was through their direction and effort that most of the passengers were evacuated from the cars. Windows were broken out of the upper sides of the coaches and ladders were placed down into the cars. This permitted rescue workers to enter the cars and provided exits. Passengers too severely injured to help themselves were secured to plywood stretchers and pulled out by ropes. Rescue workers found that the end doors of the cars were blocked and either could not be used or were very difficult to open. One of the few problems that soon developed was a shortage of ladders.

Within about 2 hours after the accident, all the injured had been removed from the scene and were being treated, the fatalities had been removed, and the remaining passengers were receiving care.

H. Examination of Locomotive Unit 4031

1. At the Scene of the Accident

The rear truck of unit 4031 remained attached to the unit when it was turned over on its side. Both of the leading wheels of this truck had flat spots about 10-3/4 inches in length These flat spots had produced a false flange on the outside edge of the tread. (See Figure 7.) The fact that there were no other flat spots on the wheels indicated that the wheels had not turned after locking. When the gearcase cover was removed, no broken gear teeth or other defects in the gears were found which would have caused the wheels to lock.

The relays and the circuits of the wheel-slip device for the rear truck had been burned to such an extent that the condition of the relays before the accident could not be determined The light bulb of the wheel-slip warning device was found to be serviceable. The throttle was in the idle position; the automatic brake valve was in the emergency position; and all other controls were in their proper position for the operation of the locomotive.

2. Inspection of the Track

Due to the finding of the locked pair of locomotive wheels, the southward main track was inspected northward from the point of the accident to Effingham. Marks were found on the rails, on joint bars, and on heel blocks and frogs of turnouts which indicated that the wheels had slid over these appurtenances. The first such mark was found on a heel block of a switch at Mason, Illinois, 27.3 miles north of the point of the accident. The mark, 20 inches in length, had been caused by contact of the flange of the wheel with the heel block. The surface of the heel block was 1-9/16 inches below the top of

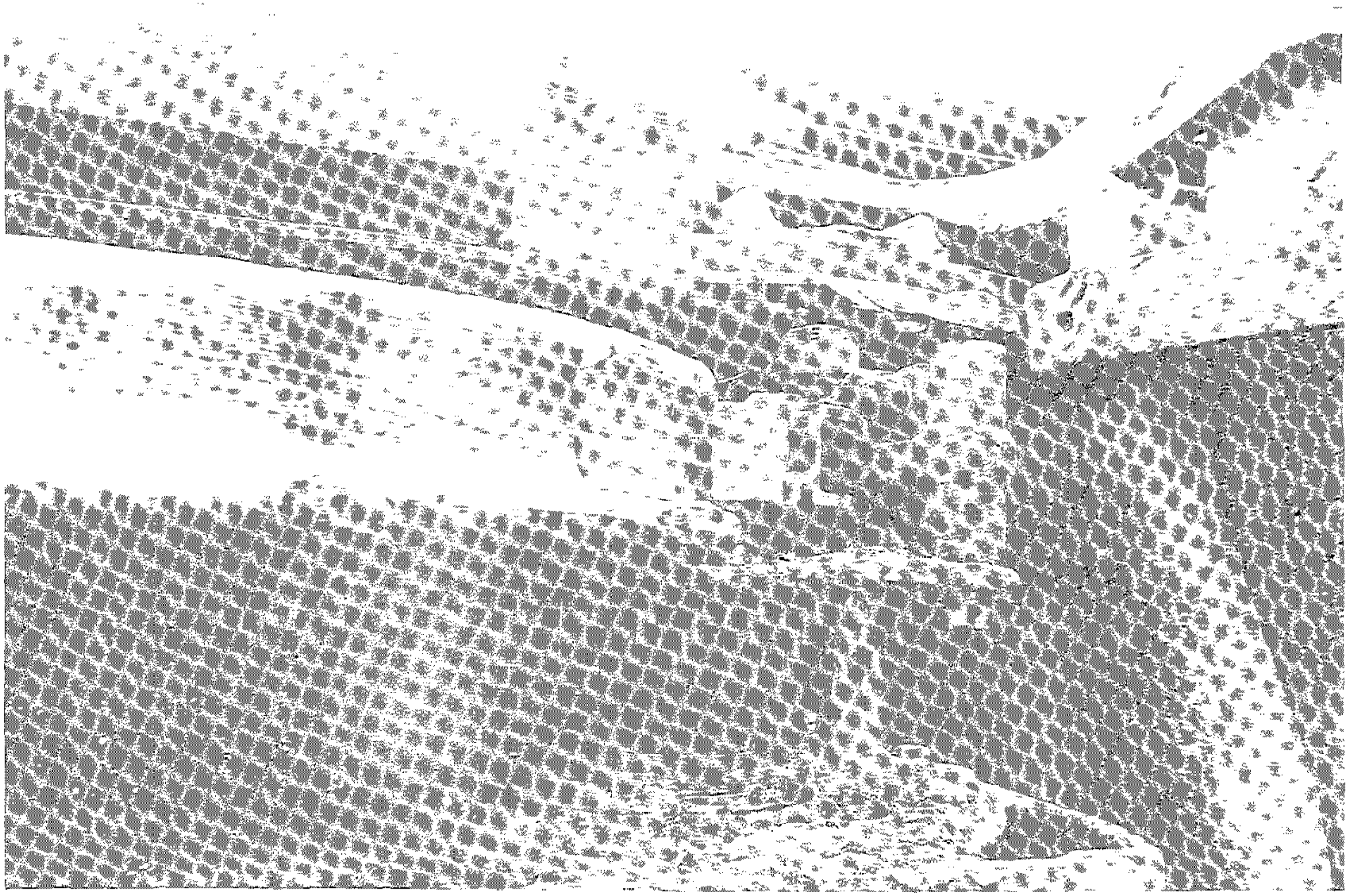


Figure 7 —Slid-Flat Spot on Locomotive Wheel as Observed at Scene of Accident. Gear Case has been Removed.

the rail and the flange height of the left wheel before it started to slide was 1-1/16 inches above the tread.

At Edgewood, several marks made by the wheel flange were found on the heel blocks of switches and several marks made by the false flange were found on the frogs of turnouts

Numerous other marks were found on the track between Edgewood and the point of the accident.

3. Later Examination of Unit 4031

In preparation for moving unit 4031 to the ICRR shops at Paducah, Kentucky, where the cause of the locked wheels and the failure of the wheel-slip device would be determined, the rear truck was replaced with another truck and the unit moved to Centralia, Illinois. While the unit was at Centralia, a review of the locomotive inspection reports by an official of the carrier disclosed that there was no notation on the reports that the blocked reverser had been corrected. The official examined unit 4031 in Centralia and found that the 3/8-inch pin was still in place in the power reverser of the No. 2 motor circuit, blocking the reverser in neutral position With the reverser so blocked, power could not be supplied to the traction motors and the function of the wheel-slip device was nullified.

4. Examination of Unit 4031 at ICRR Shops in Paducah, Kentucky

The leading pair of wheels and the traction motor were removed from the rear truck. The journal roller bearing boxes were removed and the bearings were found to be free of defects. The flat spots on the wheels were measured and the wheels examined. The results are shown in Figure 8. The traction motor was removed from the axle and the suspension bearings were found to be in good condition with sufficient oil. An attempt then was made to rotate the traction motor, but it was locked and would not move. Indications of excessive heating were observed on the armature bearing caps.

The armature was removed from the motor and disassembled. The commutator end roller bearing was damaged by heat and the grease was charred. (See Figure 9.) The pinion end roller bearing was damaged by heat. The steel rollers were flattened, grooved, and discolored. The inner and outer races were damaged. (See Figure 10.)

5. Examination of the Armature Bearings

The bearings, manufactured by SKF Industries, Inc. (SKF), were examined by a consultant from Purdue University and by representatives of SKF as part of the Safety Board's investigation. The inner rings of the bearings had attained a temperature of from 1,750°F. to 1,850°F. The rollers in the pinion end had reached a temperature of about 1,400°F, while the rollers in the commutator end reached a temperature of from 1,200°F. to 1,300°F. The H-ring showed no evidence of plastic flow in the areas where the flange contacted the rollers. It appeared that for a short period of time before seizing, the rollers had not turned although the inner race had rotated on the shaft.

Chemical and metallurgical examinations of the bearing by both the consultant and SKF representatives disclosed that the steel complied with the SKF specifications for bearings of this design.

Other parts of the bearing assembly such as the H-ring, the locking plate, and the oil seals and throwers on both bearings showed excessive wear on the parts which would have been affected by excessive lateral movement of the armature toward the pinion end. The H-ring on the commutator end bearing displayed no excessive wear. The end plate which bore against the H-ring indicated evidence of excessive wear where it contacted the end cover only. The end

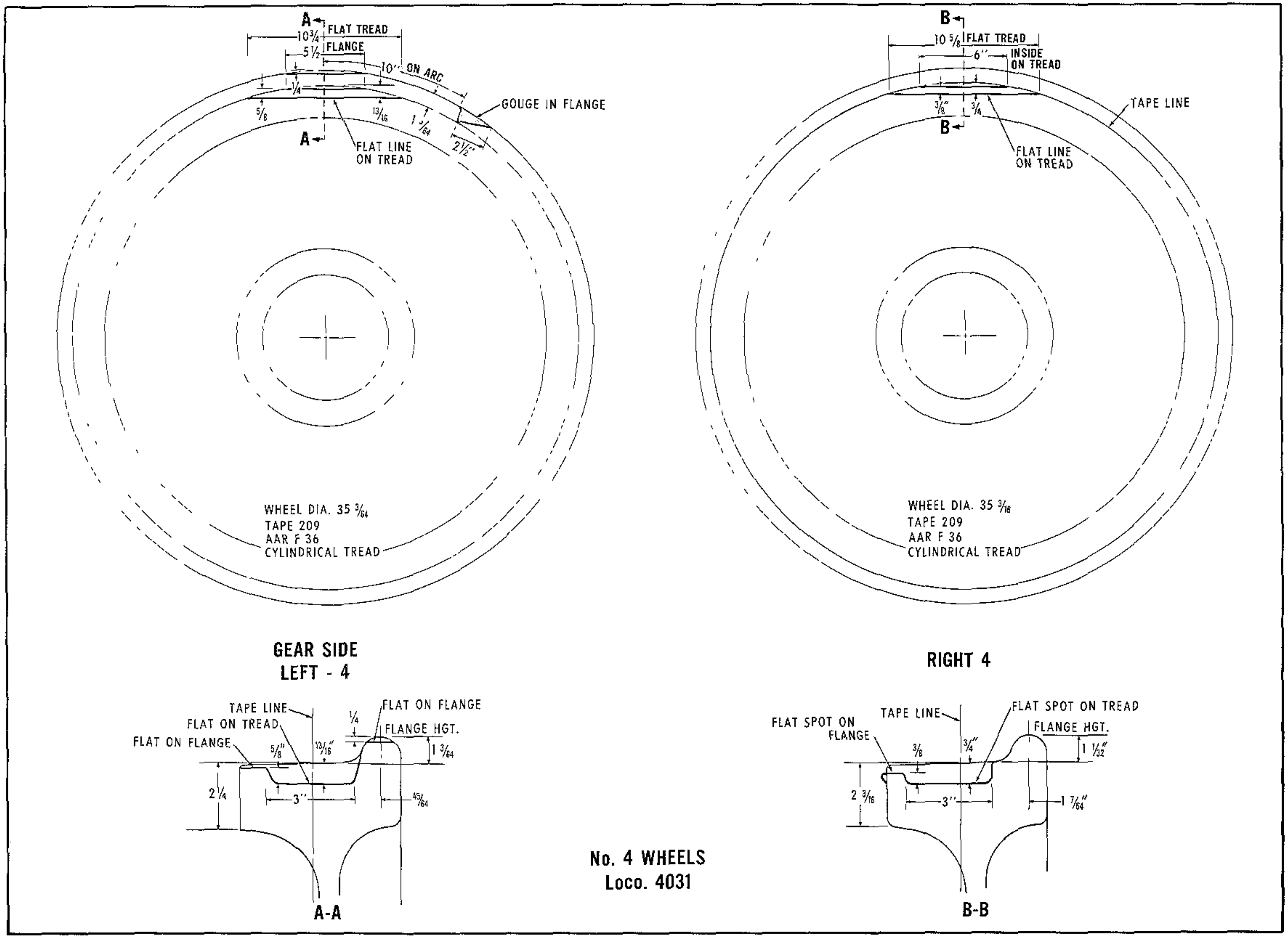

A
10 3/4 FLAT TREAD
5 1/2 FLANGE
10'' ON ARC
1/4
5/8
13/16
1 3/64
GOUGE IN FLANGE
A
FLAT LINE ON TREAD
2 1/2''
WHEEL DIA. 35 3/64
TAPE 209
AAR F 36
CYLINDRICAL TREAD
GEAR SIDE
LEFT - 4
TAPE LINE
FLAT ON TREAD
FLAT ON FLANGE
FLAT ON FLANGE
1/4
FLANGE HGT.
5/8''
13/16''
1 3/64
2 1/4
3''
45/64
A-A
B
10 5/8 FLAT TREAD
6'' INSIDE ON TREAD
TAPE LINE
3/8''
3/4
B
FLAT LINE ON TREAD
WHEEL DIA. 35 3/16
TAPE 209
AAR F 36
CYLINDRICAL TREAD
RIGHT 4
FLAT SPOT ON FLANGE
TAPE LINE
FLAT SPOT ON TREAD
FLANGE HGT.
3/8
3/4''
1 1/32''
2 3/16
3''
1 7/64''
B-B
No. 4 WHEELS
Loco. 4031

