SERIAL NO. 553

Chicago, Milwaukee & St. Paul Railway Company

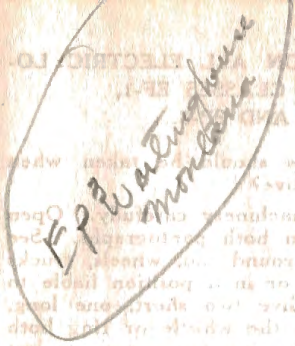
ELECTRIC LOCOMOTIVE
Examination Questions and Answers

General	EF-1, ES-2, EP-2, EP-3.
Class	EF-1.
Class	ES-2.
Class	EP-2.
Class	EP-3.

Effective March 1, 1927.

This book is the property of the Chicago, Milwaukee and St. Paul Railway Company, and is loaned to:

NAME	OCCUPATION	DATE RECEIVED	ADDRESS



PREFACE

These questions and answers which follow are prepared for study and guidance for enginemen and others desiring information with respect to operation of Class EF-1, ES-2, EP-2 and EP-3 locomotives.

The answers, as a general thing, are brief summaries of the more elaborate information given in the instruction books for these locomotives.

It is recommended and requested that enginemen and others thoroughly familiarize themselves with the information as contained in these instruction books.

GENERAL QUESTIONS ON ALL ELECTRIC LOCOMOTIVES. CLASSES EF-1, ES-2, EP-2, AND EP-3.

Q-1. What precautions should be taken when starting up a dead locomotive?

A-1. Look over the machinery carefully. Open the grounding switches on both pantographs. See that no one is working around cab, wheels, trucks or on roof of locomotive or in a position liable to cause personal injury. Give two short, one long, and two short blasts with the whistle or ring both bells, and then give ample time for anyone to get in the clear before raising trolley pole or pantograph.

Q-2 Under what conditions can repair work be done on electrical apparatus? What special precaution should be taken before working on Class ES-2, EP-2, and EP-3 electrical apparatus and why?

A-2. Only authorized persons in their line of duty are permitted to work on electrical apparatus. Pantographs and trolley pole shall be locked down and grounded when work is to be done on a locomotive under the trolley wire. On ES-2, EP-2 and EP-3 locomotives see that the motor generators are not running because the motors of these sets are equipped with shunt fields which may cause them to generate a dangerous current as long as their armatures are turning, even though their switches are open.

Q-3. What precautions should be taken before going on the roof?

A-3. Lower pantographs and trolley pole, close grounding switch and locking device on pantographs and take pantograph operating valve handle with you. Be very careful not to come in contact with trolley wire.

Q-4. What precautions should be taken before entering the contactor compartments or opening covers of the different parts of apparatus?

A-4. Open main and auxiliary switches and advise all other persons on or about the locomotive of your intentions to insure against switches being inadvertently closed. When not necessary to have locomotive energized the pantographs and trolley pole should be lowered and grounded, and keep pantograph handle in your possession.

Q-5. What general precaution should be taken when operating locomotives to safeguard the electrical apparatus?

A-5. Obey general safety instructions as they appear in small framed print in cab and in instruction books for electric locomotives.

Q-6. Outline resuscitation treatment from an electric shock.

A-6. 1. Clear victim of electric circuit.

2. Lay subject on belly with arms extended forward with face turned to one side. Clear out mouth, block mouth open and draw tongue forward.

3. Kneel straddle of subjects thighs and facing his head, placing your hands in the small of his back.

4. With arms held straight swing forward slowly so that the weight of your body is gradually brought to bear on subject.

This act should take two or three seconds.

5. Then immediately swing backward so as to remove the pressure.

6. Repeat as above twelve or fifteen times per minute, making a complete respiration in four to five seconds. Continue for two hours or longer if necessary, without interruption.

7. An assistant may loosen clothing and call a doctor. Keep patient warm.

Q-7. What air brake system is employed on all electric locomotives excepting ES-2?

A-7. The air brake equipment is Westinghouse type EL-14 with modifications. It consists of two complete equipments, one on each end, so arranged that the brakes may be operated from either cab. (Class ES-2 has one equipment only.)

Q-8. In what respect does the K-14B brake valve differ from the H-6 brake valve, used on steam locomotives?

A-8. The automatic brake valve and the independent brake valve bodies are cast in one piece, cored passages connect the two valves instead of pipes, the whole valve being mounted on one pipe bracket. The port leading to the compressor governor is plugged.

Q-9. Have the brake valve handles on the K-14B brake valves the same relative positions as the H-6 and S-6 automatic and independent brake valves on steam locomotives?

A-9. Yes, but the handles are removable.

Q-10. Are the distributing valves on the electric locomotives the same as those on steam locomotives?

A-10. Yes, the distributing valves used on the freight locomotives are equipped with quick action

cylinder caps and operate the same as the equipment on the steam locomotives that have quick action cylinder caps on their distributing valves. The passenger locomotives are equipped with brake pipe vent valves and plain cylinder caps on the distributing valves.

Q-11. Do both distributing valves operate to supply brake cylinder pressure when making automatic brake applications?

A-11. Yes.

Q-12. What is the purpose of the transfer valves?

A-12. The transfer valve is the medium through which the distributing valve on the operating end of the locomotive relays the braking functions to the distributing valve on the non-operating end during independent operation.

Q-13. What and how many pipe connections has the transfer valve?

A-13. The transfer valve has six pipe connections: One main reservoir pressure; one from brake cylinder; one from double cutout cock (main reservoir pressure); one from independent brake valve (application cylinder pressure); one from distributing valve (application cylinder pressure) - (this is the pipe which on steam locomotives connects the independent brake valve with the distributing valve, in other words the application cylinder pipe passes through the transfer valve); one from the equalizing pipe.

Q-14. What is the purpose of the equalizing pipe?

A-14. The equalizing pipe connects the transfer valves on both ends of the locomotive and establishes a connection between the brake cylinder pressure and application cylinder pressure of both ends which in turn affords a means of equalizing the brake cylinder pressure on both ends. (During independent operation it requires about 3 seconds for the brake cylinder pressure on both half units to equalize.

Q-15. What pressure is in the equalizing pipe?

A-15. Brake cylinder pressure.

Q-16. If the equalizing pipe should break or the hose connections between units break, what effect would it have?

A-16. Brake cylinder pressure could not be built up, in either independent or automatic application.

Q-17. If an obstruction occured in the equalizing pipe, such as cock turned or connection between half-units frozen, what effect would it have?

A-17. Brakes could be applied on operating end only in independent operation; they could be applied on both ends in automatic application, but the non-operating end could not be released.

Q-18. If the obstruction cannot be cleared, what should be done?

A-18. Open the bleed cock in the distributing valve release pipe (located just below the automatic brake valve), on the non-operating end.

Q-19. How can the brake on locomotive be handled in this way?

A-19. The automatic brake application will be handled the same as usual, the brakes will apply and be held applied until the brake valve is moved to release or running position and the brakes on rear end will release through the bleed cock in the release pipe, the brakes on head end will release in usual manner; the brakes on rear end could not be released with the independent brake valve, after they have been applied with the automatic brake valve.

Q-20. What test should be made to know that the transfer valves are in proper position and the equalizing pipe unobstructed?

A-20. With the system charged to train line pressure apply the locomotive brake with the automatic brake valve by making a 10 pound reduction and note that the brakes on both units apply, leave the automatic brake valve on lap and release the brakes with the independent brake valve, and note that the brakes on both units release. (Note) This test will require the assistance of the fireman as the brakes will not ordinarily stay released long when leaving the automatic brake valve in lap position and the independent brake valve in running position, a light leakage in the distributing valve or brake pipe leakage will cause the brake to creep on before the engineman could go from the operating end to the non-operating end to see if the brakes released properly.

Q-21. Trace the air from the independent brake valve on operating end to the brake cylinders on non-operating end in independent operation.

A-21. Reducing valve pressure flows from independent brake valve (application position) through application cylinder pipe to transfer valve (operating end) through transfer valve (front end position) through application cylinder pipe to application chamber in distributing valve (operating end); main reservoir pressure flows through application valve to brake cylinders; a branch from brake cylinder pipe is connected to transfer valve and brake cylin-

der pressure flows through transfer valve to equalizing pipe which connects the two transfer valves, through transfer valve on non-operating end (rear end position) to application cylinder pipe to distributing valve on non-operating end, which in turn supplies main reservoir pressure to brake cylinders on non-operating end.

Q-22. Trace the air from the brake cylinders on non-operating end to the atmosphere on operating end when releasing after an automatic application of the brakes.

A-22. When distributing valve on non-operating end moves to release position, the application chamber pressure expands into the release pipe which leads to the independent and automatic brake valves on the non-operating end, the automatic brake valve on the non-operating end being in lap position the application chamber pressure cannot escape to the atmosphere, and the brake will only be partially released, in order to completely release the brake cylinder pressure in non-operating end, the brake cylinder pressure on operating end must be reduced, this in turn will reduce application chamber pressure through the medium of the transfer valves and the equalizing pipe, in the reverse order as followed in the answer to question 21.

Q-23. Of what does the transfer valve consist?

A-23. A piston and slide valve, also a high tension spring.

Q-24. How many positions has the transfer valve?

A-24. Two (front end and rear end) positions.

Q-25. How is the transfer valve moved to the proper position?

A-25. By the action of the high tension spring and main reservoir pressure.

Q-26. What governs the application and release of main reservoir pressure to and from the transfer valve?

A-26. The 3-position double cut-out cock, located in the brake pipe below the automatic brake valve.

Q-27. What are the three positions of the double cut-out cock?

A-27. First, handle crosswise of pipe; second, handle at about 75 degree angle; third, handle at about 110 degree angle.

Q-28. Explain what effect the double cut-out cock placed in the first position will have on the position of the transfer valve.

A-28. Brake pipe pressure free to flow through the cock and main reservoir pressure port blanked, vent port from pipe leading to transfer valve open to atmosphere, this vents the main reservoir pressure from the spring side of the transfer valve piston, the main reservoir pressure which is always present on the slide valve side of the piston will then force the piston and slide valve against the tension of the spring to the (front end position).

Q-29. Explain what effect the second position of the double cut-out cock will have on the position of the transfer valve.