Figure 8

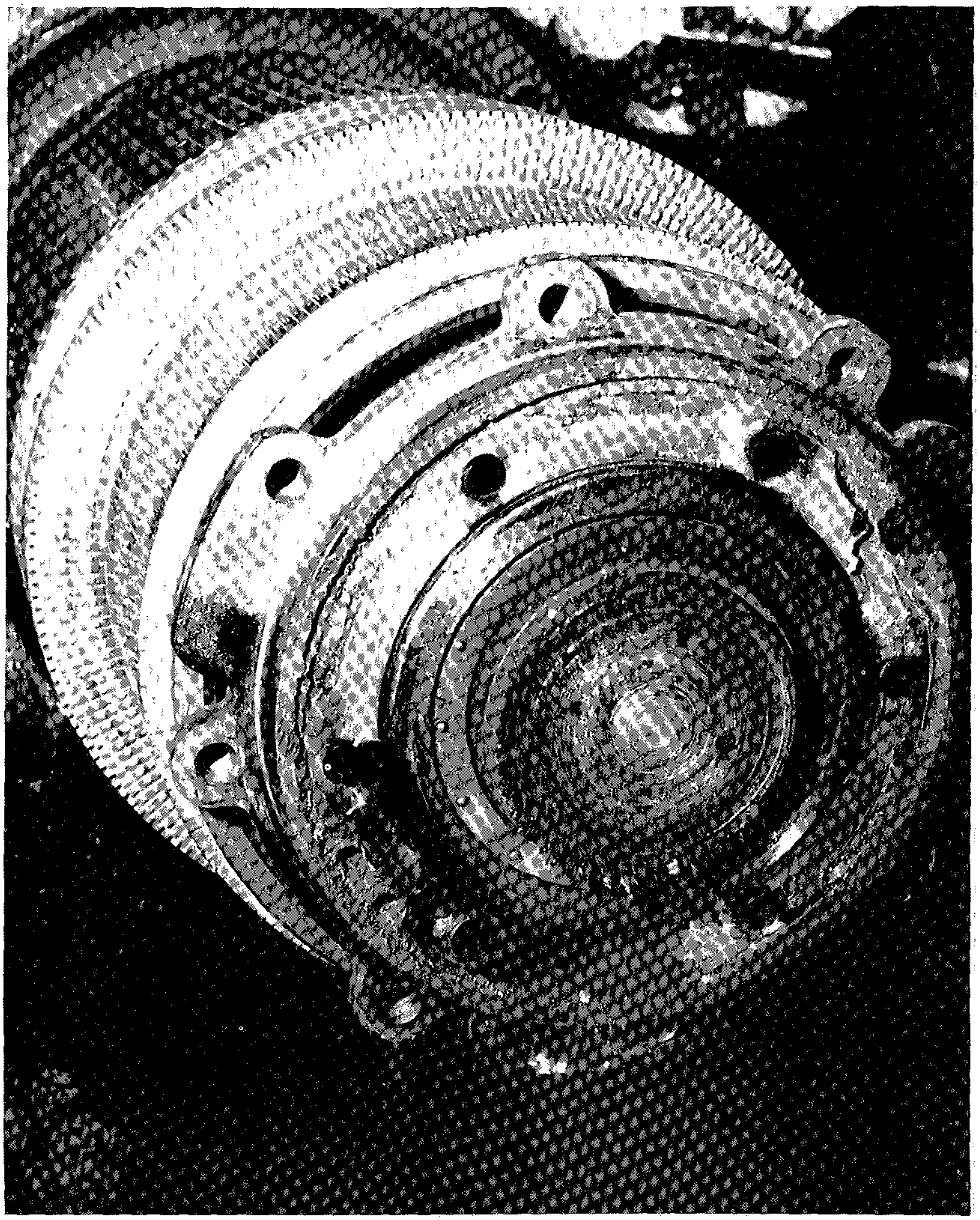


Figure 9 –Damaged Commutator End Bearing

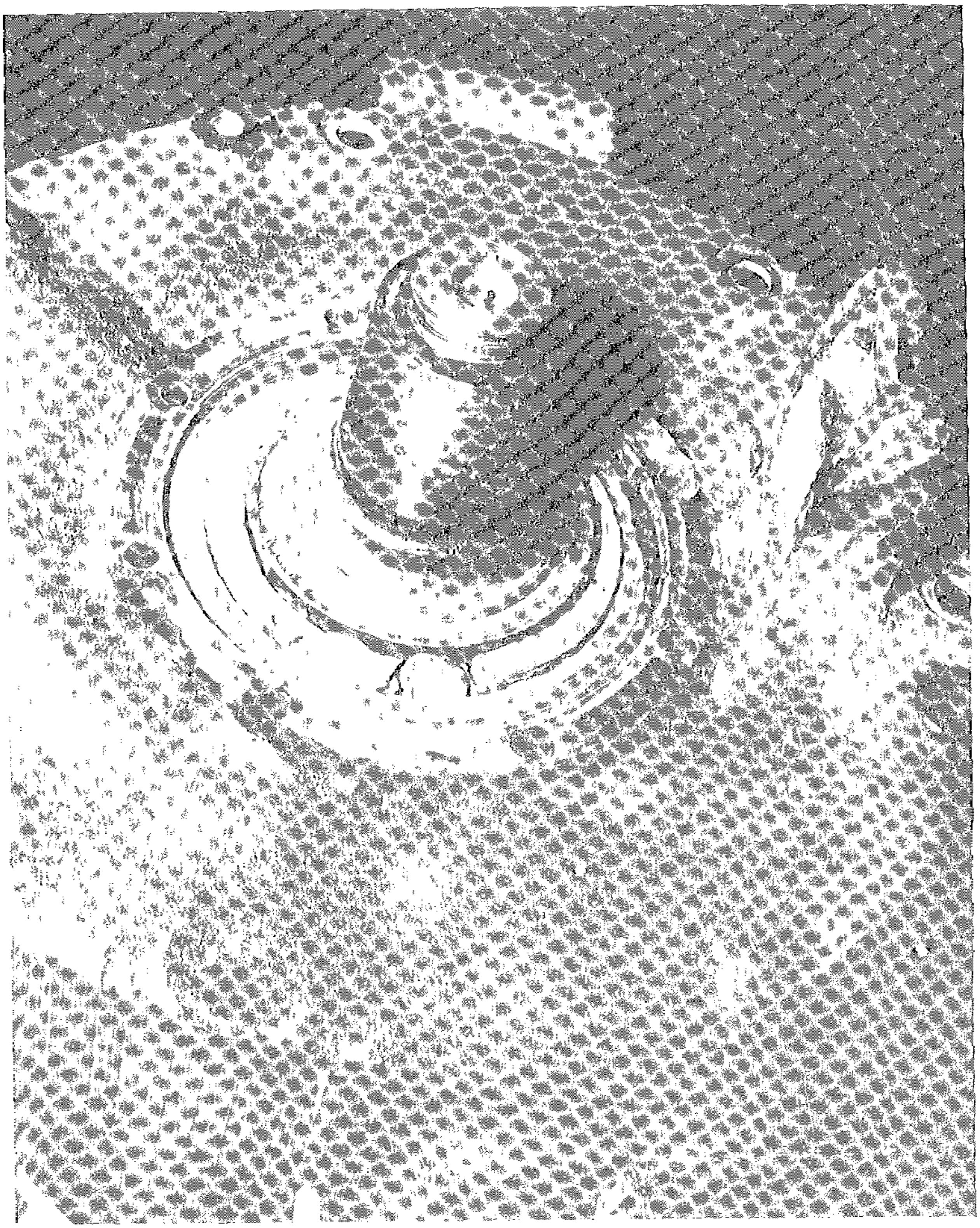


Figure 10 – Damaged Pinion End Bearing

of the armature shaft indicated no distress from movement of the locking screws.[4]

The failed bearings had been reconditioned before they were installed in the traction motor. A reconditioned bearing is one that has been removed from a traction motor and returned to the manufacturer's plant for reconditioning. All parts of the bearing are inspected, gauged, and any defective part is replaced with a new part The bearing parts are stamped to identify them as being reconditioned parts The bearing is then returned to the original owner with the same guarantee as that given for a new bearing The reconditioned bearings are coated and packaged in a manner similar to that for new bearings. After a bearing is removed from the package, it is difficult to determine whether it is new or reconditioned

The component parts of the roller bearings are marked with serial numbers and other identifying information when manufactured, and with additional markings when reconditioned. the SKF and ICRR companies do not maintain records by serial numbers of the bearings purchased. From the markings found on the pinion-end bearing and the SKF records, it was determined that the bearings had been returned to SKF on December 8, 1970, were reconditioned and returned on February 5, 1971.

I History of the Traction Motor

The traction motor which propelled the lead wheels of the rear truck of unit 4031 contained serial no. 53F476 and was built by EMD in June 1953 as a type D-37B. It was rebuilt by the Chandeysson Electric Company of St Louis, Missouri, and upgraded to a class D-77 motor The upgrading consisted, in part, of electrical improvements which qualified the motor for heavier duty operation than its original design would have permitted. The rebuilt motor was sent to the Paducah shops in November 1970 The traction motor was installed in a type GP-40 locomotive unit on November 11, 1970 On January 25, 1971, after being in service for 21,132 miles, the motor was removed because of electrical trouble and was returned to the Chandeysson Electric Company under warranty on February 17, 1971. During repairs, the reconditioned armature bearings (see above) were installed and the motor was returned to the Woodcrest shop on February 24, 1971. The traction motor was installed in unit 4031 on April 11, 1971. From the date of the installation to the time of failure, unit 4031 traveled a distance of 33,127 miles

J. The Chandeysson Electric Company

The main business of the Chandeysson Electric Company is the rebuilding of diesel-electric locomotive traction motors and generators. It is not a railroad-operated company, but it is associated with Illinois Central Industries Various railroads, in addition to the ICRR, send traction motors and generators to the company for repairs.

The methods and practices of the company were observed as part of the investigation of this accident Cyprina, a sodium-based grease, was used to lubricate the sealed armature bearings Quantity was determined by weight and the cyprina was distributed evenly throughout the bearing cavity Precautions were taken to preclude the entrance of dirt and other foreign material during the assembly of the bearing. Radial gauges calibrated from 0 001 to 0 100 were used to measure the permitted tolerances after the bearings were installed on the armature. Tolerances measured were between .003 and .012 inches.

The serial numbers of the bearings were recorded on the repair form, but a separate record of these numbers was not maintained.

After the traction motor was completed, noise and vibration tests were conducted The motor was operated at three speeds. At each speed an employee listened for noise produced by the bearings and placed his hand on the

[4] Appendix D contains photographs of wear and marks on parts of the bearing assembly

motor to determine the amount of vibration If, in his opinion, either the noise or vibrations were excessive, the motor was returned for further attention.

A record was maintained of repairs performed, material used, and the results of final tests for all traction motors. Copies of some of the reports of the traction motor involved in this accident are contained in Appendix E. It was reported improperly at the time the traction motor was repaired that the armature bearings were new

K Applicable Instructions and Regulations for Locomotive Maintenance

Maintenance instructions have been compiled by EMD for locomotive units of their design. Copies of these instructions are provided to the railroads for their use in maintaining the locomotive units The instructions, which are written for most of the component parts of the units, cover traction motors of various designs Companies engaged in repairing various parts for these locomotive units generally comply with the instructions when making such repairs The Chandeysson Electric Company repaired traction motors to the builders' specifications, which included any maintenance instructions

EMD Maintenance Instructions recommend that when a traction motor is removed from a locomotive unit, the traction motor should be operated and an audible check made of the armature bearings to detect excessive noise. This instruction serves as a means for detecting faulty bearings.[5] The Chandeysson Electric Company tested all repaired motors at speeds of 1,000 r.p m., 1,500 r.p m , and 2,000 r.p m.

ICRR uses EMD Maintenance Instructions in establishing procedures for maintaining the units purchased from EMD

Title 49, Code of Federal Regulations (CFR), Part 230 includes, the following regulations applicable to this accident:

[5] Appendix F contains excerpts from EMD Maintenance Instructions

"230.201 (d); Slipping or sliding wheel alarms

Means shall be provided whereby alarms and indications of either slipping or sliding driving wheels on any unit in a locomotive used in road service will be shown in the enginemen's compartment of the controlling unit.

Interpretation: This rule does not require both an audible alarm and a visible indication, but does require that either the one or the other, must be provided

The requirements of the rule are satisfied by a device which shows when either slipping or sliding occurs, even though not distinguishing between the one and the other

* * * * *

"230.203 Trip or daily inspection.

(a) Each locomotive unit when used in road service . shall be inspected at least once every 24 hours, . . . A report of the above inspections shall be made on an approved from to the proper representative of the railroad whether such locomotive units need repairs or not . If any defects exist which constitute a violation of the Locomotive Inspection Act, or any Federal Railroad Administration rules and regulations thereunder, such defect shall be repaired before the unit is again used and proper notation made on the report to indicate that such repairs have been made. This report shall be approved by the designated representative of the railroad and shall then be filed in the office of the railroad at the terminal at which the unit is cared for.

* * * * *

"230 262 Engines and accessories

(a) Tagging for repairs Internal combustion engines shall be maintained in a safe and suitable condition for service. Whenever any internal combustion engine has been shut down because of defects and the unit is continued in service a distinctive tag giving reason for shut down shall be conspicuously attached near the engine starting control and shall remain attached until repairs have been made."

The CFR does not contain any requirements for the maintenance or operation of traction motors or other component parts of a locomotive unit. Condemning limits and design requirements, however, are required for some parts or areas. The AAR has not established standards nor recommended practices for maintenance or operation of these parts, but has instead depended on each railroad to make rules to govern its individual needs

III. ANALYSIS

A. The Derailment of Train No. 1

When the armature on the traction motor seized, the direct connection between the pinion gear on the armature and the ring gear on the axle caused the wheels to stop turning. The friction between the sliding wheels and the rail soon wore away the tread of the wheels at the point of contact. The absence of other flat spots on these wheels indicates that once the wheels began to slide, they remained in a fixed position.

The marks found on heel blocks and frogs at Mason indicate that the wheels had been sliding long enough to increase the flange height to more than 1-11/16 inches, the distance of the heel block below the running surface of the rail. Considering the amount of wear at Mason, it is not unreasonable to theorize that the wheels seized when the train stopped at Effingham, 12.3 miles north of Mason Experience with sliding locomotive wheels and seized traction motors implies that the seizure generally occurs when the locomotive is standing and seldom during movement.

From Mason south to the accident point, evidence of contact between the wheel flanges and the track structure became more prevalent and more pronounced As the head of the rail wore into the sliding wheel, a false flange was produced on the outside edge of the wheel tread, as was shown in Figure 7. The false flange, once started, eliminated any lateral movement of the wheel and thus the wear between the wheel and the rail was concentrated in one groove, which gave more definition to the false flange. The first mark of contact of the false flange with the track structure was on the frog of a crossover at Edgewood, 14.4 miles north of the accident point.

These marks provided conclusive evidence that the wheels were sliding on unit 4031 when the train passed Edgewood. The operator did not detect the sliding wheels, nor did the crew of the freight train that passed train No 1 in the vicinity of Edgewood. The amount of smoke and sparks produced by the sliding wheels would not have been excessive and could have mixed with the dust produced by the train moving at its permitted speed of 100 miles per hour.

The trailing-point crossover switch in the southward track at Tonti required the left-hand wheels to make a transition from the switch point to the stock rail as the train moved southward. The sliding wheel could not make the transition because of the height of the false flange.

As the sliding wheel moved off the end of the switch point, the outside of the wheel continued to push the stock rail outward, increasing the gage sufficiently to allow the wheel to drop inside of the rail These and the following wheels of the locomotive derailed and pushed both rails outward. When the locomotive's derailed wheels reached the siding switch, they were diverted toward the siding. The sudden change of direction probably caused the first two units to turn over on their right sides. The destruction of the main tracks and siding south of the turnout began when the derailed locomotive struck the turnout of the siding.

B. The Failure of the Armature Bearings

Although the investigation disclosed that the armature bearings were installed to the tolerances and with the amount of lubrication as recommended by the ICRR's and the locomotive builder's specifications, there is some question whether the locking screws in the end plate were tightened sufficiently to prevent them from being loosened by the rotation of the armature shaft. The rotation of the shaft tends to loosen or tighten the plate depending upon the direction of rotation. The purpose of the locking screws was to prevent this movement in either direction.

A later design uses five cap bolts to secure the end plate to the face of the shaft. This design eliminates any movement between the plate and the shaft caused by the rotation of the shaft. However, vibration is still a factor in the loosening of the cap bolts and lockwires are employed to overcome this problem.

If the locking screws of the plate were properly tightened, the circular ends of the casehardened screws would dig into the end of the armature shaft to a slight depth to keep the plate from turning. If the plate was turned without loosening the properly-secured locking screws, the ends of the screws would mark the end of the shaft and indicate that this had occurred. The marks found on the end of the shaft in this accident were circular and apparently were not produced by a movement of the plate. (See Figure 11.)

If the end plate remained properly secured and an excessive lateral force developed from some other source, there probably would have been extensive wear between the end plate and the H-ring. The only wear on the end plate was on the rear surface where it had contacted the bearing cover plate. Little or no wear was detected on the H-ring. The excessive wear found on one side of the bearing caps, collars, oil throwers, and seals indicate that the armature shaft had moved toward the pinion end a distance in excess of that prescribed.

The bearings were manufactured from material that complied with the specified SKF requirements. The wear pattern on the various bearing parts and the amount of heat to which the various component parts of the bearings were subjected indicate that the armature had moved an excessive amount towards the pinion end. This movement caused excessive friction on the bearings and their associated parts. The friction produced enough heat to cause a lubrication failure. When this occurred, the bearings rapidly deteriorated.

C. Reconditioning Armature Bearings

The armature bearings which failed were designed and manufactured by SKF, they were adequate and were manufactured under a satisfactory quality control system. The relatively small number of bearing failures on the ICRR indicates no urgent problem.

However, the manner in which SKF reconditions bearings could create possible problems. Because the records do not identify the length of service of the bearing parts, SKF does not know what quality bearing is resulting from their reconditioning process. Without such a record, it appears that a reconditioned bearing may contain parts of various ages and of various service histories. Without such a record, the maintainability and reliability programs for such bearings can not be established.

Reconditioning bearings provides the railroad with a good bearing at a cost below that of a new one. However, since some of the parts may have been subjected to more severe service for longer periods than others in the same bearing, service life of the bearing is unknown. Although the rate of failure on the ICRR has been low, it appears that the practice should be analyzed at all levels.

D. Evaluation of the Work Performed by Chandeysson Electric Company

During the observations made at the Chandeysson Electric Company's plant in St. Louis, it was found that most of the repair operations were being performed in a manner prescribed by the builder of the traction motor and by the railroad. The use of a radial gauge, calibrated from 0.001 to 0.100, to measure

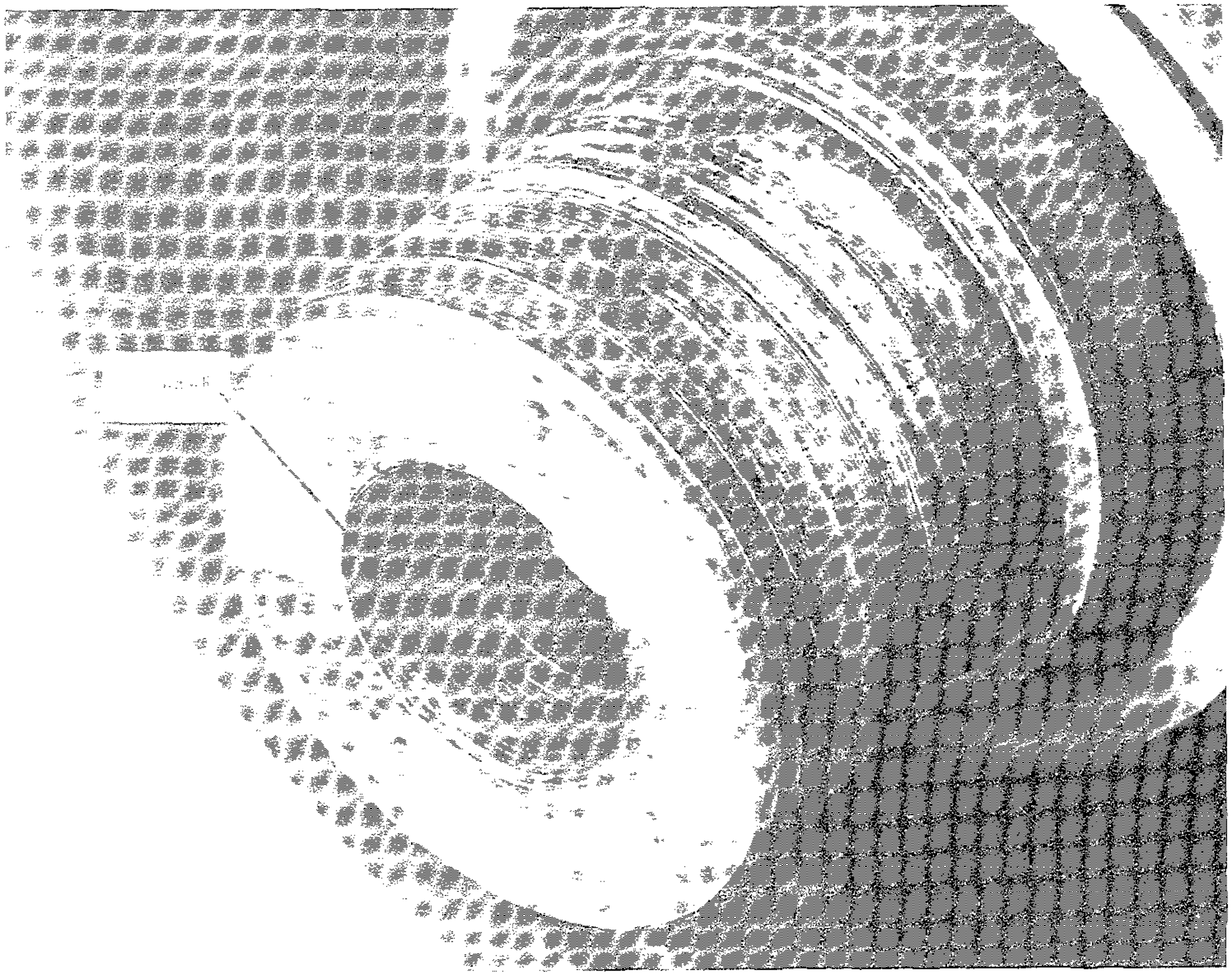


Figure 11.–Commutator End of Armature Shaft showing markings made by set Screws with no Evidence of Set Screws moving on Face of Shaft.

tolerances required to be within a range of from 0.003 to 0.012 inches is not considered good practice. Whereas this gauge can measure the tolerances, the movement of the dial is so small that it can easily be misread. A more sensitive gauge calibrated, for an example, from 0.001 to 0.050 or even 0.001 to 0.025 would portray better the situation.

The type of grease and the method used to determine the amount of grease were found to comply with the specifications. The method of application ensured that adequate lubrication would be provided the bearing. Precautions were being taken also to prevent the admission of any foreign material during the assembly operation.

Although the final tests of the traction motors were performed as prescribed by the builder and by the railroads, it is believed that a more reliable method should be adopted. The results of the noise and vibration tests depend strictly on the judgement of the operator. The training or the ability of the operator to apply his knowledge could affect significantly the results of such tests. As can be noted in the report of the tests conducted on the failed traction motor in this accident, the operator has only two choices to make: passed or failed. If the level of noise and of vibration were measured by instrument and the acceptance or rejection of a motor based on these measurements, a much improved final test would result, and a more objective standard could be established.

The improper reporting of the reconditioned bearings as new bearings did not contribute to the failure of the bearings in this case. However, if a better means were used to identify the difference between a new and a reconditioned bearing it would benefit both the bearing manufacturer and the repair company. The confusion of the similarity of the packaging of the two bearings would be eliminated.

E. The Effect of the Blocked Reverser and the Inoperative Wheel-Slip Device

When locomotive units were first put into service, the ICRR blocked the power reverser in neutral position when they were required to move a locomotive unit with an engine shut down, but later the practice was believed to be unnecessary and instructions were issued accordingly. The New Orleans Union Passenger Terminal Company apparently believes that the additional protection is still necessary and blocks the reverser when moving a locomotive unit with an engine shut down. With the power reverser of the No. 2 circuit of unit 4031 blocked in neutral position, power could not be supplied to the traction motors of the rear truck. With no power to the traction motors, the wheel-slip protection device was inoperative. Even though the wheels were not receiving power, many of the same factors that could cause the wheels to lock and slide still existed.

The middle wheel of the six-wheel truck is not powered and, therefore, is not provided with wheel-slip protection at any time. This wheel could lock and slide due to defective wheel bearings or stuck brakes and the engineer would not receive an indication of the problem.

If the wheel-slip protection device had been operative on unit 4031 on June 10, 1971, the engineer would have received a warning in the control compartment by means of the wheel-slip light before train No. 1 arrived at Mason. The indication of the sliding wheel would have occurred more than 27 miles north of the accident point. The indicator light would have remained illuminated and indicated a continuously sliding wheel. The engineer was well versed on the instructions and knew what was required in this situation.

There is no doubt that if the engineer had received the warning, he would have stopped the train, examined the locomotive, and found that the wheels had slid flat. The engine crew could have determined easily that the wheel was locked.

F. Repairs to Unit 4031 at Woodcrest Shop after Arrival on June 7, 1971

Even though unit 4031 arrived at Chicago without advance notice that the reverser was blocked, at least one engineer's locomotive inspection report indicated that the No. 2 engine was shut down and that the reverser was blocked This should have warned the repair forces sufficiently about the precautions taken by the forces at New Orleans

Under 49 CFR 230.203(a), a defect, if it constitutes a violation of FRA regulations, must be repaired before the unit is again used and proper notation must be made on the locomotive inspection report to indicate that such repairs have been made As required, a notation was made and the report was approved; however, the pin had not been removed from the reverser Since no exceptions were noted on the report, the locomotive was accepted as ready for service While the notations on the report may be considered adequate by the ICRR, the repairman's notation does not fully state what was done and one must assume that the pin was removed from the reverser.

A locomotive unit, after being repaired, should be tested to determine if it is suitable for service before being moved from the repair shop. These tests should determine the workability of the unit in general as well as the repaired part In this case, either such tests were not performed or they were inadequate to detect the cutout No 2 motor circuit

The unit was then moved from the repair shop to the ready track where it was placed as the fourth unit of the locomotive consist and tested for serviceability The sequence test performed on the locomotive should have been designed to test separately each motor circuit If this test had been designed and performed properly, the blocked reverser on the No 2 motor circuit of unit 4031 should have been detected No such condition was reported

Under existing arrangements the engineer is not required to test and cannot test the various warning circuits provided on the locomotive. He must, therefore, assume that all circuits are functioning properly when he takes over the operation of the locomotive at the initial terminal

G Adequacy of Federal Regulations Covering the Operation of Locomotives

There appears to be a deficiency in the Federal regulations relevant to this case.

49 CFR 230 201(d) requires that means shall be provided to indicate either slipping or sliding driving wheels Section 230.262 allows the continuation in service of units with an engine shut down because of defects if a distinctive tag giving reason for the shutdown is attached conspicuously near the engine starting control until repairs have been made.

When unit 4031 was operated between New Orleans and Chicago the wheel-slip indicator was inoperative on the rear truck when the No. 2 engine was shut down and tagged in compliance with Section 230.262 Being inoperative, the wheel-slip device would not indicate the slipping or sliding of the driving wheels of No. 2 engine There are no provisions in Section 230.201(d) to permit the operation of a locomotive unit without an operative wheel-slip device

The argument has been advanced that when power is removed from driving wheels, as in this case, they are no longer driving wheels and do not require an indication of slipping or sliding If this be true, the regulation is deficient because the wheels, although not being powered at the time, still possess all of the possibilities of sliding

If the interpretation of Section 230 201(d) is that driving wheels must be protected whether power is supplied or not, then the operation of the locomotive from New Orleans to Chicago on June 7, and the operation of the locomotive from Chicago to Tonti on June 10, 1971, was in violation of the regulation

A locomotive consist provided with the same type of wheel-slip device as used in unit 4031 does not have effective wheel-slip protection when operated with the throttle in idle position, even though all motors and circuits are functional A train moving on a descending grade could travel many miles with an ineffective wheel-slip device If a driving wheel locked at such a time, an accident similar to this one could occur

Although Federal regulations require a means of indicating slipping or sliding wheels, they do not require that the engineer determine whether the device is operative before leaving the initial terminal. The engineer in this case - and on other similar locomotives - had no means of checking the operability of that safety device. In contrast, in aviation there are requirements and means for checking safety devices and warning circuits before takeoff.

With the exception of the airbrake test, and train-control test where applicable, Federal regulations do not require an inspection or test of the locomotive before leaving the initial terminal The 24-hour requirement (49 CFR 230.203(a)) does not specify what should be inspected; however, the presumption is that when the inspector approves the locomotive for service, all conditions comply with regulations Most of the conditions required by regulations are not determined to be in compliance by the 24-hour inspection, and failure of parts in service is the only indication of non-compliance.

If the intent of Section 230 262 is to provide a means of moving a locomotive unit with a defective internal combustion engine to a repair shop, this intent should be stated clearly If the intent of the regulation is to provide a means for operating a unit for an extended period of time with a defective engine, then means should be required to provide for its safe operation and to provide for continued use of the warning systems. The movement of unit 4031 from New Orleans to Woodcrest shop in Chicago with the No. 2 engine shut down was apparently done for economic reasons The regulation does not require an adequate level of safety to allow for the movement of locomotives in regular service

Whereas the regulations require the use of a wheel-slip device, the use of a pneumatic control switch (PC) or of a safety control device (dead-man) is not required Accidents have been caused by the lack of these devices or by their inadequate installation or maintenance If a PC switch and a dead-man control, as well as the other warning systems provided on the unit, are necessary for the safe operation of the locomotive, then these devices and their installation and test should be required by the CFR so that adequate protection can be provided for the operation of the train

During the investigation of this accident the Safety Board brought to the attention of the Federal Railroad Administration (FRA) the deficiencies and conflicts in the rules to determine if any decisions had been made since the adoption of the rules to clarify this situation. FRA stated that the interpretation of rule 230 201(d), as made in the past, was that only those wheels receiving power were considered to be driving wheels FRA also stated that the rule as written is not clear and does not provide for all contingencies The FRA inferred that rulemaking procedures would be initiated to eliminate the conflict in the regulations and to provide the necessary degree of safety for train operation.

H The Operation of the Train

Although the first engine crew assigned to the locomotive reported to the relieving crew at Champaign that the No 2 engine of unit 4031 was not loading, the second fireman apparently assumed that the No 2 engine was loading properly after the diesel engine increased speed when the engineer advanced the throttle and after he saw that the engine regulators indicated that the engine was loading

The load meter in the control compartment reflects only the amount of electrical current being supplied to the traction motors in the No. 1 circuit. If separate load meters were available for each motor or for each circuit, the distribution of power could quickly be discerned and a nonfunctioning circuit would be apparent

Although the train was inspected by its own crew, by the crew of another train going in the opposite direction, and by the operator at Edgewood, the sliding wheels were not detected. A train running at high speeds stirs up a cloud of dust and light debris which greatly reduces the probability of visually detecting a sliding wheel. In darkness, sparks from the sliding wheels would be evident. Because it is not unusual that visual inspections fail to discover the sliding wheels, the wheel-slip indicator becomes even more important under these conditions.

The locomotive derailed before the engineer made the emergency brake application producing a heavy compressive force between the locomotive and the cars of the train The change in direction of the locomotive, which followed the turnout to the siding, combined with compressive forces, caused the cars to jackknife, and the couplers to break when forces exceeded the design strength. The momentum of the cars in the rear also contributed to the extent that in some cases, cars turned over onto their roofs before they settled back on their sides.

I. Critical Weakness in Railroad Car Crash Design

The windows on the underside of the overturned cars were broken out either when the side of the car struck the ground, or by passengers thrown against the windows. Seven or eight large holes 28 inches high and 56 to 62 inches wide, depending on the design of the car, were opened in the side of each car when the window panes were broken. (See Figure 12.) This occurred as the car was sliding over the ground on its side. Several passengers ejected through the windows, were trapped between the moving cars and the ground. A review of the 11 fatal injuries shows that six of these persons were ejected completely or partially through the broken windows. Three other passengers were either crushed in the end of a car or were ejected from the end as apparently they were moving from one car to another. One person was struck on the head by a crosstie which had been thrust through a broken window and another person apparently was thrown around the interior of the car and came in contact with the car's fixtures. One person fatally injured by ejection still remains unidentified.

The ejection of passengers through windows of passenger cars during derailments has been addressed by the Safety Board in reports of several accidents. In the Franconia accident, which occurred near Alexandria, Virginia, on January 27, 1970,[6] three people were killed when they were ejected from a car through windows and were trapped between the overturning car and the ground. In the accident near Tulsa, Oklahoma, on April 5, 1971,[7] the only fatalities occurred when two small girls were ejected through broken windows as a car turned on its side. In two accidents during 1971, the one at Tulsa and this accident, eight of the 13 persons killed were ejected through broken windows.