A-29. Brake pipe pressure blanked and main reservoir port open, vent port to atmosphere closed; this allows main reservoir pressure to flow to the spring side of the transfer valve piston, with main reservoir pressure equal on both sides of piston the high tension spring will move the piston and slide valve to (rear end position).

Q-30. Explain what effect the third position of the double cut-out cock will have on the position of the transfer valve.

A-30. Both the brake pipe and main reservoir pressure blanked, vent port from pipe leading to spring side of transfer valve open to atmosphere which vents the pressure from the spring side of the transfer valve piston, the transfer valve will then be moved to (front end position).

Q-31. When should the double cut-out cock be placed in the first position?

A-31. When the automatic brakes are to be operated from that end, as with a light locomotive or the leading locomotive in a train.

Q-32. When should the double cut-out cock be placed second position?

A-32. At all times in all classes of service on the non-operating end.

Q-33. When should the double cut-out cock be placed in third position?

A-33. On the operating end of a locomotive when the automatic brakes are to be operated from another locomotive, as when the locomotive is a helper or second engine.

Q-34. Can the independent brakes be operated when the double cut-out cock is in third position?

A-34. Yes.

Q-35. If the locomotive brakes fail to apply and release or cannot be operated with the independent brake valve when the double cut-out cock is in third position, what does it indicate?

A-35. That the transfer valve has not moved to front end position due to vent port stopped up in double cut-out cock or the cut-out cock is not in proper position to allow main reservoir air to pass through it to the transfer valve.

Q-36. Is it possible for the double cut-out cock to be in improper position when the handle is apparently in proper position?

A-36. Yes. The main reservoir air port through the double cut-out cock is small and if the handle has been offset by pounding it into position, then the handle can be apparently in proper position, but the cut-out cock will not be in proper position for main reservoir air port to be open.

Q-37. If the locomotive was being operated as a helper and the brakes had been applied from the leading locomotive and could not be released with the independent brake or in the usual manner, what would you do to release them quickly?

A-37. Open the bleed cock in the distributing valve release pipe, located just below the brake valve.

Q-38. What do you understand the term "2 stage" air compressor to mean?

A-38. One that uses a low and high pressure cylinder.

Q-39. How is the power transmitted in the air compressor from the motor armature to the pistons?

A-39. Pinions on the armature shaft mesh with gears on the crank shaft, and the crank shaft drives the connecting rods which are connected to air pistons.

Q-40. What do you understand inter-cooling pipes to be and where are they located?

A-40. Pipes exposed to the atmosphere in which the air is cooled after being compressed. They are between the low and high pressure cylinders of the air compressor.

Q-41. How would you detect leaky valves on the air compressor?

A-41. If low pressure inlet valves leak there would be blow back at intake. If the intermediate valves leak the inter-cooling pipes would be excessively hot. If high pressure outlet valves leak the compressor would run backward a little after it had stopped running.

Q-42. How would you detect if air was leaking from the high stage to low stage cylinder through the gaskets of the air compressor?

A-42. The cylinders would become abnormally heated.

Q-43. What main reservoir pressure is carried on these locomotives?

A-43. 110 lbs. minimum and 130 lbs. maximum.

Q-44. How are the pantographs operated and adjusted?

A-44. The pantographs are raised by air pressure pistons stretching springs with fixed amount of travel. The springs are adjusted to give a shoe pressure against the trolley wire of 30 lbs. in Summer and 35 lbs. in Winter.

Q-45. What would an accumulation of oil in the main reservoir indicate?

A-45. Leaky or broken piston rings in the air compressor cylinders.

Q-46. How are pantograph shoes lubricated?

A-46. By applying graphite lubricant between wearing strips.

Q-47. When should both pantographs be used in regular operation?

A-47. Only when unusual flashing at trolley is caused by frost, sleet or dirty trolley wire.

Q-48. What should be done when a pantograph is wrecked?

A-48. The parts remaining should be securely tied down in the clear and the main cable disconnected and tied so that it will not ground itself electrically.

Q-49. What precautions should be taken when changing pantograph shoes?

A-49. In addition to the precautions prescribed under question No. 3, pantographs will raise automatically with shoes removed and special care should be taken to prevent this.

Q-50. Explain the function of the pantograph operating valves.

A-50. The pantograph operating valves admit or release air pressure to and from the pantograph cylinders.

Q-51. Give location of controller switches and fuses and their function.

A-51. The controller switches are mounted on the ceiling over the engineer's seats, excepting on

EP-3 locomotives where they are at the right of engineer's front window. They supply current to the controllers for governing the locomotive operation.

Q-52. Give general safety precautions to follow when replacing fuses.

A-52. Never replace or remove any fuses unless positive that the circuit is dead.

Q-53. What is liable to happen to the armature of the motor if the prescribed speed limit is exceeded?

A-53. It may break the armature bands and throw the armature coils out of their slots.

Q-54. How are the compressors lubricated and what precautions should be taken if the compressor groans or shows a lack of lubrication?

A-54. By crank case splash system. Compressor should be shut down when there are indications of lack of lubrication.

Q-55. What do the fireman's duties consist of?

A-55. The fireman should assist the engineer in all ways possible in operation of the locomotive, read and record KWH meter reading and patrol the motor at frequent intervals, observe the operation of the locomotive and apparatus, detect hot bearings or any other abnormal conditions.

Q-56. How should the KWH meter be read, and what report should be made? (Applicant will give a practical example.)

A-56. (In giving this question in an examination a sample dial should be used and the applicant required to make several readings on several different settings. These readings should be jotted down on a standard meter book sheet, Form EE-111 Rev. and with other details filled in, such as may be used by the examiner.)

Q-57. Should the controller be advanced from the "off" position when reverse lever is set for direction opposite from the way train is moving and why?

A-57. No, because serious flashover trouble will result.

Q-58. If the controller cannot be shut entirely off or if ammeters still indicate after controller is off, what can be done?

A-58. The controller switch should be opened to shut off power under the above conditions.

Q-59. What should be done when power goes off the line while operating?

A-59. The controller should be shut off quickly and if on a mountain grade, the train brakes should be applied.

Q-60. What do you understand by "acceleration current"?

A-60. This is the current value maintained and necessary to bring the train up to speed.

Q-61. What is the effect of wheel slipping and how may it be avoided?

A-61. When wheels slip the ammeters become unsteady and the wheels may revolve so rapidly that flashovers will occur. When slipping occurs the controller should be shut off slowly until the wheel catches the rail, sand being used in the meantime.

Q-62. Why are electric motors liable to flashover with weak field current as compared to that in the armature?

A-62. Weak field current is associated with high speed, causing vibration of parts and chatter of brushes, with sparking. Moreover the armature reaction due to its higher current weakens the fields.

Q-63. How should the values of line and field current be maintained in relation to each other during regeneration?

A-63. The field current should never be less than one-half of the line current and preferably equal to or greater than the line current.

Q-64. What are the duties of a messenger on a dead locomotive?

A-64. To see that the dead engine feature is opened and the double cut-out cock in the No. 3 position in the engineer's cab on the end which he proposes to occupy, and that the double cut-out cock on the opposite end is in the No. 2 position and the dead engine feature closed. He should see that the bearings are properly lubricated and observe all bearings and apparatus enroute to avoid or take care of any abnormal conditions which may arise, and to observe the operation and eliminate the application of driver brakes which would cause sliding of wheels or undue heating of the tires.

Q-65. How are the interlock discs numbered?

A-65. From the top down.

Q-66. How are the finger type interlock and relay fingers numbered?

A-66. From left to right.

Q-67. What is meant by an "open circuit"?

A-67. Where an electrical connection is broken and no current flows.

Q-68. What is meant by a "short circuit"?

A-68. When an exposed or bare metal part of an electrical circuit comes in contact with some other part of the same circuit and the current returns to its source without having completed its designated path.

Q-69. What is meant by a "grounded circuit"?

A-69. A grounded circuit is one where the current returns through the frame of the apparatus instead of through an insulated wire. This may or may not be normal. If abnormal it would produce a short circuit.

Q-70. What is a flashover and what are the principal causes?

A-70. A flashover is an undesired flow of current through an arc from a brush holder or other current carrying parts to ground, which results in a short circuit condition. The principal causes on a motor are bad commutation, short brushes, weak field current, wheels slipping or parts in poor condition.

EXAMINATION QUESTIONS FOR LOCOMOTIVE ENGINEERS ON CLASS EF-1 TYPE ELECTRIC LOCOMOTIVES

Q-71. What is the arrangement of cabs, wheels and trucks on class EF-1 locomotives?

A-71. There are two cabs with four pairs of driving wheels and one four wheel engine or guiding truck under each cab. The first main truck under each cab includes the engine truck and two pairs of driving wheels and their traction motors. The rear main truck has two pairs of driving wheels and their traction motors.

878 **Q-72.** Name the various equipment compartments and indicate the principal equipment in each.

A-72. Engineer's cab, motor generator compartment, contactor and rheostat compartments, and air compressor compartment.

Engineer's cab contains controller, brake valves, control switches, cab heater and air compressor governor.

Motor generator compartment contains M. G. set, Traction Motor Blower, Motor Operated Rheostat DB-451, Regulating panels 102 & 113, Regenerating Braking panel 103 and Reverser.

Contactor Compartment contains the various contactors, relays, interlocks and series parallel switch.

Rheostat compartment contains the resistors for the traction motors and auxiliary apparatus.

Air Compressor Compartment contains the air compressor lightning arrester, main and auxiliary switch and fuse compartment and the reactor.

879 **Q-73.** State briefly how the wheels and bearings are numbered.

A-73. Beginning at "A" end with odd numbers on right side and even numbers on left side, when facing the "A" end. Engine trucks and drivers are numbered separately, the engine truck wheels being designated with the prefix "T".

Q-74. How are the articulating joints lettered?

A-74. Beginning at "A" end, first is A, middle connection is A-B, and "B" end as B.

880 **Q-75.** Name the auxiliary air devices and indicate the pressures at which they operate?

A-75. The auxiliary air devices are main whistles, bell ringers, pantographs and sanders. All but the bell ringers operate on main reservoir pressure. The bell ringers operate from control air pressure.

Q-76. What is meant by control air and what does it operate?

A-76. The control air has a small separate reservoir and is supplied with air pressure from the main reservoir reduced to 75 lbs. This air operates the bell ringers, reversers, and series-parallel switches. There is one control air system for each half unit. During severe cold weather the pressure is raised to 100 lbs.