Passengers in the coaches were injured seriously when thrown against sharp edges of exposed metal plates or when struck or caught by revolving seats, or by falling baggage. Although pinpointing the exact structure which caused a particular injury was impossible, some general observations can be made. At least 23 survivors were treated for lacerations, most of which resulted from contacting broken side windows. Those passengers seated on the lower side when the car turned over received lacerations of the head, upper trunk, and arms. Those on the higher side of the car received lacerations of the lower extremities, indicating that they were thrown into the baggage racks with their feet and legs contacting the window area. The unsecured tables, chairs, and fixtures in the dining cars also caused injuries.

Some of the overturned cars were penetrated by foreign objects. Rails that were torn loose broke at the joints and penetrated two cars as they slid on their sides over the ground. The use

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[6]NTSB's Report of Derailment of Richmond, Fredericksburg, and Potomac Railroad Train 10/76 at Franconia, Virginia, on January 27, 1970, NTSB RAR-71-1

[7]NTSB's Report of Collision of a Motor Truck with an Atchison, Topeka and Santa Fe Railway Train near Collinsville, Oklahoma, on April 5, 1971, NTSB-RHR-72-1

Figure 12.–Large observation type windows broken out when car 2616 overturned. Note outward distortion of broken glass in two nearest windows. The broken out windows became the floor of the passenger compartment as the car slid to a stop. At least one or as many as three passengers were ejected through these holes and were fatally injured.

of welded rail would eliminate all but a few of the rail joints, reducing the possibility of such penetration. A heavy compressor was driven through the roof of the dining car, and a crosstie was thrust through a broken window. The potential lethality of these objects is obvious but, in this accident, only the crosstie struck a passenger which resulted in a fatal head injury.

The bending of the roofs downwards caused the metal ceiling to separate, producing sharp edges in three of the overturned cars.[8] (See Figure 13.) The deformation of the superstructure of the cars not only caused injuries but made rescue of the passengers extremely difficult. The passageways at the ends of the cars were either blocked or difficult to use, and with no emergency exits, the passengers had to wait until the rescue personnel could break windows on the top sides and provide ladders for climbing out. (See Figure 14.)

The basic structure of a passenger car provides excellent protection for passengers during accidents of the magnitude obtained in this derailment. Some features in the design of the car interior, in addition to the windows, however, could be changed to eliminate their injury-causing capabilities during accidents If windows could be designed to prevent a passenger's being ejected and if the injury-causing features could be corrected, the railroad passenger fatality rate could be reduced to almost zero

Preliminary reports from railroads using clear, unbreakable, plastic panes in side windows of passenger cars indicate that if windows of this material can be better secured in the car, the window may be able to withstand the forces in accidents and thus prevent persons from being ejected from cars. The use of smaller windows and guards to prevent the ejection of passengers would be another alternative. The use of this type of window, however, requires other emergency exits

Propane tanks, beneath the car floors, were torn loose from their mountings and scattered throughout the wreckage (See Figure 15) Rescue personnel smelled propane when they first arrived on the scene, and all persons in the vicinity were warned about smoking and the use of open fires around the coaches. The escaping gas was not ignited, but if fire had started in the overturned coaches, the results could have been disastrous, because the passengers' only escape was through windows overhead Whereas the propane was used to operate the air conditioning systems on some of the cars in this train, the air conditioning systems on most passenger cars of other trains are operated either by electricity or steam.

Emergency tools, first-aid equipment, and fire extinguishers found on many other passenger trains, although not required by Federal Regulations, were not available on many of the cars in this train. Because of pilferage, it was the policy of the ICRR not to maintain emergency tools on passenger cars. In the railroad accident which occurred at Glenn Dale, Maryland, the Safety Board found emergency tools camouflaged and recommended that either the container for the tools or the tools be painted a contrasting color to the car's wall.[9]

J. The Evacuation of the Injured and Care of the Passengers by People of Salem

The response by the local people was the most prompt and the post accident activities were the best that has been found by the Safety Board in any railroad accident it has investigated. The success of this endeavor was the result of previous planning and practice by the officials and people of Salem. If other towns in the United States would recognize this need and would make in-depth plans for emergencies, many disasters could be minimized.

[8] The Safety Board has found this problem to exist on intercity buses and school buses involved in accidents and has made recommendations for correction

[9] NTSB's Report of Derailment of Penn Central Train 153 at Glenn Dale, Maryland on June 28, 1969, NTSB-RAR-70-1

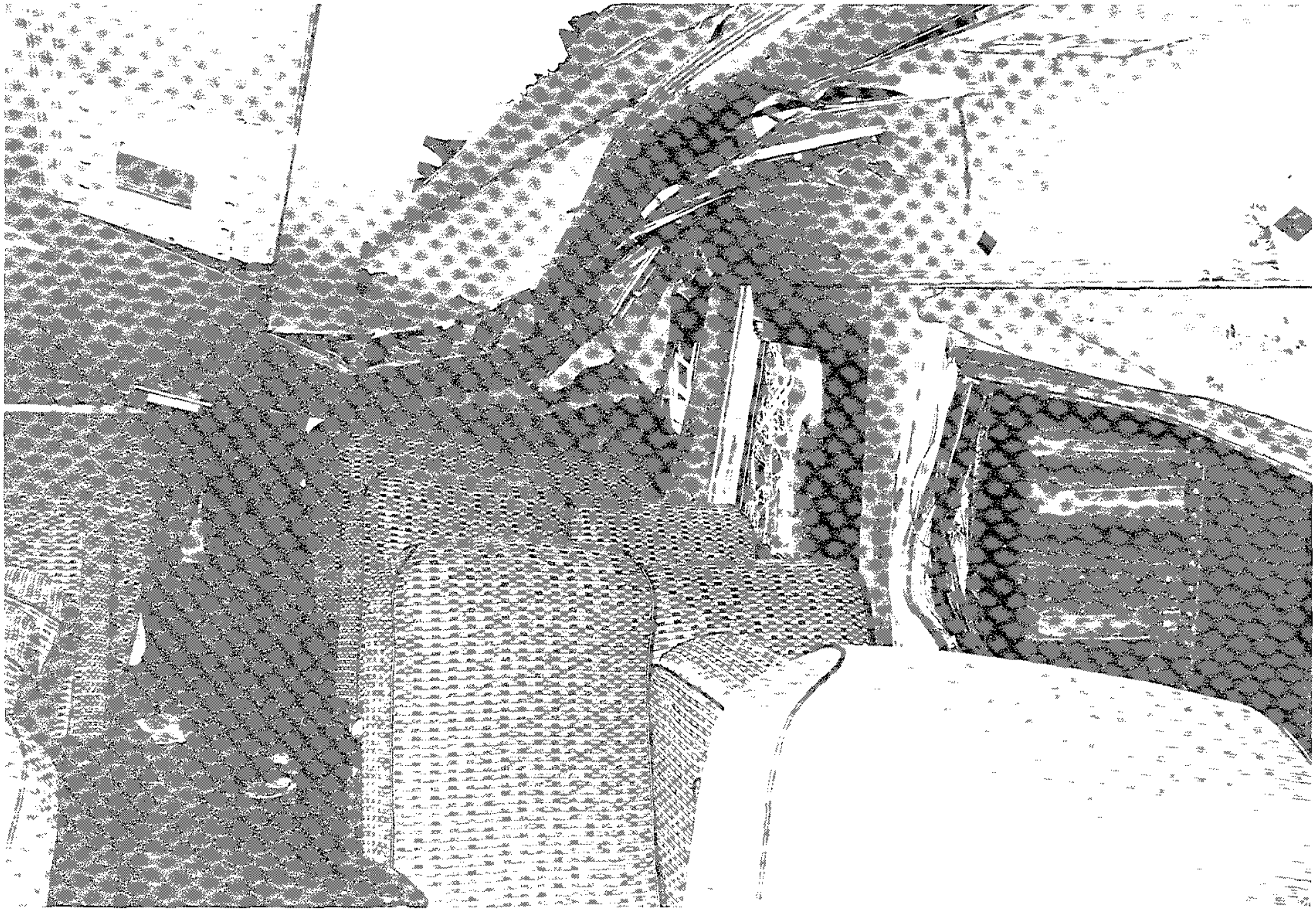


Figure 13.—Separation of metal ceiling which produces sharp edges.

a Injured passengers being helped out the end of the car and down to the ground after having climbed over partitions and through the 2-foot high tunnels over or under the rest rooms

b Some were rescued by being lifted up through windows by means of ropes

c Other rescue workers brought ladders to assist passengers to the ground after they climbed up the seats and out the windows

d View of rescue workers lowering a ladder through a window they have knocked out to rescue passengers

Figure 14

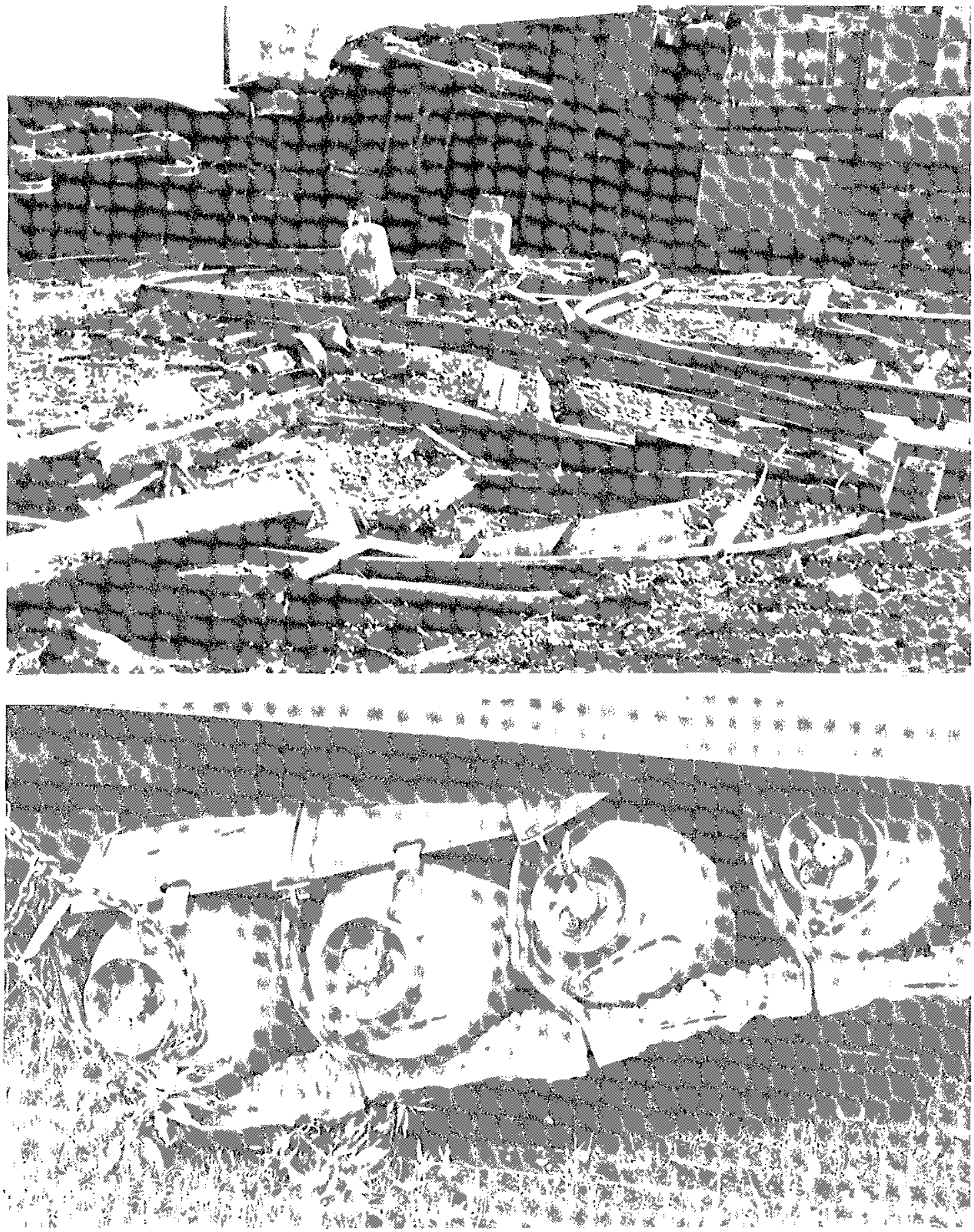


Figure 15 —Views of Damaged Propane Cylinders

Therefore, the Safety Board commends the town of Salem and all those persons who assisted after the accident for their exemplary response to the emergency created by this accident.

IV. CONCLUSIONS

1. Locomotive unit 4031 was operated from New Orleans to Chicago on June 7, 1971, with the No. 2 motor shut down and the power reverser of that circuit blocked in neutral position. The motor was tagged in compliance with 49 CFR 230.262.
2. Information on the daily Locomotive Inspection Report for June 7, 1971, indicated that the power reverser for the No. 2 circuit of unit 4031 was blocked.
3. ICRR repairmen repaired unit 4031 prior to use on June 10, 1971, and indicated on the Locomotive Inspection Report that the repairs had been completed; however, the power reverser for the No. 2 circuit was left blocked in the neutral position.
4. Tests made of the repairs on unit 4031 did not detect the blocked reverser.
5. The carrier's required tests of a locomotive prior to dispatch from an initial terminal did not detect the cutout circuit on unit 4031.
6. Unit 4031 was dispatched on train No. 1 from Chicago on June 10, 1971, with the No. 2 circuit power reverser blocked in neutral position which eliminated the means of indicating sliding of the driving wheels of the rear truck.
7. Use of unit 4031 on train No. 1 from Chicago on June 10, 1971, with no means to indicate the sliding of the driving wheels on the rear truck violated 49 CFR 230.201(d).
8. The engineers had no means of testing the operability of warning devices on the locomotive.
9. The first engine crew of train No. 1 detected the condition of the No. 2 circuit of unit 4031 and informed the second crew at Champaign.
10. The load meter in the locomotive control compartment only indicated the amount of current being supplied to one motor circuit
11. The engineer and fireman with their knowledge and with the appliances furnished to them could not have been expected to determine whether power was supplied to all traction motors.
12. The train was operated in accordance with the rules of the carrier between Champaign and the point of the accident.
13. The leading pair of wheels of the rear truck of unit 4031 probably became locked when the train made its scheduled stop at Effingham and slid continuously from Effingham to the point of the accident, a distance of 39.8 miles.
14. Loosening of a locking plate in a traction motor armature bearing permitted excessive lateral movement of the armature.
15. The excessive lateral movement of the armature caused overheating of the bearings, deterioration of the lubrication, and eventual failure.
16. The reconditioning of the armature did not contribute to the failure of the bearings in this accident.
17. Title 49 CFR 230.262, which allows a unit to continue in service after a defective motor is cut out, nullifies the wheel-slip indicator. This is in conflict with Section 230.201(d), which requires indication of slipping or sliding driving wheels, and the regulation does not provide an adequate level of safety in the operation of locomotives in mainline service.
18. Neither Federal Regulations nor Recommended Standards of the AAR provide for the maintenance and operation of traction motors and other major component parts of locomotives.
19. As a result of the derailment, passenger cars were jackknifed and turned over on their sides by the high compressive forces

produced between the locomotive and the cars in the train

20 Almost all of the 43 large observation type windows which happened to be on the lower sides of the five overturned coaches were broken out either as a result of impact against the ground or by the weight of the passengers or luggage on the inside

21 Six persons who fell or were thrown through the large window openings were injured fatally

22 Although the basic structure of the passenger cars withstood well the stresses of collision, the cars displayed inadequate design crashworthiness Sharp edges were raised, hard surfaces were present, and seats and furniture were secured inadequately The large observation type windows constituted a critical weakness, destroying the crash integrity of the structure.

23. The use of propane as fuel in passenger cars created a serious fire hazard that could have resulted in a catastrophic accident

24 The people of Salem provided an outstanding example of what can be accomplished by preplanning and practicing for emergencies

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this derailment was the displacement of the east stock rail of the southward main track by the false flange on the left-hand wheel on the leading axle of the rear truck of locomotive unit 4031 This wheel slid flat when the traction-motor armature bearings failed and locked the driving wheels Failure to detect the sliding wheels was caused by the dispatch of the locomotive with an inoperative wheel-slip indicator

The cause of six of the eleven fatalities was the ejection of passengers through the large side windows which broke when the cars overturned. The other fatalities were caused by passengers being ejected from the end of the car, or being struck by a crosstie, or being hurled around the inside of the car A total of 163 passengers and employees were injured when impacted against injury-producing surfaces inside the cars

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Railroad Administration review Part 230 of Title 49, CFR, and make necessary amendments and additions to:
   - (a) Clarify the intent of application and reconcile the conflict between sections 230 201(d) and 230 262.
   - (b) Require a practical initial terminal test that will indicate whether the locomotive complies with the Federal regulations before use in train service
   - (c) Require use of warning systems other than the wheel-slip warning device that are needed to protect the operation of the locomotive, and require that means be provided for testing all warning systems.
2. The FRA in establishing near-future safety standards for railroad and rail rapid-transit passenger cars, give priority to the problem of ejection of passengers through large side windows Regulations should be promulgated on realistic performance tests This source of fatalities, even though small in number, is of such a large proportion among passenger fatalities as to warrant action prior to the issuance of the Mechanical Standards.
3. The FRA promulgate regulations for railroad passenger cars to minimize the sources of direct impact injury such as described in this report.

4. Amtrak, in the meantime, correct those injury - causing features pointed out in this report as passenger cars are renovated or rebuilt Purchase specifications for future passenger cars should be established to insure against passenger ejection through windows in overturning accidents and to insure that interiors are designed to minimize impact-type injuries These specifications should include provisions for the practical escape of nondisabled passengers from overturned cars when the exits at the ends of the cars are blocked.

5. The Association of American Railroads evaluate the requirements for maintenance and overhaul of traction motors and other major component parts of locomotive units and establish standards and recommended practices for such maintenance.

6 The Office of Civil Defense of the United States Army review the plans made by the town of Salem, Illinois, for such emergency situations and consider advising associated state and county Civil Defense Agencies of their contents and results in this instance.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

Louis M. Thayer, Member, was absent, not voting.

August 30, 1972

APPENDIX A

ILLINOIS CENTRAL RAILROAD COMPANY

The rules herein set forth govern the railroads operated by the Illinois Central Railroad Company.

They take effect June 1, 1970, superseding all previous rules and instructions inconsistent therewith.

Special instructions may be issued by proper authority.

W. H. Thompson

Vice President Operations and General Manager

Approved:

O. H. Zimmerman

Senior Vice President–Operations

12. HAND, FLAG, AND LAMP SIGNALS.

MANNER OF USING.	INDICATION.
(a) Swung at right angle to track.	Stop
(b) Horizontal movement held at arm's length at right angle to track.	Reduce speed
(c) Raised and lowered vertically.	Proceed
(d) Swung vertically in circle at arm's length at right angle to track.	Back
(f) Swung horizontally above head at right angle to track, when standing.	Apply air brakes
(g) Held at arm's length above head, when standing.	Release air brakes
(h) Any object waved violently by anyone on or near track.	Stop

12 (i). Hand, flag and lamp signals prescribed in Rules 12 (a) through 12 (g) must be used for the purposes described.

Other hand, flag or lamp signals may be used for other purposes providing such signals are understood by all members of the crew. Employes in train, engine and yard service and others concerned must keep a constant lookout for them. Employes giving signals must locate themselves so as to be plainly seen and give them so as to be clearly understood. The utmost care must be exercised to avoid taking signals that may be intended for other trains or engines

111 (a). Conductors must inspect, and require their trainmen to inspect, cars in their trains as often and closely as practical, while on the road, for any defects or conditions that might render cars unsafe. Special attention must be given to hot journals, sticking brakes, sliding wheels, dragging or defective equipment, evidence of fire, dangerously shifted lading and any other condition which may endanger movement of train. If train is moving when defect or dangerous condition is discovered, it must be stopped at once, unless it is definitely known that further movement may be safely made. They must remedy as far as possible any defects or dangerous conditions discovered and remove from the train as soon as possible any cars that are unsafe to run.

Drawbars, brake beams or other fixtures or appliances of sufficient size to endanger trains, which may fall from their train, must be removed from the track.

111 (b). Enginemen and trainmen on engine must frequently look back, especially when moving on curves and approaching and passing stations, to observe signals and to note condition of train. Engineers will require other employes on engine to obey this rule.

111 (c). All employes are required, as far as practical, to observe passing trains for defects mentioned in Rule 111 (a) and will signal crew of such trains if any such defect or condition is observed, using stop signal, Rule 12 (a).

Station employes, when practical, must be out on ground or station platform when trains are passing and must use a white light by night in giving signals to trainmen and/or enginemen.

111 (d). When two or more employes are working together, one or more employes must, as far as practical, be on each side of track so as to permit both sides of a passing train to be observed.

111 (e). Crews of trains must be on the alert to receive signals from employes when passing any location where employes are near the track When practical, trainmen must be on rear platform of train to receive such signals. On train equipped with radio, employes on engine must notify employes on rear to receive such signals

111 (f). When a hot box is detected, train must be stopped immediately, hot box inspected

and no attempt made to run it to next station until it has been ascertained it is safe to do so. When cars with hot boxes are set out, fire must be extinguished, box lids closed and thorough inspection of car made to see that floor or other parts of car are not on fire.

111 (g) Any employe observing a condition that may result in an accident or interruption of train operation must make prompt report, and, if necessary, arrange proper protection. In such emergencies or obstruction, suggestions based upon observation of the actual situation must be made promptly, followed by frequent reports of progress. In the absence of designation, the employe upon whom the responsibility most naturally falls will assume authority.

D-151. Where two main tracks are in service, trains must keep to the right unless otherwise provided.

Where three or more main tracks are in service, they shall be designated by numbers and their use indicated by special instructions.

APPENDIX B

Code of Federal Regulations

TITLE 49

Parts 200 to 999

Revised as of January 1, 1971

CONTAINING A CODIFICATION OF DOCUMENTS
OF GENERAL APPLICABILITY AND
FUTURE EFFECT AS OF JANUARY 1, 1971

With Ancillaries

Published by the Office of the Federal Register
National Archives and Records Service
General Services Administration
as a Special Edition of the Federal Register

monthly report will not be required for the month in which this report is filed

NOTE: Samples of Forms Nos 1 and 3, indicating exact size, color, weight, and grade of paper, will be furnished on application

§ 230.162 Accident reports.

In the case of an accident resulting from failure, from any cause, of a locomotive or tender, or any appurtenances thereof, resulting in serious injury or death to one or more persons, the carrier owning or operating such locomotive shall immediately transmit by wire to the Director, Bureau of Railroad Safety, Federal Railroad Administration, at his office in Washington, D C, a report of such accident, stating the nature of the accident, the place at which it occurred, as well as where the locomotive may be inspected, which wire shall be immediately confirmed by mail giving a full detailed report of such accident, stating, so far as may be known, the causes and giving a complete list of the killed or injured

Subpart C—Other Than Steam Locomotives and Appurtenances

§ 230.200 Applicability of subpart.

This subpart contains rules and instructions for the inspection and testing of locomotives propelled by other than steam power except electrically operated units designed to carry freight and/or passenger traffic operated by a single set of controls For multiple operated electric units see Subpart D of this part.

§ 230.200a Responsibility for design, construction, inspection, and repair.

The railroad company is held responsible for the general design construction, inspection, and repair of all locomotives used or permitted to be used on its line It must know that all inspections, tests, and repairs are made and reports made and filed as required, and that all parts and appurtenances of every locomotive used are maintained in condition to meet the requirements of the law and the rules and instructions in this subpart Nothing contained in the rules and instructions in this subpart, however, shall be construed as prohibiting any carrier from enforcing additional rules and instructions not inconsistent with those in this subpart contained, tending to a greater degree of precaution against accidents

§ 230.201 Locomotive unit.

(a) *Definition* A locomotive may consist of one or more units. The term "unit" as used in the rules and instructions in this subpart means the least number of wheel bases together with superstructures capable of independent propulsion, but not necessarily equipped with an independent control

(b) *Marking front.* The letter "F" shall be legibly shown on each side of every locomotive unit near the end, which, for identification purposes, will be known as the front end The unit number shall be legibly shown on each side of every locomotive unit and shall be shown on the specification card, Form No. 4–A

Form No. 4–A.

SPECIFICATION FOR LOCOMOTIVE UNIT NO. ___

Operated by ________________ Company
Built by ______________________________
at ________________ date __________, 19__
Builder's number ______________________
Propelled by __________________________
Gauge of wheels _______________________
Kind and number of current collectors _____
____
Trolley wire or third rail voltage __________
Number, make and type of motors ________
____
______ Voltage _________________________
Make and type of control equipment_______
____
______ Control circuit voltage ____________
Make and type of internal combustion engine
____
____
Kind of brakes _________________________
____
(Give make, type and schedule number)
Number, make and type of air compressors __
____
Main air reservoir pressure _______________
Train line pressure _____________________
Make and type of lightning arrester ________
____
Does unit carry steam boiler?_____________
Total weight, working order ________ pounds,
weight on driving wheels ________ pounds,
weight on trucks ________ pounds
Maximum tractive effort _________________

Attach to or make hereon diagram showing general outline of unit and principal dimensions

Approved _________________
Title _______________

(c) *Control of units* When locomotive units are coupled in multiple control all parts and components of each unit capable of providing power for propulsion or supplying the retarding effect which will enable the enginemen to control the speed or stop the locomotive or train, shall respond to control from the enginemen's compartment of the controlling unit

Interpretation On locomotive units coupled in multiple control, the parts and components capable of producing power to propel the locomotive or train, the air brakes capable of retarding or stopping the locomotive or train, and the sanders, shall respond to control from the operating compartment

(d) *Slipping or sliding wheel alarms* Means shall be provided whereby alarms and indications of either slipping or sliding driving wheels on any unit in a locomotive used in road service will be shown in the enginemen's compartment of the controlling unit

Interpretation: This rule does not require both an audible alarm, and a visible indication, but does require that either the one, or the other, must be provided

The requirements of the rule are satisfied by a device which shows when either slipping or sliding occurs even though not distinguishing between the one and the other

§ 230.202 Term "inspector"

The term "inspector" as used in the rules and instructions in this subpart means, unless otherwise specified, the railroad company's inspector

§ 230.203 Trip or daily inspection

(a) Each locomotive unit when used in road service (including belt-line, transfer or work-train service) shall be inspected at least once every 24 hours, except locomotive units operated on through runs exceeding 24 hours, may be inspected at the next crew change point immediately beyond the point at which the 24-hour period expires Each locomotive unit when used exclusively in yard service shall be inspected at least once during each calendar day A report of the above inspections shall be made on an approved form to the proper representative of the railroad whether such locomotive units need repairs or not This form shall show the name of the railroad, the initials and number of the unit, the place, date and time of the inspection; the defects disclosed by such inspection, and the signature of the employee making the inspection If any defects exist which constitute a violation of the Locomotive Inspection Act, or any Federal Railroad Administration rules and regulations thereunder, such defects shall be repaired before the unit is again used and proper notation made on the report to indicate that such repairs have been made This report shall be approved by the designated representative of the railroad and shall then be filed in the office of the railroad at the terminal at which the unit is cared for

(b) A record shall be maintained on each locomotive, or on each unit comprising the locomotive, showing the place, date and time of the last previous inspection for each unit

(c) Any competent employee may be designated by the railroad to make the inspections required by this rule

(d) Any official or responsible employee designated by the railroad may approve the inspection report The unit may be used in further service without waiting for such approval, provided defects reported have been repaired as required by this rule

(e) This rule prescribes the minimum number of inspections that are required to be made and is not intended to prevent the railroad from making additional inspections

(f) The instructions on the approved form should not be varied from, nor should the form itself be materially altered. Additional items may be added to this form to cover anything the railroad may desire to have inspected

FRA Form No 2-A

Locomotive No ________
Unit No ______________
Initials ______________
_____ _____ _ _____ Railroad

LOCOMOTIVE INSPECTION REPORT

INSTRUCTIONS: Each locomotive unit shall be inspected in accordance with Rule 203 of the Laws Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam

Inspected at ___ ________ time ______ m
Date ____________ 19 __
Repairs needed:

____
____
____
____
____
____

Main reservoir pressure ______ lbs
Brake pipe pressure ______ lbs
Condition of brakes and brake rigging ____
____
Signature of employee making inspection
____
Occupation ______ ________

The above work has been performed except as noted, and the report is approved

____
(Signature)
____
(Occupation)

[33 F R 19621, Dec 25, 1968, as amended at 34 F R 11973, July 16, 1969]

§ 230.262 Engines and accessories

(a) *Tagging for repairs* Internal combustion engines shall be maintained in a safe and suitable condition for service Whenever any internal combustion engine has been shut down because of defects and the unit is continued in service a distinctive tag giving reason for the shut down shall be conspicuously attached near the engine starting control and shall remain attached until repairs have been made

AE-300M-4 70

ILLINOIS CENTRAL RAILROAD

2021 Form 1443 A Rev 0 80

LOCOMOTIVE INSPECTION REPORT

Ill Central Railroad   Loco Unit No 4031 4033 Initial ICC

INSTRUCTIONS: Each locomotive unit shall be inspected in accordance with Rule 203 of the Laws, Rules and Instructions for inspecting and testing locomotives

Inspected at Champaign Time____M Date 6-7 19 71

Work Item	Repairs Needed—Reported by Engineer (One Item on Each Line)	REMARKS
1	#2 eng dead & drained house water	
2		
3	leak on engine 2024	Union Fitting Wally & George
4		
5	#2 engine 4031 dead & tagged	[illegible]
6	& has reverser blocked	