Q-77. What is the type of the air brake equipment and of what does it consist?

A-77. The air brake equipment is Westinghouse type EL-14 with modifications. It consists of two complete equipments, one on each half unit so arranged that the brakes may be operated from either cab.

Q-78. How is the brake rigging operated?

A-78. The brake rigging is operated by brake cylinders and pistons, one on each side of each main truck which operate the brake shoes on adjacent driving wheels.

Q-79. Name the different parts of the air brake equipment located in each half unit.

A-79. One K-14B brake Valve; one No. 6 distributing valve; one transfer valve; one double cut-out cock; one two-stage air compressor; one electro-pneumatic compressor governor; one double pressure feed valve; one reducing valve and air gauges. Some of these locomotives are equipped, also, with complete set of air signal equipment.

Q-80. Where are the cut-out cocks in the pantograph air line located?

A-80. Over hand brake or over right side door.

Q-81. From what point in the air system is the air taken which operates the reversers and series-parallel switches?

A-81. Tapped on right front end of each half unit to main reservoir pipe and to a single pressure reducing valve near hand brake staff, and then to control air reservoir.

Q-82. At what pressure is the air used to operate the reverser and series-parallel switch?

A-82. 75 pounds normally, 100 lbs. during severe cold weather.

Q-83. Where is the reducing valve, cut-out cock and gauge located in this line?

A-83. By the hand brake staff near the floor.

Q-84. Where is the air compressor governor located?

A-84. One in each engineer's cab.

Q-85. How do you adjust the main reservoir pressure with the air compressor governor?

A-85. The cut-out or maximum pressure is obtained by means of the adjusting screws in top of cylinders and the cut-in or minimum pressure is regulated by means of the range pin in its bracket.

Q-86. Where are the air compressor contactors located and what are their numbers?

A-86. On the right hand side of the forward end of the contactor compartment and are numbered 52 and 53.

Q-87. Explain their operation in starting the air compressor with resistor No. 53.

A-87. In starting, contactor No. 52 is closed and the heavy rush of current into the motor standing still compresses a spring in contactor 53 and holds it open while the current flows through resistance. When the motor gets started the current flow decreases so that the spring can close contactor 53 which by-passes the current around the resistance directly to the motor.

Q-88. What adjustment is made on No. 53 contactor?

A-88. To close in 2 to 4 seconds after No. 52 closes.

Q-89. Where is the cab heater switch located and what is its number? Where is the foot warmer switch located?

A-89. The main heater switch is No. 54 and is located on right hand side at the forward end of the contactor compartment. The foot warmer switch is in the engineer's cab back of engineer's seat.

Q-90. Where is the main cab heater located and what is its voltage?

A-90. Located in each engineer's cab and the voltage is 3000 volts.

Q-91. How would you disconnect the cab heater circuit from the rest of the auxiliary circuit?

A-91. By removing the heater disconnecting rod located in the H. V. switch and fuse box.

Q-92. Where is the braking controller connection box located, what control wires are in it and how are they numbered?

A-92. At the left of front door of each engineer's cab and are numbered 25 to 36 inclusive, numbering downward from the top.

Q-93. Where is the main controller connection box located, what control wires are in it and how are they numbered?

A-93. Under the fireman's seat of each engineer's cab and contain control wires 1 to 24 inclusive, numbering from left to right.

Q-94. Where do the wires of the single wire connections in the main controller and braking controller connection boxes lead to?

A-94. They lead to the apparatus on that half-unit.

Q-95. Where do the wires of the three wire connections in the main controller and braking controller connection boxes lead to?

A-95. One wire leads to the controller, one wire leads to the rear end control coupler socket and the third to the front end control coupler socket.

Q-96. What is the purpose of the control jumpers?

A-96. To connect the controllers and control system of both half units together.

Q-97. What control wires does the long jumper contain?

A-97. Nos. 1 to 12.

Q-98. What control wires does the middle jumper contain?

A-98. Nos. 25 to 36.

Q-99. What control wires does the short jumper contain?

A-99. Nos. 13 to 24.

Q-100. Explain how the 0 and 8 wires are connected and why?

A-100. They are purposely crossed in the jumper between half units because one half unit is always backing up when the other is going forward.

886 **Q-101.** Give number, location and function of the line contactors.

A-101. The line contactors are located in the right side of the contactor compartment near the H. V. switch and fuse box. They are numbered 1 to 4. They make and break the current connections to the traction motors as controlled by the operation of the main controller.

887 **Q-102.** Give number, location and function of the rheostat contactors.

A-102. Rheostat contactors numbered 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22, 23 and 24 are located in the contactor compartment. Nos. 5 to 13 are located on the right side. Nos. 16 to 24 are located on the left side. These contactors are used to short circuit or to by-pass current around the traction motor resistors in regular manner when the main controller is being operated.

Q-103. Give number, location and function of the shunting contactors.

A-103. Nos. 14 and 26. No. 14 is located in contactor compartment, right side and No. 26 is located in contactor compartment left side. They are used to connect field shunts to by-pass 50 per cent of the current around the traction motor fields.

Q-104. Give number, location and function of the braking contactors.

A-104. Nos. 15 and 25. No. 15 is located on the right side and No. 25 is located on the left side of the contactor compartment. They are used to connect the exciter armatures to the traction motor fields during regenerative braking.

Q-105. Give location and function of main controller.

A-105. There is one located in each operating cab and it furnishes with other apparatus the means of regulating the current flow to the traction motors while motoring.

Q-106. Give location and function of braking controller.

A-106. There is a braking controller mounted above the main controller in each operating cab for the purpose of regulating the braking effort while regenerating.

Q-107. Where is the friction trip located and what is its function?

A-107. Each main and braking controller has a friction trip located in the compartment between them. They cut off control current when ceasing regeneration.

Q-108. Where is the dash pot on the controller located and what is its function?

A-108. The dash pot is located at the top in the rear of the main controller and is used to prevent rebound of the lever when shutting off quickly.

Q-109. Give name, capacity, location and function of all 3,000 volt fuses on the locomotive.

A-109. Three high voltage fuses for 3,000 volt circuits as follows: Main fuse, 500 amperes, located in the H. V. switch and fuse box; to protect the traction motors. Auxiliary fuse, 40 amperes, located in the H. V. switch and fuse box; to protect the motor generator and air compressor and cab heater. Lightning Arrester fuse, 20 amperes; located in Lightning Arrester box. To protect the Lightning Arrester.

Q-110. Give name, capacity and location of all low voltage fuses on locomotive.

A-110. Six cab lamp fuses, 10 amperes, two located in each engineer's cab and one in each air compressor compartment. Two foot warmer fuses, 15 amperes; one located in each engineer's cab. Two headlight fuses, 15 amperes; located in each engineer's cab. Two compressor control fuses, 10 amperes; one located in each air compressor compartment. Two air compressor governor fuses, 10 amperes; one located in each engineer's cab. Two controller fuses, 60 amperes; in control switch box, one located in each engineer's cab. Two control generator fuses, 100 amperes; one located in box at top of each 102 panel. Two regenerative braking fuses, 25 amperes; one located on each 102 panel.

Q-111. Give the number and location of the grid resistors and explain what they are used for.

A-111. In resistor compartment, numbers 1 to 28 inclusive; numbering from rear right hand side forward and from the forward left hand side to the rear. In some locomotives number one grid resistor has been removed. Number one, when in place, is disconnected. Number four grid resistor is used for motor generator set and air compressor. All others are used for traction motor acceleration.

Q-112. What kind of current is used on the headlights?

A-112. 90-volt, single phase A. C. from control generator is reduced to 17-34 volts by the headlight transformer.

Q-113. How is the headlight dimmed?

A-113. The headlight may be dimmed by moving its switch handle to the low position. This changes headlight transformer taps to supply current at a lower voltage.

Q-114. Where is the high voltage switch and fuse box located and explain the operation of its parts?

A-114. The H. V. switch and fuse box is located at the rear of the contactor compartment in each

half unit. The main switch and a fuse supply current to, and protect the traction motors. The auxiliary switch supplies current for the main cab heater, M. G. set and air compressor. The disconnecting rods furnish a means of separating the heater from the M. G. and air compressor circuit.

Q-115. Where are the interlocks on contactors 1, 2, 3, 14, 15, 25 and 26, and No. 60 relay located?

A-115. They are attached to the contactors so numbered, and under and in front of the contactor.

Q-116. Where is the series interlock located? Where is the parallel interlock located? Where is the cut-out interlock located?

A-116. The series interlock is located under 33 and 34 contactors. The parallel interlock is located under 29 and 30 contactors. The cut-out interlock is located back of the cut-out levers.

Q-117. Where is the reverser interlock located and what is its function?

A-117. The reverser interlock is in the top right hand forward part of the reverser box. It prevents the line contactors 1 and 4 from closing unless the reverser throws properly.

Q-118. Where is the DB-451 interlock located?

A-118 On top of DB-451 Motor Operated Rheostat.

Q-119. What is the function of the first disk of the interlock on No. 60 relay?

A-119. To open Nos. 1 and 4 contactors in case the overload relay trips on the first 16 notches of the controller.

Q-120. What is the function of the first disk of the interlock on No. 2 contactor?

A-120. To prevent contactors 1 and 4 from opening until No. 2 contactor opens if the overload relay trips from the 16th notch and beyond.

Q-121. What is the function of the second and third disks of the interlock on No. 3 contactor?

A-121. To prevent the series-parallel switch from throwing unless No. 3 contactor is open.

Q-122. What is the function of the second and third disks of the interlock on No. 25 contactor?

A-122. To prevent the series parallel switch from throwing unless No. 25 contactor is open.

Q-123. What is the function of the third disk of the series interlock on the series-parallel switch?

What is the function of the third disk of the parallel interlock on the series-parallel switch?

A-123. To hold air on the series side of the series-parallel switch after it has once thrown to series position and No. 3 contactor has closed. To hold air on the parallel side of the series-parallel switch after it has once thrown to parallel position and No. 3 contactor has closed.

Q-124. What is the function of the first and second disks of the series interlock on the series-parallel switch? What is the function of the first and second disks of the parallel interlock on the series-parallel switch?

A-124. To prevent No. 3 contactor from closing until the series-parallel switch has reached the series position. To prevent No. 3 contactor from closing until the series-parallel switch has reached the parallel position.