Main Reservoir Pressure 130-140 Lbs   Brake Pipe Pressure 110 Lbs

Condition of brakes and brake rigging Good / Good

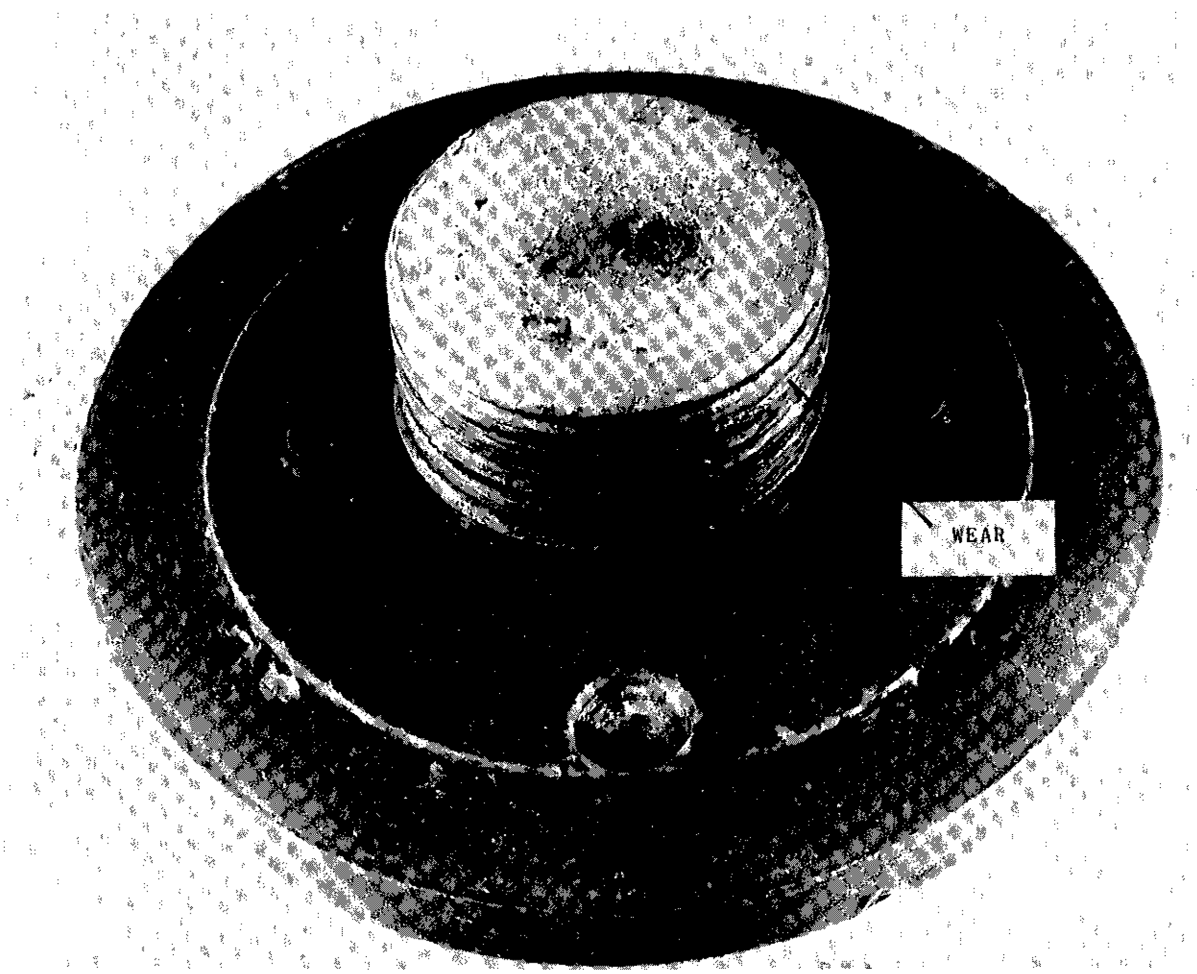
SIGNATURE L. E. Haney ENGINEER

	Repairs Needed—Reported by Inspector (One Item on Each Line)	REMARKS
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		[illegible]

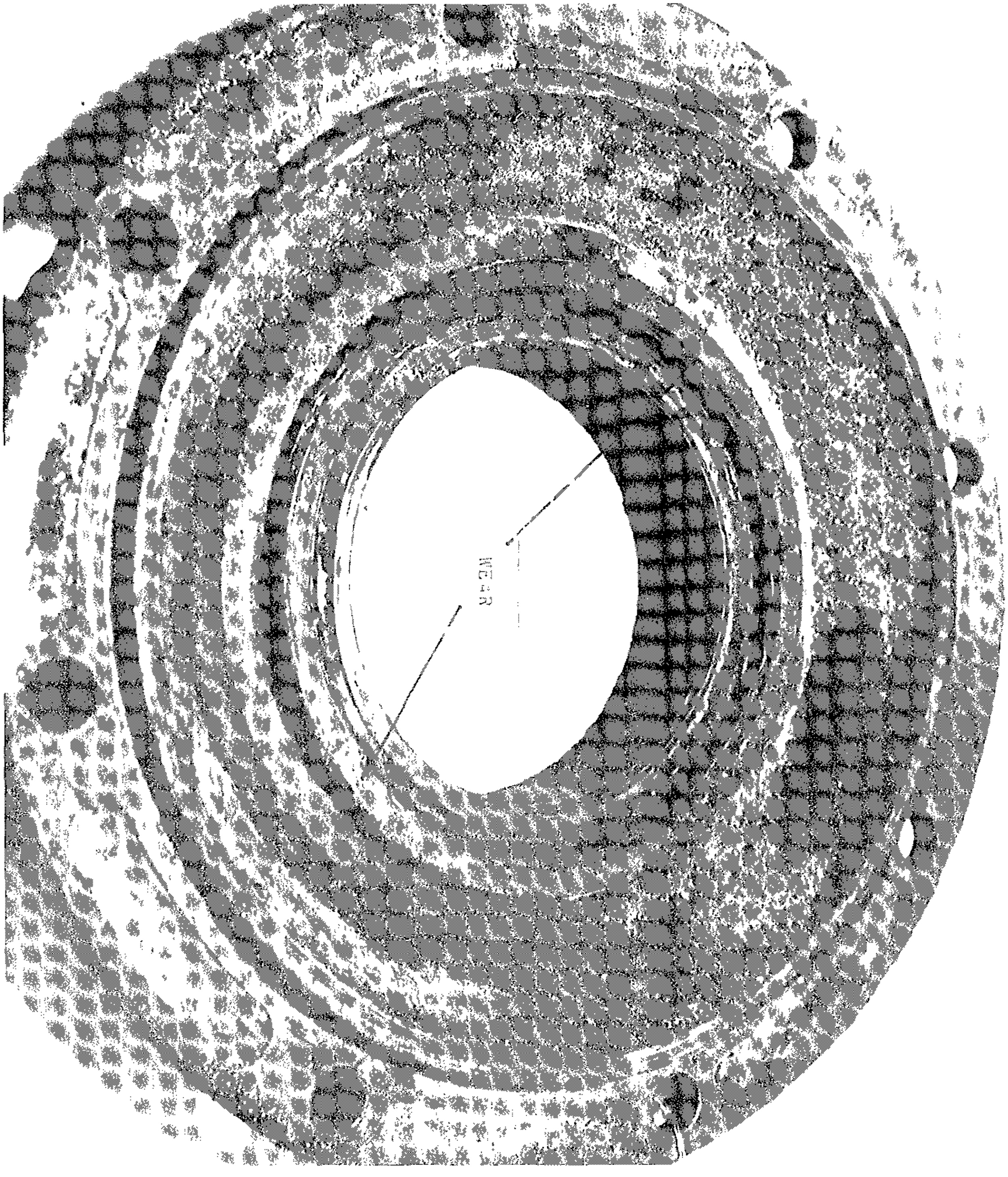
________ Inspector   The above work has been performed, except as noted, and the report is approved

APPENDIX D

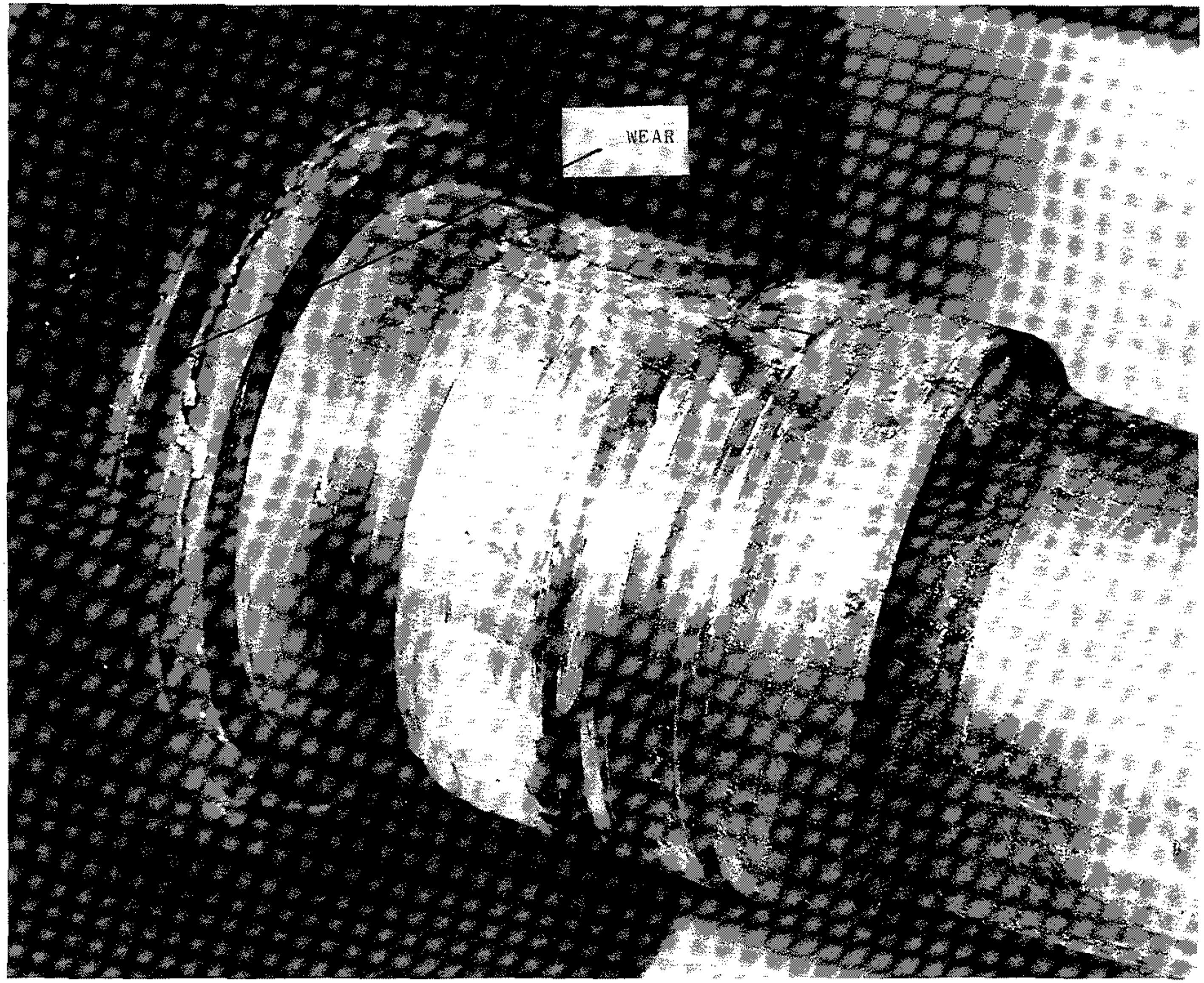
Photographs of Wear and Marks on Parts of Bearing



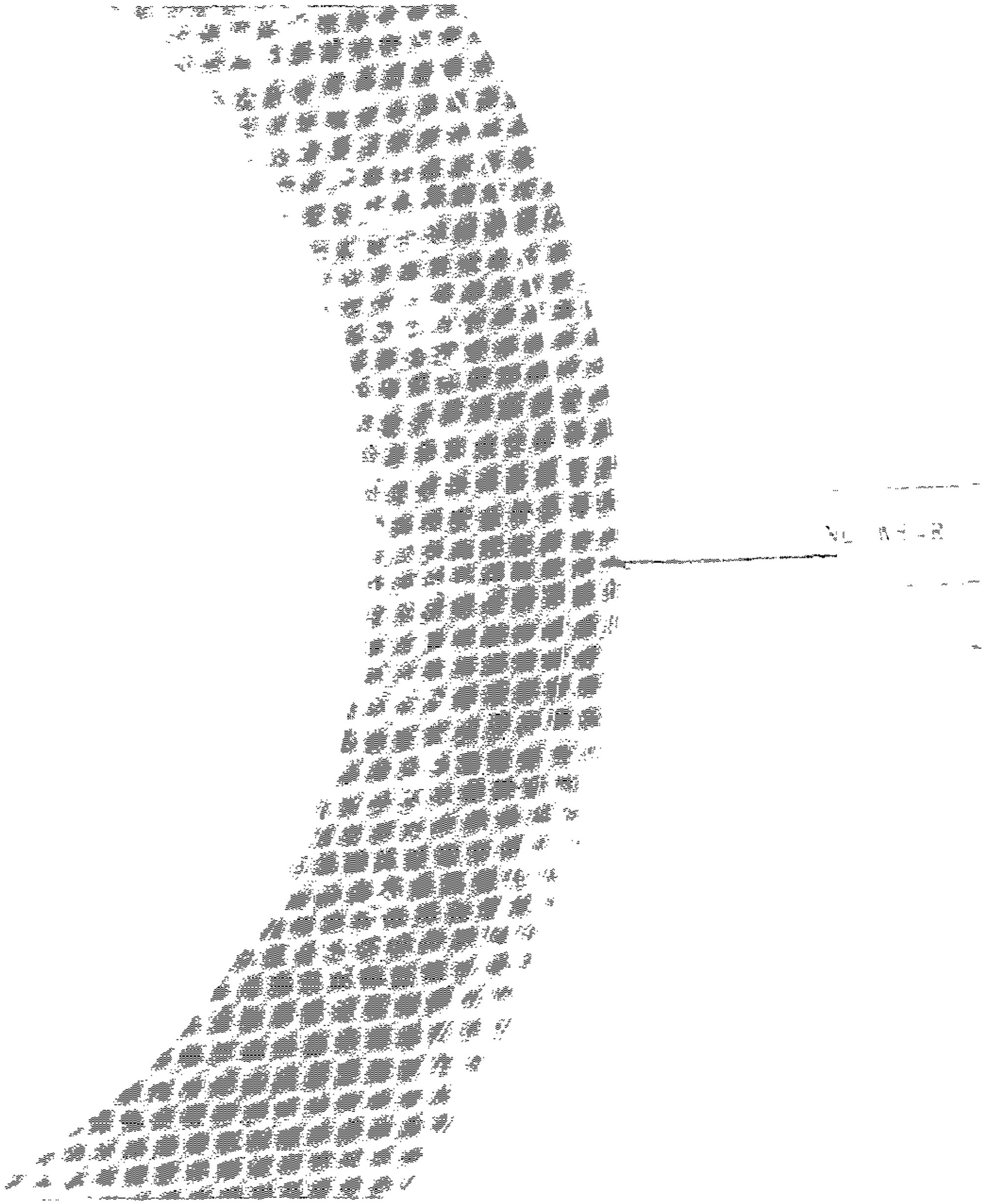
Photograph 1D --Inner Face of Locking Plate Showing worn threads and Lack of wear on outer edge where Plate should Contact H-Ring.