Q-125. What is the function of the first disk of the cut-out interlock?

A-125. To provide a path around the series and the parallel interlock with a pair of motors cut out so that Nos. 3 and 16 contactors will close on the 18th notch.

Q-126. What is the function of the third disk of the interlock on No. 60 relay?

A-126. To open Nos. 3 and 16 contactors in case the overload relay trips on the first 16 notches.

Q-127. What is the function of the second disk of the interlock on No. 2 contactor?

A-127. To prevent No. 3 contactor from opening until No. 2 opens if the overload relay trips in the 16th notch or beyond.

Q-128. What is the function of the second disk of the interlock on No. 60 relay?

A-128. To open No. 2 contactor when the relay trips.

Q-129. What is the function of the third and fourth disk of the interlock on the cut-out interlock?

A-129. To prevent Nos. 2 and 24 contactors from closing when a pair of motors are cut out.

Q-130. What is the function of the first disk of the interlock on No. 1 contactor?

A-130. To prevent No. 24 contactor from closing before No. 1 closes.

Q-131. What is the function of the second disk of the interlock on No. 24 contactor?

A-131. To close No. 6 contactor when No. 24 contactor closes.

Q-132. What is the function of first disk of the interlock on No. 15 contactor?

A-132. To prevent contactors 14 and 26 closing when contactor 15 is closed.

Q-133. What is the function of the second finger on No. 57 relay?

A-133. To open 58 and 59 relays when No. 57 relay trips.

Q-134. What is the function of the second disk on the cut-out interlock?

A-134. To prevent regeneration on that half-unit with a pair of motors cut out, by opening Nos. 58 and 59 relays.

Q-135. What is the function of the third finger, right, and the third finger, left, wire 26D and G, on the interlock of DB-451?

A-135. To prevent relay 58 from closing unless the arm of the DB-451 is in the "W" position, that is, regeneration can not be started unless the arm is in the weak position.

Q-136. What is the function of the fourth finger on No. 58 relay?

A-136. To hold relay 58 closed after the interlock on DB-451 has opened.

Q-137. What is the function of the first finger on No. 57 relay?

A-137. To cut all resistance back into the exciter shunt field when No. 57 relay trips.

Q-138. What is the function of the first finger on No. 58 relay?

A-138. To energize the C15 wire during regeneration.

Q-139. What is the function of the first and second fingers, right, of the interlock on DB-451?

A-139. To return the arm of the DB-451 to the weak position when both controllers are shut off during regeneration.

Q-140. What is the function of the third disk of the interlock on No. 15 contactor?

A-140. To prevent No. 62 relay from closing unless No. 15 contactor has closed.

Q-141. What is the function of the contacts on No. 62 relay in its two positions?

A-141. In the up position it energizes the mov-

ing contact of No. 66 relay. In the down position it connects the C15 and "W" wires together so as to turn the arm to the weak position.

Q-142. What is the function of the contacts on No. 66 relay?

A-142. To energize the "S" and "W" clutch coils of DB-451.

Q-143. What is the function of the first and second, left, fingers, of the interlock on DB-451?

A-143. To de-energize the "S" and "W" clutch coils in the extreme positions.

Q-144. What is the function of the second and third fingers on No. 58 relay?

A-144. To close Nos. 15 and 25 contactors during regeneration.

Q-145. What is the function of the first disk of the interlock on No. 14 contactor?

A-145. To prevent No. 15 contactor from closing when No. 14 is closed.

Q-146. What is the function of the first disk of the interlock on No. 26 contactor?

A-146. To prevent No. 25 contactor from closing when No. 26 is closed.

Q-147. Where are the K. W. H. meters and resistors located and what are the numbers of the resistors?

A-147. On right side of rear of contactor compartment of each half-unit. The meters are outside underneath the sand box and the resistors, which are numbered 73 in each case, are just inside the compartment.

Q-148. Where is the lightning arrester located?

A-148. In the "A" end just over the air compressor motor.

Q-149. With reference to the M. G. Set, where are the motor, the exciters and the control generator located?

A-149. The motor is on the rear end next to the traction motor blower. The exciter is forward adjacent to the motor and the control generator just forward of the exciter and outside the main case of M. G. Set.

Q-150. What kind of current does the exciter generate and for what purpose?

A-150. The exciter generates on each of its commutators up to 40 volts direct current for the purpose of exciting the traction motor fields during regeneration.

Q-151. What kind of current does the control generator generate and for what purpose?

A-151. The control generator on each half-unit generates 120 volts direct current for the foot-warmer, cab lights and control. It also generates 90 volts alternating current for the headlight. Transformers reduce this to 34 and 17 volts for the main lamps of the headlight.

Q-152. Where are the M. G. switch and contactor located and what are their numbers?

A-152. On the right side of forward end of contactor compartment of each half-unit and are number 50 and 51 respectively in each case.

Q-153. Explain their operation in starting the M. G. Set with resistor No. 51.

A-153. The first heavy rush of current through resistance into the dead motor compresses a spring which later closes contactor 51, thus cutting out the resistance when motor is running.

Q-154. How do you adjust No. 51 contactor?

A-154. To close in 2 to 4 seconds after No. 50 switch is closed.

Q-155. Where is the Motor Operated Rheostat located and what is its function?

A-155. On the left side of the M. G. Set compartment. It regulates the current in the exciter field during regeneration.

Q-156. Where are panels 55 and 74 located and what are their purposes?

A-156. No. 55 is located in right side of forward end of each contactor compartment. No. 74 is located on left side of the rear end of each contactor compartment. No. 55 resistor is connected in series with the bottom or line coil of Brautigam Balancing Relay No. 55. No. 74 is connected in series with the trip coil of relay No. 57, the operating coil of relay No. 56 and the top coil of relay No. 55. Their function is to reduce the current through the coils of these relays.

Q-157. Explain the purpose of the ammeters and air gauges.

A-157. The line ammeter indicates the current to the armatures of traction motors 1 and 2 at all times. The field ammeter indicates their field current at all times except on the 32nd notch of the controller, at which time the ammeters indicate double the current through the fields. The air gauges indicate the air brake pressures. The speed

indicator indicates the speed of the locomotive in miles per hour.

Q-158. Where is the 102 panel located and what is its purpose?

A-158. On the right side of the forward end of M. G. Set compartment. It regulates the control generator current at 120 volts.

Q-159. Where is the 103 panel located and what is its purpose?

A-159. On the left side of the forward end of M. G. Set compartment. It controls the Motor Operated Rheostat during regeneration.

Q-160. Where is the 113 panel located and what does it contain?

A-160. At the forward end of M. G. Set compartment above the control generator. It contains resistance tubes and condensers for the 102 panel.

Q-161. Where are the reactors located and what is their purpose?

A-161. Under the roof on the right hand side of air compressor compartment of each half-unit. Their purpose, in conjunction with lightning arrestor, is to protect electrical apparatus from surges produced by lightning or other causes.

Q-162. Where are relays No. 55 located and what is their function?

A-162. At the right hand forward end of the contactor compartment under switch No. 50, in each half-unit. Their function is to close the line contactors when starting regeneration.

Q-163. Where are pilot light relays No. 56 located and what is their function?

A-163. In the right hand side, forward end, of the contactor compartment of each half unit, underneath panel 51. They energize the pilot light of 103 panel, indicating that resistor panel No. 74 and tripping magnet of relay No. 57 are in operating condition.

Q-164. Where are relays No. 57 located and what is their function?

A-164. At the right hand side of the forward end of contactor compartment in each half unit, under panel 53. They protect the traction motors against excessive voltage during regeneration.

Q-165. Where are braking relays No. 58 located and what is their function?

A-165. In the right hand forward end of contactor compartment of each half unit, under con-

tactor No. 9. Their function is to close the operating circuit for the motor of the Motor Operated Rheostat, as well as the operating circuits of contactors Nos. 15 and 25, which connect the exciter armatures to the traction motor fields during regeneration.

Q-166. Where are motoring relays No. 59 located and what is their function?

A-166. At the central part of right hand side of contactor compartment under contactor seven in each half unit. They control the operating circuits of line contactors 1 and 4 and permit motoring with both half units or regeneration with the operating half unit only.

Q-167. Where are overload relays No. 60 located and what is their function?

A-167. In the rear right hand side of contactor compartment of each half unit, between contactors 2 and 3. They protect the traction motors from excessive current.

Q-168. Where are the No. 61 relays located and what is their function?

A-168. At the top of 103 panels. They cut out braking on each respective half unit when the motor generator set on that half unit is not operating.

Q-169. Where are No. 62 relays located and what is their function?

A-169. On the No. 103 panels. Their function is to energize No. 66 relay during regeneration and to return the arm of the Motor Operated Rheostat to "W" position when regeneration ceases.

Q-170. Where are the No. 63 and 64 relays located and what is their function?

A-170. One each on each 103 panel and their function is to put current on the shunt coil of relay No. 66 in the proper direction during regeneration.

Q-171. Where are the No. 66 relays located and what is their function?

A-171. On No. 103 panels and they are for the purpose of regulating the Motor Operated Rheostat during normal regeneration.

Q-172. Where are the No. 67 relays located and what is their function?

A-172. At the top of 102 panels. They control relays No. 68A, 68B, and 68C.

Q-173. Where are No. 68A, 68B, and 68C relays located and what is their function?

A-173. On the 102 panels. They regulate the resistance in the control generator field circuit to maintain control current at 120 volts.

Q-174. Where are the No. 69 relays located and what is their purpose?

A-174. They open the control generator field circuit in case of over-voltage due to failure of the voltage regulator.

Q-175. Give locations and function of the reversers and explain their design.

A-175. Between traction motor blower and contactor compartment of each half unit. They are electro-pneumatically controlled switches for changing the direction of current flow through the traction motor fields. The main contacts and the interlock are moved by a cam shaft operated by air pistons.

Q-176. Where are the forward operating coils of the reversers located?

A-176. On the left side of the reverser in each half unit.

Q-177. Where are the reverse operating coils of the reversers located?

A-177. On the right side of the reverser in each half unit.

Q-178. Give locations and function of series-parallel switches and explain their design.

A-178. In left hand side of forward end of contactor compartment of each half unit. They are electro-pneumatically controlled switching mechanisms for changing the traction motor connections to arrange them electrically in series or parallel grouping. Each has contactors 27 to 38 inclusive and the series, parallel and cut-out interlocks all worked by a cam shaft.