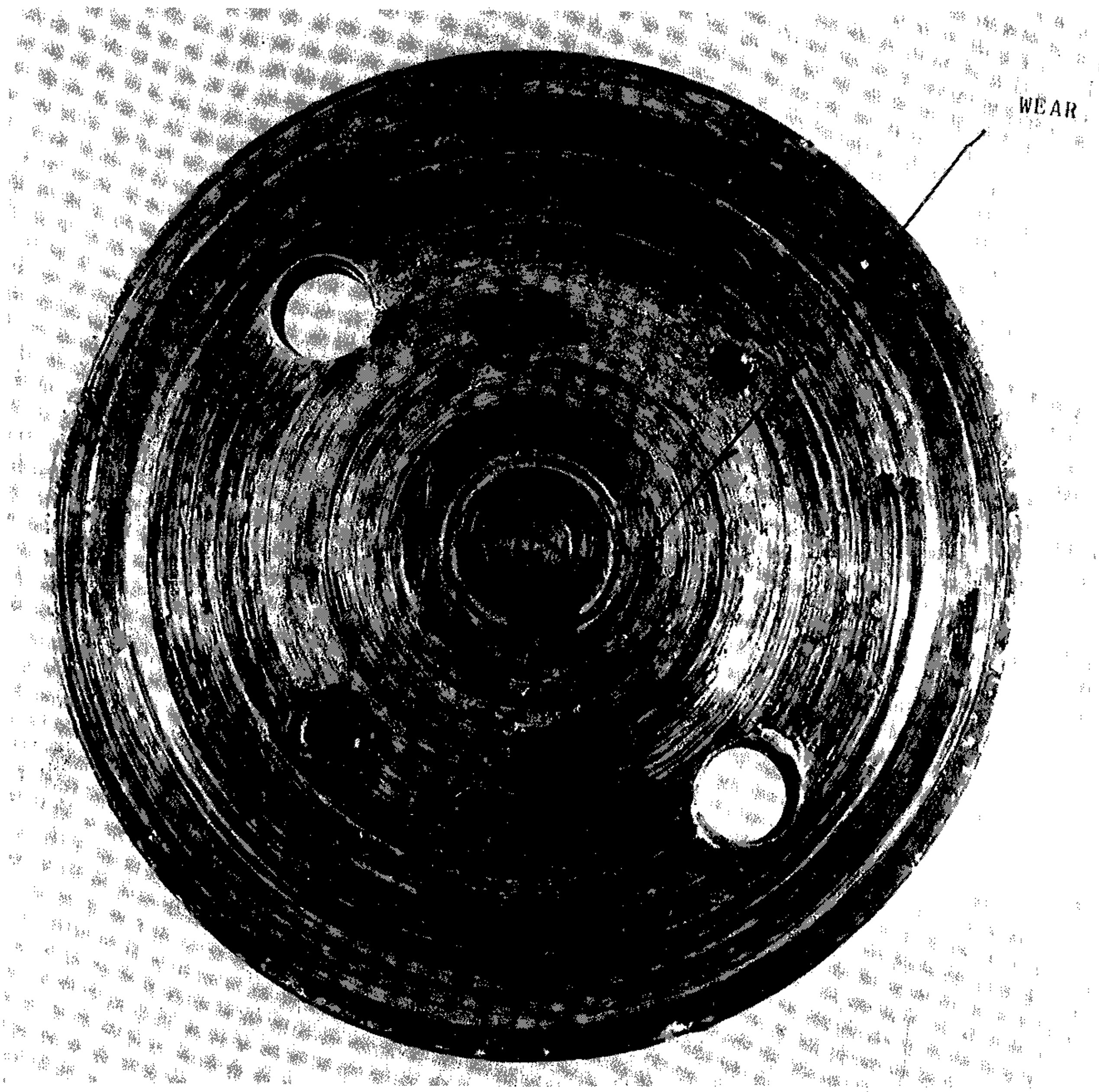
Photograph 2D.—Pinion Bearing End Cover Showing Excessive Wear from Contacting Outer Oil Thrower



Photograph 3D.—Pinion End of Armature with Bearing Removed, Note Excessive Wear on Oil Thrower



Photograph 4D.—A Portion of the H-Ring showing No Wear on Bearing Surface.



Photograph 5D.—*Outside Surface* of Locking Plate showing Wear due to Plate Contacting the Commutator Bearing End Cap.

APPENDIX E

Repair Forms for Traction Motor 53F 476
Chandeysson Electric Co.

EXHIBIT 4-M-4

ABC#10

CHANDEYSSON ELECTRIC COMPANY
TRACTION MOTOR WORK SHEET

RPO 20934F

MAKE EMD

TYPE D77B1 CUSTOMER I.C R&R ✓ UE PURCH WAF ✓

SERIAL # 53F 476 FRAME #

SHIPPED TO IC DATE 2/24/71 UE R&R ✓ PINION NONE

PRELIMINARY INSPECTION | SPACING

MEG ___ REPLACE INTERPOLE PIECE # ___ BETWEEN BORES CE ___ AXLE CAP ARM HT. (4)

HI-POT ___ REPLACE MAIN POLE PIECE # ___ ℄ TO ℄ (17.111) PE ___ CE ___ AXLE CAP ~~HOLE LOCAT.~~

RES ___ AXLE CAP TYPE ___ PE ___

Mileage OK

Low Bore

CE ARM. BORE | PE ARM. BORE

A ___ | A ___

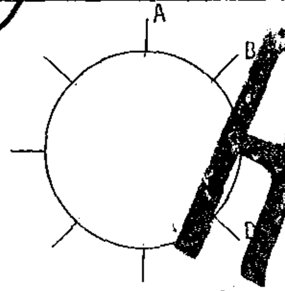
B ___ | B ___

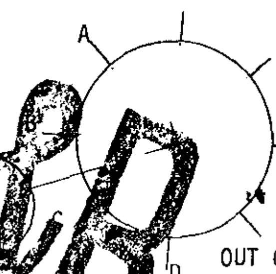
C ___ | C ___

D ___ | D ___

AVE. ___ | AVE. ___

OUT OF ROUND ___ | OUT OF ROUND ___



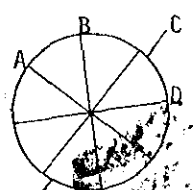


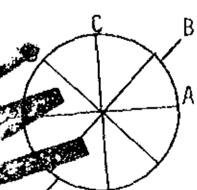
R&R

DECISION ___ | DECISION ___

CE AXLE BORE | PE AXLE BORE

OUTER		INNER
___	A	___
___	B	___
___	C	___
___	D	___
___	AVE	___





OUTER		INNER
___	A	___
___	B	___
___	C	___
___	D	___
___	AVE	___

DECISION ___ | DECISION ___

REJECT

CE SPLINE FIT

	OUTER	INNER
CLEARANCE	___	___
CAP	___	___

PE SPLINE FIT

	OUTER	INNER
CLEARANCE	___	___
CAP	___	___

SPACING

AXLE BORE FACES (41.875)
CONDEMNING LIMIT (41.815)

ARM. BORE FACES (41.125)
CONDEMNING LIMIT (41.117)

MIN. C.E. ARM. BORE WALL THICKNESS 1-1/32"

not granted

TRACTION MOTOR FRAME - FOR EMD ONLY - FILL IN QUANTITIES USED (NEW ONLY)

_______ - 212-302 - D27-D57 Interpole Connectors - short

_______ - 212-307 - D27-D57 Interpole Connectors - long

_______ - 214-000 - D27-D57 Cross Connector Assy. - Br. Holder - Top

_______ - 214-001 - D27-57 Cross Connector Assy. - Br. Holder and "A" Lead

_______ - 214-100 - "AA" Lead

_______ - 214-101 - "F" Lead

_______ - 214-102 - "FF" Lead

_______ - 214-329 - D77 Brushholder Cable with "A" Lead

_______ - 214-330 - D77 Brushholder Cable

_______ - 215-015 - D77 Ringsdorff Brushholder - Complete

_______ - 215-006 - D77 Brushholder, Complete, Constant Tension

_______ - 220-000 - D27-D67 National Brush - 2 Wafer - NC 20-6438

1.76 _______ - 220-001 - D77 National Brush - 3 Wafer - NC 20-6417

_______ - 220-008 - D77 Stackpole Brush - 3 Wafer - AC100

_______ - 220-009 - D77 Ringsdorff Brush

99.25 _______ - 250-001 - D27-D77 SKF P.E. - New

_______ - 250-001S- D27-D77 SKF P.E. - Remanufactured

6.04 _______ - 250-021 - D27-D77 SKF C.E. - New

_______ - 250-021S- D27-D77 SKF C.E. - Remanufactured

_______ - 251-000 - D27-D77 P.E. Bearing Housing

_______ - 251-010 - D27-D77 - C.E. Bearing Housing

_______ - 252-004 - D27-D77 - P.E. Bearing Cover

_______ - 252-006 - D27-D77 C.E. Bearing Cover

_______ - 252-008 - D27-D77 Anti-churn Insert

_______ - 252-020 - D27-D77 P.E. Inner Bearing Cap

_______ - 252-022 - D27-D77 C.E. Bearing Cap

_______ - 255-001 - D27-D77 P.E. Outer Ring

_______ - 256-002 - D27-D77 P.E. Outer Seal

_______ - 257-000 - D27-D77 P.E. Inner Oil Thrower

TYPE D77B1 RPO 80934F

FRAME WORK SHEET & INSPECTION RECORD

	OPERATION	RE	CLOCK NO.	DATE	START	STOP	TIME LAPSE	
1	BLOW OUT	10						
2	CONNECT TO HEATERS							
3	CHECK CONNECTIONS		209	3/22/71				INSPECT
4	DIP, WIPE BORES, DRAIN	20						
5	PLACE IN OVEN	10						
6	REMOVE FROM OVEN	05						
7	TORQUE BOLTS	15	301					
8	TAP ALL HOLES EXCEPT PIN. END	25	301					
9	APPLY KEYS & DRILL CAPS	5	Day shift ✓					
10	CALL WELDER TO WELD KEYS,							
	OIL DRAINS AND OTHER WELDING		✓					WELDER
11	REMOVE WELD SPATTER, CLEAN	15	✓					
	OUTSIDE OF FRAME		284					
12	REMOVE CHIPS AND BLOW OUT INSIDE							
	OF FRAME INTERIOR	10	✓					
13	PAINT INSIDE OF FRAME AND B.H.							
	BLOCKS (MASK TERMINALS)	10	✓					
14	APPLY CAPS, SHIELD, CHECK OIL							
	PLUGS & CAPS, HAVE INSPECTOR							P.E ARM.
	CHECK ARM. HEIGHT	25	✓					INSPECT
15	MAKE UP & APPLY NAMEPLATE	5						IMPEDACE CHECK 20V
16	APPLY LEAD BLOCK, BANDS & PUTTY	15	✓					-----AMP.
17	APPLY GROUND CABLE	5	✓					
18	BUFF LUGS	5	284					
19	TAP P.E. ARM. BORE HOLES	5	284					
20	INSTALL BRUSHHOLDERS	20	284					FINAL
21	BLOW OUT FRAME	10	284					FRAME INSPECT 209

2
7/24/69

CHAND[illegible]SON ELECTRIC COMPANY
ASSIGNMENT RECORD

DEPT. EMD WHEEL AREA

J F Mathews

NAME [illegible] DATE 2-22-71 SHIFT 2nd RPO # 20934F

NAME Hollis Minton DATE 2-22-71 SHIFT 3rd TYPE # D77B1

ACTIVITY	RE	REQ	ACTUAL HOURS LOG START	STOP	ELAPSE	NO. INIT	WORK Inspected	INSP. ST. or RECORD
REWIRE								
Place in Wheel, Sand, Paint	40	40				25	Brazes	
Install Mains & Baffles	60	240				25	Appear	
Install F/FF & Braze Mains	85	85				25	Baffles	
Install I.P. & Baffles	60	60				256	Leads	
Install I.P. Connect & Braze	65	65				256	Ties	
Install AA Lead	30	30				286	M.F. Res.	209
Install A & B.H. Lead	40	40				205	C.F. Res.	
Install B.H. Lead	20	20				256	M.F. Meg.	
Install all Wrap	40	40				205	C.F. Meg.	
Make all Tie Downs	65	65				205	Hi-Pot	
Install Lead Blocks & Lugs	40						Polarity	
Res-Meg-Hi-Pot-Polarity	5	5				205	B.H.	
Remove from Wheel	5	5				205	Appear	
Check All Conn. with 800 A	20						Hi-Pot	
							CE Inner	001
PROCESS							CE Outer	003
Install in Wheel	10	[illegible]	✓			234	CE Roller	003
Check for Shim	40						PE Inner	001
Shim (#New Baffles)	90						PE Outer	003
Res-Meg-HI-Pot-Polarity	10						PE Roller	002
Replace AA Lead	35						Arm End Play	008
Replace A & B. H. Lead	50						Noise	
Replace B.H. Lead	30						Vibration	
Replace F/FF Lead	30						Appear	
One String Tie	5						Hi-Pot	
One Wrap	3							
Locate Ground	25							
Replace IP Coil (2 Old 1 New)	60							
Replace Main Coil (1 New __ Old)	60							
Install One Lug	10							
Replace One Lug	10							
Remove from Wheel	15							
Drill Air Baffles All D	10							
Check All Conn. with 800 A	20							
Build Up Armature	30							
Assemble Arm. in Motor	30							
Space Brush Holders	20							
Install Brushes	20							
TOTALS								

Rebuild Coils

Installation (soldering) none
found in blanked off 4 coils
reason for removal

2-23-71
2-24-71

A TYPE D77B

EMD TRACTION MOTOR ARMATURE ONLY

No.	Work Performed	No.	Date	Clock#	Insp. Stamp
1.	Cut for Strip	1	2/5/71	282	
2.	Strip	2	2-5-71	275	
3.	Clean Lamination	3	2-5-71	275	
4.	Remove Old Weights	4			
5.	Cob, Blow Out and Inspect	5	2/5-71	218	204
6.	Replace Lam. (____")	6			
7.	(Comm.) Shaft - Circle One or Both	7	2-12-71	281	
8.	Knock Out Butts	8	2/5/71	201	
9.	Hypot, Hand Saw, Short Circuit Test & Clean Back of Riser	9			
10.	Clean Wedge Slots	10	2/5/71	201	
11.	Clean Laminations and Inspect	11	2/5/71	201	Comm.
12.	SC Test and HiPot by Winder	12	2-15	223	
13.	Armature Core Ground Insulation	13			
14.	Cross Connectors and Filler	14			
15.	Insulation Cement and Short Circ. Test	15			
16.	Insulate over cross connectors	16			
17.	Lower Coils & Hypot Lower Coils	17			
18.	Set Leads, Filler &Cement Behind Riser	18			
19.	Insulate over lower coils & prepare PE Clips	19			
20.	Top Coils	20	[illegible]	223	
21.	For Lights & Preheat	21			
22.	Install in Squeeze Box	22			
23.	Remove from Squeeze Box	23			
24.	HyPot ✓ Wedge ✓ HyPot ✓ Inspect ____	24			
25.	(Set Leads) & Install Top Fillers	25	2/16	111	
26.	Insulate P.E.	26	2/16 71	287	
27.	Short Circuit Test	27	2/16 71	287	
28.	Machine Riser	28	2/17/71	282/264	
29.	Solder or TigWeld & Inspect	29	2-17	286	223
30.	Machine after solder or clean tigweld	30	2-17	286	
31.	Short circuit test	31	2-17	286	
32.	Braze & Inspect	32	2-17	296	CPS
33.	Insulate Pinion End Conn. & Inspect	33	2-17		[illegible]
34.	Insulate and install p.e. & inspect	34	2-17		CPS
35.	Insulate pinion end for wire band	35	2-17-71	267	
36.	Imp Armature T.C.B 2-18-71 279	36	2-18	279	
37.	Glass Band & Inspect	37	2-18-71	220	
38.	String Band String only 2-18-71	38	2-18	266	
39.	Wire Band & Inspect 220	39	2-19-71	263	
40.	Dip Armature	40			Stor [illegible]
41.	Tighten Comm Bolts	41	2-19-71	222	
42.	Final Machining: Brush Surf. Runout .001 PE Runout .0015 CE Runout .0015 CE Spacer ok PE Flinger ok CE Collar ok	42	2/19/71	260	
43.	Undercut or hand saw and burr [illegible]	43	2-19-71	293	
44.	Fin. Insp, Meg. 600 Ductor 6.6 PE Band ok CE Band ok String Band ok Shaft 4 1/32 10 1/4 Shaft Diam ok Taper ok Threads ok PE&CE Parts ok Br. Surf. Width 6 1/2 Riser Width 7/8 Comm. Diam 15 7/8 Riser Diam 18 3/16 Hi Freq 32 ok Core Loss 430 Stamp Date	44			[illegible]
45	Balance Armature	45	2-22	225	
46	Assemble Armature	46			

T.C.B. [illegible] 2/18/71

(225) 1/2 2/19/71

Carroll 2-26-71 220

TRACTION MOTOR TEST RUN

TYPE D77B1 FRAME RPO 20934-F ARM RPO 20555-A

1000 RPM RUN (½ HR. MINIMUM) Room Temp. 20 °C.

Started 11:45 Stopped 12:15 Hours Run ½

C.E. Bearing Temp.= 28 - 20 - 8 °C. Rise

P.E. Bearing Temp.= 27 - 20 - 7 °C. Rise

Vibration Practically none, slight, too much (circle one) — circled: Practically none

C.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: quiet

P.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: quiet

1500 RPM RUN (½ HR. MINIMUM) Room Temp. 20 °C.

Started 12:15 Stopped 12:45 Hours Run ½

C.E. Bearing Temp= 36 - 20 - 16 °C. Rise

P.E. Bearing Temp= 33 - 20 - 13 °C. Rise

Vibration Practically none, slight, too much (circle one) — circled: Practically none

C.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: quiet

P.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: quiet

2000 RPM RUN (½ HR. MINIMUM) Room Temp. 20 °C.

Started 12:45 Stopped 1:15 Hours Run ½

C.E. Bearing Temp.= 26 - 20 - 16 °C. Rise

P.E. Bearing Temp.= 35 - 20 - 15 °C. Rise

Vibration: Practically none, slight, too much (circle one) — circled: Practically none

C.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: slight noise

P.E. Bearing noise: quiet, very slight noise, noisy (circle one) — circled: quiet

Brush Grade DE7 split, solid (circle one) — circled: split

Tested by (initial & clock no.) ZC232-MF268 Date 2-23-71

Cummings — Foster, Sr.