Q-179. Where are the series operating coils of the series-parallel switches located?

A-179. Near the center aisle side of the contactor compartment of each half unit.

Q-180. Where are the parallel operating coils of the series-parallel switches located?

A-180. On the aisle side of the contactor compartment in each half unit.

Q-181. Where are the cut-out levers for the traction motors located?

A-181. On the forward end of the series-parallel switches on each half unit.

Q-182. How are the cut-out levers arranged with respect to the traction motors on each half unit?

A-182. Lever for 3 and 4 traction motors is forward of lever for 1 and 2 traction motors.

Q-183. Explain the operation and purpose of the traction motor field shunts.

A-183. They are brought into operation by the closing of contactors 14 and 26 on the 32nd notch of the main controller. They by-pass current away from the traction motor field windings. This increases the train speed under light load.

Q-184. Where are the traction motor field shunts for Nos. 1 and 2 traction motors located?

A-184. On the right side of each half unit under the operating cab.

Q-185. Where are the traction motor field shunts for Nos. 3 and 4 traction motors located?

A-185. On the left side of each half unit under the operating cab.

Q-186. How many traction motors are there on one half unit and how are they numbered?

A-186. Four, and numbered 1 to 4 from forward end of each half unit.

Q-187. How are the traction motors suspended on the axle and secured to the truck?

A-187. On one side they are supported on the driver wheel axles by means of the suspension bearings and on the other side a nose on the traction motor housing rests on a spring equipped bracket bolted to the truck bolster.

Q-188. How is the power transmitted from motor armature to the drivers?

A-188. By means of spring gears and solid pinions.

Q-189. How is the driving gear attached to the axle and how is the gear constructed?

A-189. The driving gear center is pressed on to the driving wheel axle and secured by a key. The gear consists of separate center and rim with six interposing springs.

Q-190. What is the gear ratio of the driving gear to the armature pinion?

A-190. 82 to 18, ratio 4.56.

Q-191. What has this gear ratio to do with the speed limit of the locomotive?

A-191. At 30 MPH, locomotive speed, the traction motor armatures are running at a rate of about

880 RPM, which is the safe maximum which the windings and band wires will stand.

Q-192. What is the appearance of traction motor commutator, brush holders and brushes after flash-over occurs?

A-192. Commutator appears burned and rough on outside edge; the arcing horn on brush holder shows burning; the brush holder insulators may be burned black or chipped and broken; brushes may be worn out.

Q-193. What temporary repairs may be made to avoid complete failure in case of traction motor flash-over? What is the minimum length of brush?

A-193. If conditions permit cut out the unit or the motors that are flashed over. Proceed until conditions require the use of all motors or until reaching some convenient point where motors may be examined. This will result in commutator being smoothed up to some extent, but will wear brushes very rapidly. If the brush holder insulators are found to be badly burned and broken, they may be broken off completely, being careful to break off only the porcelain. This will prevent creepage across the damaged insulator. This to be done only as a last resort when motors cannot be otherwise operated. When this is done make report to Master Mechanic's office promptly so that motor may be brought to terminal for repairs. The minimum length of brushes is 1¼" or sufficiently long so that brush holder spring will rest on brush and not on brush holder.

Q-194. How many brushes are used in each brush holder?

A-194. Two.

Q-195. Which traction motors are most subject to flashovers and why?

A-195. One and three, because they are on trolley side of each series group.

Q-196. Which brush holders are the most liable to be flashed over and why?

A-196. Two and four, because they are on the positive side of circuit and have the highest voltage to ground.

Q-197. How are the motor armature bearings, suspension bearings, driver journals and engine truck journals lubricated?

A-197. All are waste packed bearings.

Q-198. What should be the height of the oil in the oil well along the side of the packing box of the armature bearings?

A-198. Not less than three and one-half inches.

Q-199. What lubrication by the enginemen is required on locomotives at outside points?

A-199. In addition to inspecting all bearings prior to each trip to determine if proper lubrication prevails, all armature and suspension bearings must be gauged and filled if necessary every second day.

Q-200. How are the M. G. Set bearings lubricated and what precautions should be taken when the bearings become excessively hot?

A-200. Ball bearings in M. G. Sets are grease lubricated. Sleeve bearings in M. G. Sets are oil lubricated. M. G. Set should be shut down if bearings run excessively hot.

Q-201. How should the controller be advanced in normal operation?

A-201. One notch at a time with perceptible pause on first notch and also first step in parallel to permit time for operation of air operated switches.

Q-202. What will the ammeters indicate when the main controller lever is brought to the first notch in normal operation?

A-202. About 80 amperes.

Q-203. If the ammeters do not indicate what does it show?

A-203. That there is something wrong.

Q-204. How far should the controller be advanced if the ammeters do not indicate?

A-204. Not more than the third notch.

Q-205. If a pair of motors are cut out on what notch will the remaining pair operate?

A-205. Eighteenth notch.

Q-206. What are the first sixteen notches?

A-206. Series rheostat steps.

Q-207. What is the seventeenth notch and what takes place on this notch?

A-207. The first running position, called FULL SERIES. All four traction motors on each half unit are connected in series, with all resistance cut out.

Q-208. What are the twentieth to the thirtieth notches?

A-208. Parallel rheostat steps.

Q-209. What is the thirty-first notch and what takes place on this notch?

A-209. The second running position, called FULL PARALLEL. The traction motors are connected so

that there are two sets, each with two motors in series, working in parallel, with all resistance cut out on each half unit.

Q-210. What is the thirty-second notch and what takes place on this notch?

A-210. The shunt position and is used when it is desired to obtain higher speed under light load conditions. Some of the current which would otherwise go through the field windings is being by-passed or "shunted."

Q-211. Can the controller lever be moved backward and forward for switching purposes without going to the off position each time?

A-211. Yes.

Q-212. How should the controller be operated to effect a smooth transfer from series to parallel with about 100 amperes in full series?

A-212. Move controller from 17th notch to 18th step and pause before going farther.

Q-213. With about 150 amperes in full series how should controller be operated to complete a smooth transfer from series to parallel?

A-213. Move controller from 17th notch to 19th step and pause before going farther.

Q-214. With about 200 amperes in full series how should controller be operated to complete a smooth transfer from series to parallel?

A-214. Move controller from 17th to 20th notch and pause before going farther.

Q-215. With about 250 amperes in full series how should controller be operated to complete a smooth transfer from series to parallel?

A-215. Move controller from 17th to 21st notch and pause before going farther.

Q-216. When trolley voltage lowers to 2,000 volts how should the locomotive be operated?

A-216. Locomotive should be operated in FULL SERIES.

Q-217. At what amperes may the controller be advanced to the 32nd notch, shunt position?

A-217. One hundred and forty amperes or less.

Q-218. When should the controller be taken out of shunt notch?

A-218. When amperes exceed 210 or drop below 125.

Q-219. How should a freight train be started on level track?

A-219. By alternately putting controller on and off of 1st notch until slack has been gradually taken up without producing undue shocks to draft gear.

Q-220. Give method for starting freight trains on heavy ascending grade.

A-220. Sand should be applied and controller notched out to give starting current required without wheel slippage. As speed increases, controller may be advanced within current limitations. Helper motor should be started with first indication of change in slack from leading locomotive.

Q-221. What method should be observed when shutting off controller from parallel to series on heavy loads?

A-221. Move controller directly from 20th to 16th notch, then if desired to run in series controller should be moved to 17th notch.

Q-222. Why should driver brakes be kept released while regenerating?

A-222. To lessen possibility of skidding, especially in series regeneration.

Q-223. What are the braking cut-out snap switches for?

A-223. So that the engineer can cut out regeneration on the non-operating half unit from his position,

Q-224. What happens if the braking cut-out snap switch is turned to "ON" position while regenerating?

A-224. This will flash traction motors.

Q-225. What is the minimum field current that may be used while regenerating on a mountain grade?

A-225. Not less than line current or a minimum of 150 amperes.

Q-226. What is the minimum field current that may be used while regenerating on other than mountain grades?

A-226. Seventy-five amperes.

Q-227. What are the maximum line and field currents that may be used while renegerating?

A-227. Two hundred and ten amperes line, two hundred and fifty amperes field.

Q-228. Is it permissible to regenerate with one-half unit when the other half unit is defective, and when?

A-228. It is permissible only when the non-operating end is properly cut out.

Q-229. How would you make a stationary regeneration test?

A-229. With locomotive ready for operation, open motoring cut-out switch on braking controller, advance main controller to 17th or 31st notch and then braking controller one notch at a time observing field current which should increase for each notch up to 250 amperes on the 7th notch.

Q-230. Describe how you would start regeneration with heavy tonnage on light grades.

A-230. With the main controller in full series or full parallel running position. The braking controller should be advanced to run the train slack in gradually and to hold the train at constant speed with proper field and line currents.

Q-231. Describe how you would start regeneration with heavy tonnage on heavy grades on head locomotive.

A-231. With the driver brakes applied and motoring cut-out switch in the "OFF" position, the main controller should be advanced to the 10th notch for series regeneration or the 20th notch for parallel regeneration; then the braking controller should be advanced to obtain 250 amperes field current. The driver brakes should then be gradually released, holding the train slack in. As speed increases to about 15 miles per hour, the balancing relay will close the line contactors automatically. This will be indicated by the line ammeter, following which the main controller should be advanced to the running position and the regeneration regulated with proper field and line current values.

Q-232. Describe how you would start regeneration on heavy grade with helper locomotive?

A-232. If one helper in train: As soon as train starts, move motoring cut-out switch to "OFF" position. Advance main controller to 10th notch for series or 20th notch for parallel regeneration; advance braking controller to obtain 225 amperes field current. Apply independent brakes gradually not to exceed 20 lbs. Then as soon as the line ammeter indicates that the line contactors have closed, notch out main controller to full running position and operate braking controller as may be required; release driver brakes as regeneration starts. Sanders should be used during time driver brakes are applied.

If two helpers in train; The first helper should operate as described for one helper.

Second helper should help in same manner except the field current should be built up to 200 amperes.

This system is used for the purpose of having the first, second and third locomotives start regeneration in proper order.

Q-233. What may cause the line ammeter to become unsteady and how can this be avoided?

A-233. This may be the result of wheels slipping, and sand should be applied and the braking controller eased off until this condition is corrected. If necessary the train brakes should be applied to assist in controlling the speed.

Q-234. What should be done if the power should go off while regenerating or regeneration fails?

A-234. The controllers should be shut off and train stopped with the air brakes.

Q-235. Describe how to make stop with a heavy tonnage train while regenerating on a heavy grade:

1. With the road locomotive.
2. With the helper locomotive.

A-235. Train brakes should be applied from the leading locomotive, the braking controller should be eased off gradually and when the line amperes come down to zero both controllers should be shut off entirely and the driver brakes applied. The engineer on the helper motor should follow the same operation, beginning at the time when he notices the first brake pipe reduction. With the controllers off the driver brakes should be allowed to apply.

Q-236. Give method of changing operating cab of locomotive.

A-236. 1st. Have both pantographs up. Apply air brakes with independent brake valve and train brakes if required. Open MG set and heater switches. Close cut-out cock in pantograph air line to hold pantographs up. Place double cut-out cock in No. 2 position. Remove automatic brake valve handle, pantograph operating valve handle, independent brake valve handle, reverse handle and take them to other cab.

2nd. Put independent brake valve handle in place and move to application position. Place pantograph operating valve handle in position to raise pantographs and open necessary cut-out cocks in pantograph air line and see that pantographs are up. Close M. G. set switches. Put automatic brake valve handle in place and move double cut-out cock to No. 1 or No. 3 position as required.

Q-237. Give method for tying up a locomotive without any qualified person in direct charge.

A-237. Remove reverse handle, place control switches, M. G. Set main and auxiliary switches in off position, lower pantographs, put reverse and pantograph handles in designated place, close all doors and windows before leaving locomotive. If

locomotive is standing on a grade all wheels should be securely blocked.

Q-238. How long can the locomotive be operated with blowers running and using 210 amperes?

A-238. Indefinitely.

Q-239. How long can the locomotive be operated with blowers running, using 250 amperes?

A-239. 90 minutes.

Q-240. How long can the locomotive be operated with the blowers running using 300 amperes?

A-240. 55 minutes.

Q-241. In case an M. G. set fails enroute, how long is it permissible to use 210 amperes without the blowers with traction motors at running temperature?

A-241. 40 minutes.

Q-242. With 175 amperes?

A-242. 55 minutes.

Q-243. With 150 amperes?

A-243. 1 hour and 30 minutes.

Q-244. With 125 amperes?

A-244. 2 hours and 30 minutes.

Q-245. With 90 amperes?

A-245. Indefinitely.

Q-246. Holding 300 amperes on the motors after the eighth notch, how many minutes can be spent in getting out to the 17th notch?

A-246. 16 minutes.

Q-247. Holding a value of 200 amperes after the eighth notch, how many minutes can be spent in getting out to the 17th notch?

A-247. 23 minutes.

Q-248. When a locomotive is operated as above what grid resistors are liable to become overheated?

A-248. Nos. 13, 17 and 19.

TRACING OF CIRCUITS

Trace and explain the following or any additional circuits from Drawing No. ED-1398-B.

Q-249. With the C116 controller in the first notch and the reverser in the forward position, trace the current from control generator to ground through each wire.

Q-250. Trace the circuits energized by the 1st notch of the C116 controller with the reverse drum in the reverse position.

Q-251. With either pair of motors cut out, explain the changes that have taken place in the control circuits.

Q-252. With the C116 controller in the first notch, trace the current in the traction motor circuits, from trolley to ground, naming each piece of apparatus passed through in its proper order.

Q-253. Trace the current in the traction motor circuits, from trolley to ground, naming each piece of apparatus passed through in its proper order, for notches 2 to 17, inclusive, of the C116 controller.

Q-254. Trace the circuit from trolley to ground through the traction motor circuits for all steps of the switch transfer.

Q-255. Trace the current in the traction motor circuits, from trolley to ground, naming each piece of apparatus passed through in its proper order, for the 18th notch of the C116 controller.

Q-256. Trace the current in the traction motor circuits, from trolley to ground, naming each piece of apparatus passed through in its proper order, for notches 19 to 32 inclusive, of the C116 controller.

Q-257. With the C116 controller in the 31st notch and the C117 controller in the equalizing notch, trace the control circuit energized by the 11th finger of the C117 controller.

Q-258. Trace all control circuits that are energized by the C117 controller, when it is in the first notch braking.

Q-259. Trace all control circuits that are energized by the C117 controller from the 2nd to the 13th notch, inclusive, braking.

Q-260. Trace the control circuits energized by the 25 ampere regeneration fuse when the C116 controller is in the 31st notch and the C117 controller is in the 1st notch braking.

Q-261. Trace the path of the current through the traction motors with the C116 controller in the 31st notch and the C117 controller in the 1st notch braking or beyond.

Q-262. Trace the control circuit from the control generator through all fuses and relays on panel 102.

Q-263. Trace the control circuit from the control generator to ground through the operating coil of No. 52 compressor motor contactor.

Q-264. What circuits do the line and field ammeters indicate when locomotive is operating in series motoring.

A-264. All motors on that half-unit.

Q-265. What circuits do the line and field ammeters indicate when locomotive is operating in parallel?

A-265. No. 1 and 2 motors on that half-unit.

FAILURES AND REPAIRS

In answering questions on failures and repairs it will be optional with the examiner to require the answers to be made by actual explanation of the necessary details on a locomotive.

Q-266. Give the various causes of the air compressor failing to start when compressor control switch is closed and the motor generator set is running.

A-266. Dirty or frosty commutator; brushes sticking in the holder or a defective armature; or the auxiliary fuse blown.

Q-267. What will prevent the air compressor from coming up to full speed?

A-267. Failure of contactor No. 53.

Q-268. What would be the probable cause if the air compressor starts and pumps up pressure to 140 lbs. or more?

A-268. Failure of the air compressor governor to cut out as adjusted to 130 pounds.

Q-269. If the motor of the air compressor flashed over how would you correct the trouble?

A-269. See that the brushes are in good condition, the commutator clean and the brush holder insulators in good condition.

Q-270. What would prevent the main cab heater from heating?

A-270. Auxiliary fuse blown, bottom disconnecting rod gone, or switch No. 54 not in good repair.

Q-271. What would cause the cab heater blower motor to stop running?

A-271. Dirty commutator, stuck brushes, or burnt out resistance tube in the cab heater.

Q-272. If one of the line contactors was badly burned or grounded what is necessary to be done?

A-272. To be explained on a locomotive by practical demonstration.

Q-273. If a grounded cable existed between a resistor and a contactor how would you correct it?

A-273. By removing the grounded cable connections from both ends.

Q-274. What would be the probable cause if none of the ammeters indicate on either half-unit on first controller notch, with motor generator in the half-unit where controller is being operated running, main switches "ON", main fuses in place, controller switch "ON" and its fuse in good condition, and how would you correct the trouble?

A-274. The friction trip may not be set; series-parallel switch may be stuck in parallel; reverser may be in the wrong direction, or pair of motors on each half-unit may be cut out. Also the overload relays may not be set. Correction for each of the above would be in restoring normal operation of the defective apparatus.

Q-275. What would be the trouble if the ammeters do not change in either half-unit when pulling a load, on some controller notches, and on others show large increases, and how would you correct it?

A-275. Some of the resistance contactors are not operating correctly. This trouble should be corrected by taking contactor pickup, locating the faulty apparatus and making necessary corrections.

Q-276. What would be the probable causes if ammeters on one half-unit indicate more than on the other?

A-276. Some of the resistance contactors may not be operating correctly. The series-parallel switch may be stuck in the wrong position. Take contactor pickup, locate faulty apparatus, making necessary corrections.

Q-277. What would be the probable causes if all ammeters indicate alike, but locomotive does not move, even with the controller in the third notch, and how would you correct it?

A-277. This may be caused by the reversers on the two half-units being set to move the locomotive ends in opposite directions. There may also be a fault in the control wiring or the reverse handle drums. The defective apparatus must be located and necessary repairs made.

Q-278. If when motoring and the controller is moved off one notch, all power goes off, what would be the trouble and how would you correct it?

A-278. The friction trip is opening in the operating controller. This may be corrected by cleaning

the contacts and pushing the friction trip closed by hand, or putting a wire jumper around it.

Q-279. What would be the probable causes if the cab lights burn on the operating half-unit but the ammeters do not read nor does the locomotive move when the controller is brought to first notch, and how would you correct it?

A-279. This may be caused by fault in the traction motor circuits, in which case the main fuse should be inspected, and anything else which may be reason for this should be located and necessary repairs made. Contactor pickup will show if it is control trouble, in which case the defective apparatus can be located and necessary repairs made.

Q-280. What would be the probable causes if the cab lights do not burn with the M. G. Set running, and how would you correct it?

A-280. This is usually caused by relay 69 tripping; voltage regulator not working right; fuse blown; or brushes not making contact on commutator of control generator. The apparatus should be tested and the faulty part repaired. If necessary, proceed the same as outlined for reversed polarity.

Q-281. What would be the probable causes if one half-unit only failed to operate in either direction, and how would you correct it?

A-281. This may be caused by open circuit in wire 1, wire 25 or wire 1-F, or poor contact on the interlocks involved, which would keep the proper contactors from closing. Contactor pickup should be taken. Locate apparatus not working properly and make necessary repairs to its control wiring.

Q-282. What would be the probable causes if one half-unit failed to operate in one direction only, and how would you correct it?

A-282. This may be caused by defect in the "O" or "8" wires; fault in the reverser interlock contacts or by the reverser not following the controller correctly. This should be corrected by isolating the faulty apparatus and putting it in proper repair.

Q-283. What would be the cause, if on notching out from "OFF" to full series, the locomotive takes excessive current on certain notches on both half-units, and how would you correct it?

A-283. This trouble is caused by control circuit of the contactors being energized out of turn due to insulation break down in the control jumpers.

Q-284. What would be the effect on the locomotive if control wire 15 became open circuited be-

tween main control connection box and ground, and how would you correct it?

A-284. This will leave No. 12 contactor open causing no connection on the 12th notch of the controller, then on the 13th notch contactor 11 drops out and cuts in the resistance 3-5-6-7 and the locomotive slows down. The correction would be to put a jumper from control wire 14 to 15, which will hold contactor 11 from dropping out on either half-unit in series.

Q-285. What control wires, becoming open circuited, will cause serious trouble in accelerating the locomotive?