Pinion installed: yes, no, new, used (circle two) — circled: no, new No. Teeth NONE

Lapping time ______ minutes

1st advance ______ 2nd advance ______ 3rd advance ______

Room temp. ______ Pinion surface temp. ______ Final advance ______

Pinion installed by (initial & clock no.) ______ Date ______

Motor must be checked & signed by an inspector:

Inspector [redacted] 209 Date 2-23-71

Shelton

APPENDIX F

Excerpts from
EMD Maintenance Instructions

ELECTRO-MOTIVE DIVISION • GENERAL MOTORS CORPORATION

SERVICE DEPARTMENT

MAINTENANCE INSTRUCTION

GENERAL MAINTENANCE—MODEL D37, D47, D57, D67, D75, AND D77 TRACTION MOTORS

DESCRIPTION

This bulletin covers general or "running" maintenance recommended for traction motors. It includes a procedure for removing a traction motor from a locomotive and the various inspections that should be made in such instances.

The D47 traction motor is almost identical to the preceding D37 model both in appearance and construction. The main difference is in the field coils which differ in copper size, insulation and resistance. Thus with the exception of the field coils and aluminum baffles all other components in these motors are interchangeable. Following the D47, the model D57 was developed for use in both high speed and extremely heavy drag freight service. The general appearance of the D57 traction motor remains the same as the previous models, however, there were several manufacturing improvements including better insulation methods in the stator, application of a modified silicone varnish to the armature coils to greatly increase the heat resistance, use of a stainless steel non-magnetic square wire wedge to

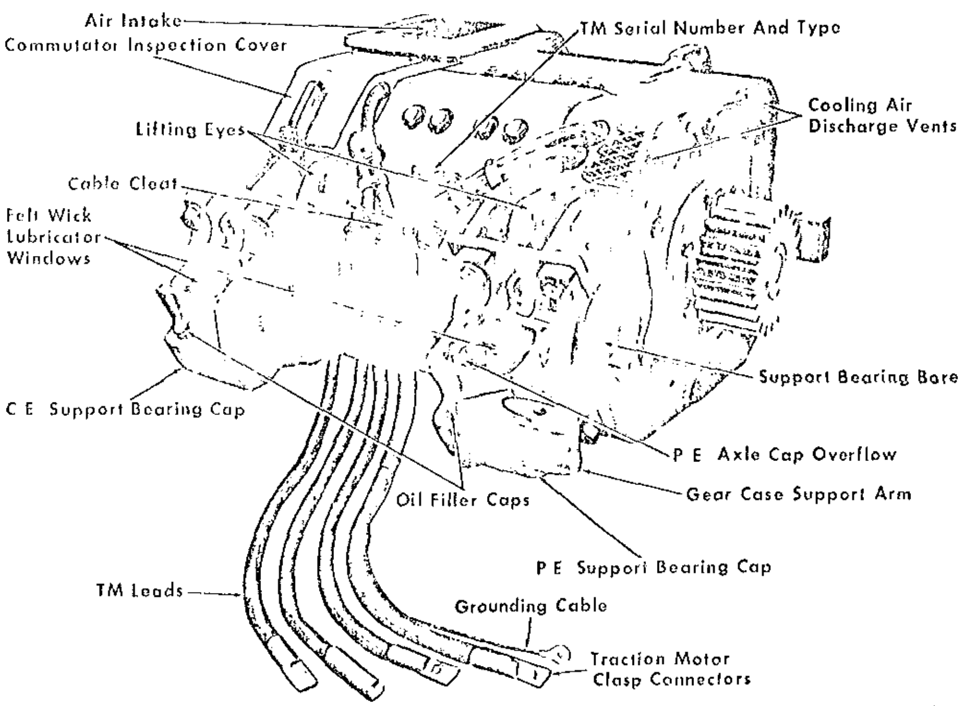


Fig. 1 — D77 Traction Motor

*This bulletin is revised and supersedes previous issues of this number.

hold the two armature coil halves firmly within the core slot, improved seasoning of the commutator to raise the operating temperature by 50° C., and the use of constant pressure brush holders.

With the development of the new higher horsepower locomotives came the need for an even more powerful traction motor to succeed the D57. This new model, the D67, had many major improvements including new armature coil construction for temperature reduction and better moisture proofing; new type brush holders with longer brushes for extended brush life, the addition of a nylon grease retaining insert in the P.E. cover to prevent grease from purging, a new axle cap oil overflow arrangement to prevent overfilling, a manganese-steel wear plate to the motor nose support to obtain longer wear plate service life, a new high temperature non-silicone varnish and commutator end recabling to reduce temperature of C.E. bearing under high speed, high current, dynamic braking.

The D77 motor, Fig. 1, is a product of the continuation of the never ending search for improvement. The four areas of major improvement are:

1. A thinner and stronger (both electrically and mechanically) armature insulation, which due to its decreased thickness provides room for an approximate 20% increase in copper.
2. A TIG welded joint between the armature coil and the commutator which insures a more positive electrical connection between the coils and commutator.
3. Three-wafer resilient pad brushes to provide improved commutation and increase brush life.
4. Nomex vee rings in the commutator which improves commutator stability and performance.

MAINTENANCE

Although these traction motors are designed to withstand the rugged service required of them, and are constructed of the finest materials available, like any machine they require a certain amount of maintenance. If the inspections and maintenance are carefully performed on a scheduled basis, the traction motors should provide the fine performance and long life built into them.

Reference should be made to the recommended maintenance intervals specified in the applicable Scheduled Maintenance Program. Particular attention should be given to each of the items covered under the following headings.

CLEANING

It is essential that the traction motor be kept as clean as possible, both on the inside and outside. Oil and grease soaked dust and dirt should not be allowed to accumulate as this can prove detrimental to insulation and motor performance in general.

Cleaning the outside of the motors can be done by the common method of using a steam jet at the same time the trucks, underframe and fuel tank are washed. If this method is used, the diesel engine must be running at about 450 RPM to force sufficient traction motor blower air through the motors to prevent water or moisture from entering.

The motor interior can be conveniently cleaned by blowing dust and dirt away with compressed air. A large volume of clean, dry compressed air should be used at a reasonable low pressure. Blasts of high pressure air should be avoided due to the possibility of loosening or damaging the protective coating on the insulation.

Clean, dry lintless cloths should be used in conjunction with the air to clean away

9. Start the electric welding machine and adjust voltage to run the motor armature at approximately 1000 - 1500 RPM.

10. Feed grinding stones into commutator slowly until a light contact is made, then feed stones across commutator. Repeat as necessary, then finish by running stones across commutator several times without feeding radially.

11. After grinding and restoring the commutator surface to a satisfactory condition, remove the grinding equipment. Using a wire hand brush, deburr the edges of the commutator bars to remove any copper slivers that may have occurred during grinding. Draw the brush across the commutator in the direction of the bars.

12. When the depth of the mica undercut between the commutator bars is less than 3/64", use commutator slot file, 8238905, as shown in Fig. 9, to undercut the mica to the proper depth. Do not exceed the mica undercut maximum depth of 5/64".

8536

Fig. 9 - Cleaning Commutator Slots

13. Use chalk stone for final clean up of commutator. Do not use emery cloth or sandpaper for this purpose. Lubricant should never be used on commutators as brushes have enough graphite to supply their own lubrication.

14. Thoroughly clean the motor to remove all copper dust and slivers. This can be done by running the motor and directing compressed air on the face of the commutator. Wipe dirt and copper dust away using clean cloths. Carefully inspect the cleaning job and particularly the slots between the commutator bars to see that all traces of undesired copper have been removed.

15. Restore motor for operation after grinding by replacing brush holder assembly and/or renew brushes removed during grinding operation. Reconnect cables and install inspection cover. Check motor for proper rotation before returning locomotive to service.

NOTE: If the commutator has been damaged to such an extent that the grinding process outlined proves ineffective, the motor will have to be removed and the armature turned in a lathe.

ARMATURE BEARINGS

NOISE TEST

Each time a traction motor is removed from a locomotive truck it should be motored so that a noise check can be made for faulty armature bearings. Performing this test will serve as a means of detecting faulty bearings thus preventing such a motor from operating in service where it would likely result in a road failure.

The power source and cable connections for this test are the same as described previously for motoring the armature during commutator grinding. The armature speed should be brought up to about 1500 RPM and then the power shut off to allow the armature to coast to a standstill. Carefully listen and try to determine the source of any noise that might be considered unusual. Experience and comparison with other motors will help distinguish a faulty bearing from a normal one.

SEALED GREASE LUBRICATED BEARINGS

Unless otherwise specified by the customer, all traction motors are manufactured with sealed grease lubricated armature bearings. A specific type of grease is used. The amount and method by which it is applied is carefully controlled. Effective with D67 traction motor, and available for older models, is a sectionalized nylon insert installed in the pinion end bearing cover to prevent an excessive amount of grease from being moved into the rollers by slumping action caused by vibration. This reduces "churning" of the grease which in time causes the grease fibers to become soft and susceptible to purging. These factors should permit the motor to be operated without further bearing attention to the motor overhaul period specified in the applicable Scheduled Maintenance Program. For information on repacking these bearings refer to Maintenance Instruction 6850.

OIL LUBRICATED BEARINGS

On special order, all models of traction motors can be equipped with oil lubricated armature bearings. Such motors may be readily identified by the oil filling tube applied to the bearing covers. This tube has a spring loaded button valve at the opening to protect the armature bearings from dirt and moisture encountered in service.

The interval at which oil should be added to such bearings is outlined in the applicable Scheduled Maintenance Program. The specific type of oil to be used is listed in Maintenance Instruction 1756. Specially designed oil dispenser 8191382 should be used as recommended in the Service Tools Catalog. A meter on this dispenser accurately measures the ounces of lubricant added. This is important since over lubrication will result in the excess oil working out of the bearing and getting into the motor. The meter will not register when air is pumped.

GEAR CASE AND GEARS

The gear case houses the traction motor pinion and mating axle gear protecting them from dirt or damage and carries the gear lubricant. The cases are made of two close fitting halves and feature offset seals to provide complete contact and closure. Removable gutters over each seal retainer, and grease deflectors, divert the flow of grease away from seal surfaces.

The inspection opening and grease filler cap is located at the axle end of the upper and lower halves of the case. This makes it more convenient for inspecting gears, checking and adding lubricant.

The caps are sealed by mating machined surfaces without the need of gaskets. A leaf spring assembled to the top of the filler cap maintains pressure against the flanges around the gear case filler opening, assuring a positive sealing action. The current filler caps may be easily removed or applied by depressing the leaf spring using tool 8250241 as shown in Fig. 10.

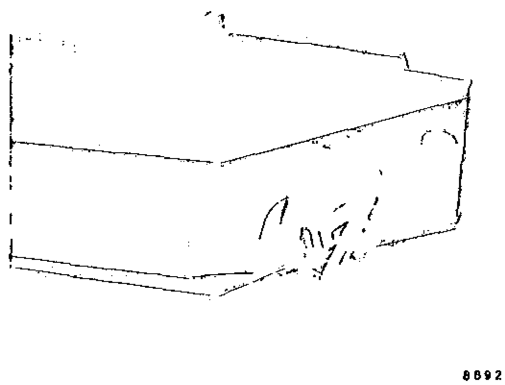


Fig. 10 — Filling Cap Removal Tool

The current gear case also features unit type felt seals inserted into the channels at the axle and pinion openings. The seals are held in place by small pieces of metal at one end of the channels next to the inside of the case and are designed to prevent the seal from turning. This will tend to prevent the excessive loss of lubricant that occurred when the previous type felt seals would move in the channels due to the turning forces imposed on them.

Older style gear cases can be modified to use the unit seal by first removing the old felt and cement from the channels. Then seven small pieces of metal are welded, at the top and bottom, opposite to each other at one end of the channel next to the inside of the case as shown in Fig. 11. Gasket compound or cement is not required for unit seals thus the previous task of cleaning out channels during seal replacement is no longer necessary. It is then a simple matter to replace worn unit seals with new ones.

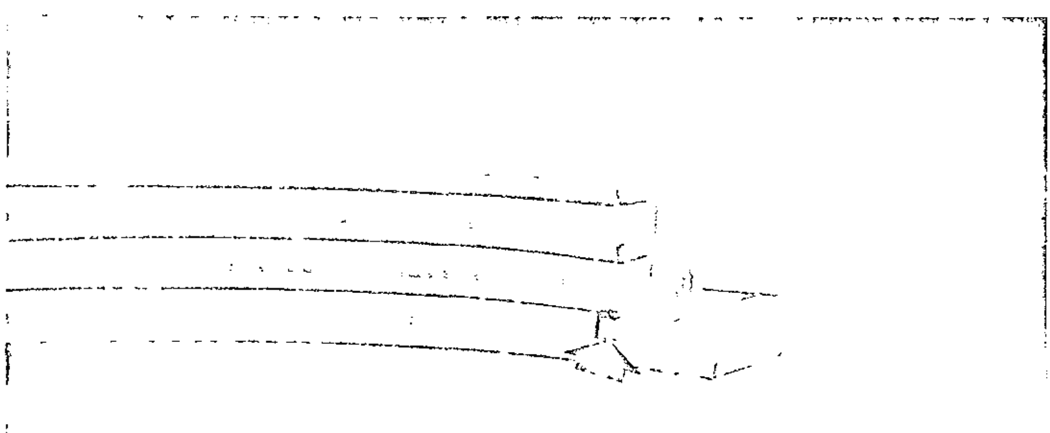
NOTE: The preceding gear case improvement plus the installation of the new style removable gutters are explained in detail in Maintenance Instruction 9532.

LUBRICATION

Inspection of gear cases should include checking for lubricant leaks. Excess lubricant will be discharged through the drain slot of the traction motor grease seal during the first few thousand miles of operation and is no cause for concern. Prolonged leakage at any other point, however, should be corrected.

Refer to the applicable Scheduled Maintenance Program for the recommended interval of gear case inspection and the type of lubricant to be used. Frequent gear case grease level inspections should be made using such intervals as a guide until the maximum mileage between lubrication intervals can be determined for the specific type of service encountered.

The need for lubricant can be readily determined by observing the condition of the gear teeth through the gear case inspection opening. Gear teeth appearing dry or having bright spots indicates that the lubricant level should be checked and that grease may have to be added. The table below indicates minimum lubricant levels for the various gear cases. Two pounds of recommended lubricant should be added when such inspections indicate the need.



9 10 1

Fig. 11 — Gear Case Modification