A-285. 5, 11, 19, 8D, 3B, 2B, 12, 13, 14, 20, 21 and 22.

Q-286. How would you correct the above trouble on the different control wires?

A-286. Take contactor pickup, locate defect and make necessary corrections.

Q-287. Can you regenerate with the half-unit which has No. 1 or No. 4 contactor blocked or jumped out?

A-287. No.

Q-288. What would be the probable cause of trouble if a locomotive handling a tonnage train accelerates up to and including the 5th notch properly, and then the head half-unit begins to take more current than normal and the rear half-unit less than normal, on all notches from the 6th to 15th inclusive; then on the 16th notch the rear half-unit takes slightly more than on the previous notch, and on the 17th notch it takes normal current or the same as on the head half-unit? How would you correct it?

A-288. This trouble could be caused by the short inside control jumper between half-units becoming disconnected and the correction would be to replace with a spare jumper.

Q-289. What would be the probable causes if the ammeters on one half-unit indicate less than the ammeters on the other after reaching the parallel position and how would you correct it?

A-289. Series-parallel switch may not be in parallel; relay 58 may be stuck in; contactors 24, 2, or 3 may not have closed. Take contactor pickup, locate faulty apparatus and make necessary repairs.

Q-290. What would cause the series-parallel switch to fail and how would you correct it?

A-290. See if the switch will throw by pressing on the magnet valves by hand. This will determine

whether it is an air failure or an electric control failure. In either case difficulty must be located and corrected. Observe control air gauge to see that there is correct air pressure.

Q-291. What would be the probable causes if when making stationary test with main or motoring cut-out switches open, both motor generators running, cab lights in both units burning brightly, main controller "ON", braking cut-out switches "ON", neither field ammeters indicate at all, and how would you correct it?

A-291. This might be caused by blown control switch fuse; 25 ampere fuse on the 102 panel blown or the friction trip may not be operating. Make proper examination and replacement.

Q-292. How can contactor pickup be taken for regenerative braking?

A-292. Can be taken by shutting down the M. G. Set, opening the main and auxiliary switches, blocking 61 relay closed and operating the controller in the other half-unit.

Q-293. If, on making stationary test, you find the field ammeter on one half-unit reading backward, what would be the trouble? How would you correct it?

A-293. This is caused by reversed polarity of control generator and may be corrected by removing the 100 ampere fuse on the 102 panel at the defective M. G. Set, place both controllers on first notch with both controller switches on, and excite the defective control generator from the good end.

Q-294. If the field ammeter indicates on the equalizing notch, but not on succeeding notches what would be the probable causes, and how would you correct it?

A-294. The Motor Operated Rheostat may not be turning because of the motor not running or defective magnet clutches; relay 62 may not be closed or there may be some defect in the dial segments of the Motor Operated Rheostat. In either case the defective apparatus must be tested, located and necessary repairs made.

Q-295. What would be the trouble if the field ammeters indicate correctly on the equalizing notch, but on the succeeding notches indicated values are too high?

A-295. Relay 66 being out of adjustment, loose contacts on the braking control connection box on wires 30 to 35 inclusive, or relays 63 or 64 not closing when they should.

Q-296. What would be the trouble if while regenerating the locomotive goes dead suddenly but motor generator sets keep on running, and how would you correct it?

A-296. There must be some control trouble or relay 57 or 60 has tripped out. If the latter, shut off the controller to the first notch and start over again. If control trouble, take contactor pickup, locate defect and make repairs.

Q-297. What would be the trouble if, while regenerating, the line ammeter reading is unsteady and fluctuates considerably? How would you correct it?

A-297. This may be due to wheels slipping or the trolley line voltage changes. It may also be due to defects in the control wiring, in which case contactor pickup should be taken and the defect located and repairs made.

Q-298. What would be the trouble if both half units regenerate alike, as indicated by the line and field ammeter, but speed of train keeps increasing even though the line and field ammeters indicate high current values? How would you correct it?

A-298. This would be caused by one or more contactors No. 25 not closing, thus putting all the load on traction motors No. 1 and 2 in each case. This should be located by taking contactor pickup and making repairs.

Q-299. What would be the trouble if while regenerating the line and field ammeters show a certain reading, then suddenly one half-unit goes to motoring with the same reading on ammeters? How would you correct it?

A-299. This might be caused by the braking contactors opening up while the braking controller was being operated. Contactor pickup should be taken and the faulty apparatus located and repaired.

Q-300. How would control jumper failure show on a locomotive?

A-300. By each half-unit operating properly from its own controller but not from the controller on the other half-unit.

Q-301. If you had a ground in the control circuit how would you test in order to determine which unit the ground was in?

A-301. By pulling control jumpers and making contactor pickup tests from each controller.

Q-302. What would be the probable causes that would prevent the M. G. Set from starting and how would you correct it?

A-302. Power may be off the line; the top disconnecting rod gone in the H. V. switch and fuse box; auxiliary fuse may be blown; starting resistance panel No. 51 may be open circuited or resistor No. 4 open circuited, or brushes out of the motor. The faulty apparatus should be located and repairs made.

Q-303. What is the trouble if the motor generator set starts up properly, but starting resistance gets hot or smokes? How would you correct it?

A-303. Contactor No. 51 stuck open which would cause the overheating of the resistance. It can be corrected by adjusting properly.

Q-304. What are the probable troubles when M. G. Set runs at normal speed, but cab lights are dim and locomotive will not start when operating from controller on the half-unit where the lights are dim? How would you correct it?

A-304. One or more contacts of relays No. 68 are not making good contact; relay No. 67 may be at fault and the trouble should be located and repairs made.

Q-305. If the M. G. Set becomes inoperative on head half-unit and cannot be operated, how would you proceed to get control current on that unit from the rear half-unit.

A-305. Put a jumper from the 1st to the 4th finger of both main controllers, remove 100 ampere fuse and 25 ampere fuse on the 102 panel on the defective half-unit, have both friction trips closed and operate controller in normal manner with the exception that the reverse handle on the half-unit where the defective M. G. Set is, must not be thrown without first opening the controller switch on the other half-unit.

Q-306. Should you sand the commutators of the motor of the M. G. Set with the power on?

A-306. No, because it might flash and result in personal injury.

Q-307. What work is necessary in case a pantograph insulator is grounded?

A-307. Disconnect the main cable from the pantograph and tie it in the clear from ground.

Q-308. What work is necessary if the lightning arrester becomes grounded?

A-308. Disconnect the lightning arrester cable from the trolley bus or pantograph.

Q-309. If you find that the pantograph is not making contact on account of lack of spring tension, how could you overcome it?

A-309. The spring should be properly tightened or if the pistons are stuck in the cylinders kerosene may be used to lubricate them.

Q-310. Should you renew the main or auxiliary fuse with the pantograph or trolley pole against the trolley wire?

A-310. No.

Q-311. What would be the trouble if there was no indication on ammeters when starting, but a flash on contactors 3 and 4 in series position, each time the controller is brought to the first notch and shut off?

A-311. In this case some of the traction motor resistors may be grounded.

Q-312. How would you proceed to test in order to determine what circuit the trouble was in?

A-312. Block contactor No. 37 open, put controller on and off first notch and see if line contactors flash. If they do the ground is in the resistors themselves, if not the ground must be in the traction motors. If in the resistors leave controller on first notch for a few minutes, then lower pantograph, open switches and feel resistors and the last warm one being where the ground is located.

Q-313. If, after cutting a pair of motors out one at a time, there is still no indication on the ammeters but there is a flash on the contactors when the controller is shut off, what does it indicate and how would you check it?

A-313. There is probably a ground in the traction motor circuits. This should be isolated by blocking open No. 37 contactor and cutting one pair of motors in and out at a time and locate the fault, making repairs.

Q-314. With a grounded resistor box what work is it necessary to do and why?

A-314. The ground must be cleared and a circuit provided around the trouble. Examiner may require practical demonstration on locomotive.

Q-315. What is meant by leads when talking about resistors?

A-315. Leads are the insulated cables connecting the contactors to the grids.

Q-316. What is meant by bus bars?

A-316. Bus bars are bare copper bar connections between contactors, grid boxes, or other parts of electrical equipment.

Q-317. What is meant by top of contactor? What is meant by bottom of contactor?

A-317. Top of contactor means the top terminal of the contactor on the aisle side. Bottom of the contactor means the bottom terminal of the contactor on the aisle side.

Q-318. Why does relay No. 60 trip out on the first notch of the controller if the ground is in the first few boxes of resistors?

A-318. Because there is not much resistance in the circuit and allows the current to build up at a high value.

Q-319. Why does it not trip out if the ground is in the last boxes?

A-319. Most of the resistance is still in the circuit and does not allow the current to get to a high value.

Q-320. Can a locomotive be operated with a grounded traction motor or grid resistor and why?

A-320. No. With a ground in the circuit the current is diverted away from the proper apparatus.

Q-321. What position must the series-parallel switch be in before you can cut a pair of motors out?

A-321. Must be in series position.

Q-322. What precaution should be taken when cutting out a pair of motors?

A-322. See that the lever is pushed down as far as possible and that the latch engages so that the lever cannot fly back; also locomotive must be standing still.

Q-323. What must be done when a locomotive having a grounded traction motor is handled dead in the train?

A-323. The main reverser contacts should be insulated.

Q-324. What is the trouble when with a locomotive at rest there is no indication on the ammeters when the controller is brought to the first notch, pilot light burns but there is no flash at the line contactors when the controller is shut off? How would you correct it?

A-324. There is an open circuit in the traction motors somewhere and it should be corrected by cutting out the defective motor.

Q-325. What is the trouble when with a locomotive at rest there is no indication on the ammeters when the controller is brought to the first notch,

pilot light does not burn and there is no flash at the line contactors when the controller is shut off?

A-325. An open circuit in the traction motor resistors. Block open contactor 37, operate the controller one notch at a time until pilot light burns. This will burn when the resistor having the open circuit in it is cut out. Repairs may be made by putting a jumper around the resistor.

Q-326. In the above trouble what contactors can be blocked?

A-326. 5, 6, 7, 8 and 17 contactors can be blocked closed.

Q-327. Would you treat a grid resistor that has the leaves badly burned the same as one which has a leaf broken and why?

A-327. Yes, a grid resistor which is badly burned may not be grounded and if not grounded, does not have to be removed from the circuit.

Q-328. What is the difference in the work to be done between a grounded resistor and an open circuit resistor?

A-328. With a grounded resistor it is necessary to remove all connections to resistor and then close the open circuit by jumping contactors. With an open resistor it is only necessary to close the open circuit by jumping contactors.

Q-329. What is the difference in the indications when making a test between a grounded traction motor circuit and an open circuit in the traction motor circuit?

A-329. The difference is that with a ground in the traction motor circuit, the line contactors will arc on opening when the controller is shut off. With an open circuit the contactors will not arc.

Q-330. How can wheel slipping be detected?

A-330. Ammeters become unsteady, making a constant decrease in their indication down to a low value but do not go entirely off. The traction motors make a humming noise which can be detected by an experienced engineer.

Q-331. What precaution should be taken in case of a derailment and it is necessary to move a locomotive under its own power?

A-331. In case locomotive gets off the track it should be carefully grounded to the rail if pantograph is in contact with the wire.

Q-332. When is it permissible to block No. 3 contactor closed?

A-332. When operation requires cutting out two motors and using the other six to start the train.

Q-333. With No. 3 contactor blocked closed what notch or notches are the running positions?

A-333. The 31st and 32nd only.

Q-334. How would you block No. 3 contactor closed?

A-334. By opening main switch, then putting controller on proper notch to close No. 3 contactor and driving a hardwood wedge between its armature and the channel support at the back side of the contactor.

Q-335. If, on notching out the main controller, the ammeters on one half-unit read normally at first, but after a few moments indication falls off to zero and possibly reads backward, what does this indicate and how could you correct it?

A-335. This is caused by the exciter armature of the motor generator set being grounded. If both line and field ammeters read backward, exciter No. 3 is grounded; if line ammeter only reads backward, exciter No. 4 is grounded. The half-unit on which this takes place cannot be operated in this condition.

Q-336. Would it be possible to operate a locomotive in the above condition and how?

A-336. The defective half-unit should be properly cut-out with main reverser contacts insulated.

Q-337. In what position should the cab light transfer switch be in at all times when the M. G. Set is running? Why?

A-337. In down position; so that if 69 relay trips out it will be instantly indicated by cab lights going out.

Q-338. What is the arrangement of cabs, wheels and trucks on class ES-2 locomotives?

A-338. One steeple cab structure is mounted on two trucks, each having two pairs of driving wheels and two traction motors geared to the axles. The draft rigging is placed on the cab structure.

Q-339. Name the various equipment compartments and indicate the principal equipment in each.

A-339. The contactor compartment contains the line, rheostat and auxiliary contactors, series-parallel switch, overload relay, KWH meter and traction motor blower. The engineer's cab contains the cab heater, brake valves, controller, 102 panel, M. G. Set and heater switch operating handles, control switches, reactor; motor generator and reverser are beneath the cab floor. The air compressor compartment contains the air compressor and governor, H. V. switch and fuse box and lightning arrester. The rheostat compartment contains the traction motor resistors.

Q-340. State briefly how the wheels and bearings are numbered.

A-340. Beginning at the "A" or No. 1 end with odd numbers on the right side and even numbers on the left side when facing the "A" or No. 1 end.

Q-341. Name the auxiliary air devices and indicate the pressure at which they operate.

A-341. The main whistle, sanders, bell ringer, pantograph, operate from main reservoir pressure at 110 to 130 lbs.

Q-342. What is meant by control air and what does it operate?

A-342. The control air has a small separate reservoir supplied with air pressure from the main reservoir reduced to 75 lbs. This air operates the series-parallel switch and reverser.

Q-343. What is the type of the air brake equipment used?

A-343. The air brake equipment is Westinghouse type EL-14 modified.

Q-344. How is the brake rigging arranged?

A-344. There are four brake cylinders, two to each truck mounted on the truck frames between adjacent driving wheels. Each cylinder applies the shoes by means of levers on the two wheels on one side of each truck.

Q-345. Name the different parts of the air brake equipment.

A-345. One K-14B brake valve, one No. 6 distributing valve, one engineer's brake valve, cut-out cock, one two stage air compressor with governor, one feed valve, one reducing valve and air gauges.

Q-346. What is the normal brake cylinder pressure allowable?

A-346. The straight air reducing valves are set for 40 lbs. In ordinary operation 33 lbs. is sufficient braking effort.

Q-347. What pressure should the pop on the distributing valve be set for?

A-347. 40 lbs.

Q-348. Give location and function of horn gap fuse holder.

A-348. It is located on the roof of contactor compartment and is for the purpose of protecting all electrical apparatus inside the locomotive.

Q-349. Give name, capacity, location and function of all 3,000-volt fuses on the locomotive.

A-349. The horn gap fuse is located on the roof of the contactor compartment and is rated 200 amperes. It protects all of the electric apparatus. The main fuse is in the lower left side of the H. V. switch and fuse box and is rated 200 amperes. It protects the traction motors. The auxiliary fuse is in the lower right side of the H. V. switch and fuse box. It is rated 20 amperes and protects the M. G. Set, air compressor, and cab heater. The lightning arrester fuse, rated 20 amperes, is in the lightning arrester and protects it.

Q-350. How do you adjust the main reservoir pressure with the air compressor governor?

A-350. The cut-out or maximum pressure of 130 lbs. is obtained by means of the adjusting screws in top of cylinder and the cut-in or minimum pressure of 110 lbs. is regulated by means of the range pin in its bracket.

Q-351. Where are the air compressor contactors located and what are their numbers?

A-351. At the left rear end of the contactor compartment. They are numbered 43 and 44.

Q-352. Explain their operation in starting the air compressor with resistor No. 44.

A-352. In starting, contactor No. 43 is closed by the governor and the heavy rush of current into the motor standing still compresses a spring in contactor 44 and holds it open while the current flows through resistance. When the motor gets started the current

flow decreases so that the spring can close contactor 44 which by-passes the current around the resistance No. 44 directly to the motor.

Q-353. How do you adjust contactor No. 44?

A-353. To close in 2 to 4 seconds after No. 43 closes.

Q-354. Trace the flow of power current through the air compressor motor in normal operation from the trolley wire to the track: (a) When compressor is starting; (b) When compressor is up to full speed. To be answered with the aid of drawing No. ED-1444.

A-354. Power current flows from the trolley wire through the pantograph, horn gap fuse, reactor, H. V. auxiliary switch and 20 ampere fuse, resistor 45, contactor 43, resistor 44, operating magnet of contactor 44, No. 1 armature and field and No. 2 armature and field of the air compressor motor, K. W. H. meter shunt, locomotive frame, wheels and track, (ground). When the compressor gets started contactor 44 is closed by a spring and the current flows through contactor 44 and its holding magnet instead of resistor 44 and the operating magnet of contactor No. 44. Otherwise the circuit remains the same.

Q-355. Where is the cab heater switch located and what is its number?

A-355. It is No. 40. The operating lever is in the engineer's cab and the switch is in the left rear end of the contactor compartment.

Q-356. What is the cab heater voltage and through what fuses does its current flow?

A-356. 3,000 volts. Current flows through horn gap and auxiliary fuses.

Q-357. Trace the flow of power current through the M. G. Set motor in normal operation from the trolley wire to the track. (a) When M. G. Set is starting; (b) After M. G. set has come up to speed. (To be answered with the aid of drawing No. ED-1444.)

A-357. Power current flows from the trolley wire through the pantograph, horn gap fuse, reactor, H. V. auxiliary switch and 20 ampere fuse, resistor No. 45, switch No. 41, resistor 42, operating magnet of contactor 42, No. 1 and No. 2 armatures of M. G. Set, commutating and series fields of M. G. Set motor, K. W. H. meter shunt, locomotive frame, wheels and track (ground). After the M. G. Set gets started contactor 42 is closed by a spring and the current flows through it and its holding magnet instead of through resistor 42 and contactor 42 operating magnet.

Q-358. Where is the M. G. Set located and what is its purpose?

A-358. The M. G. Set is located under the cab floor in front of panel 102. It is used for the purpose of supplying 120-volt current to control the locomotive and compressor, and for lamps.

Q-359. How many field windings has the motor of the M. G. Set? Name them and explain how they are connected.

A-359. There are three field windings in this motor. The commutating and series fields are connected in series with the two motor armatures. The shunt field winding is connected to the armature of the control generator.

Q-360. How is the voltage of the control generator regulated and at what voltage?

A-360. The control generator voltage is regulated at 120 volts by panel 102, similar to class EF-1 locomotives. (Applicants who have not passed EF-1 examination must give this answer in detail as follows: With the control generator voltage below 119 volts relay 67 spring closes its contacts thus causing relays 68A, B and C to close their contacts. This cuts out resistance in the generator field coil circuit which increases their strength and the armature voltage. When this increases above 121 volts relay 67 contacts are opened by its magnet thus causing relays 68A, B and C to open. This cuts resistance into the field coil circuit which weakens them and decreases the armature voltage to about 119 volts, when 67 relay closes again. This process is repeated rapidly so that the average is about 120 volts.)

Q-361. How many traction motors and how are they arranged on ES-2 locomotives?

A-361. Four traction motors drive the four pairs of wheels through single gearing. One motor to each pair of drivers.

Q-362. What is the current rating of the traction motors?

A-362. The traction motors are rated 68 amperes continuously. In switching service the current can be run up to the slipping point of the wheels or 160 amperes momentarily.

Q-363. Where is the overload relay and what is its purpose?

A-363. The overload relay is mounted on the wall over the series-parallel switch. It is for the purpose of cutting off the current to the traction motors and resistors if the flow exceeds 175 amperes.

Q-364. When the overload relay trips in what order do the contactors open?

A-364. 1st: Contactor No. 13; 2nd: Contactor No. 3; 3rd: Contactor Nos. 1 and 2 open when this relay trips.

Q-365. How may the overload relay be reset?

A-365. By returning the controller to the 1st notch.

Q-366. Give the number of the line contactors and their location and function.

A-366. They are Nos. 1, 2 and 3. They are double contactors and located in the contactor compartment on the left side. They make and break the power current connections to the traction motors.

Q-367. Give the number of the rheostat contactors and their location and function.

A-367. The rheostat contactors are Nos. 4 to 13 inclusive. They are located five on each side at the forward end of contactor compartment. They bypass traction motor current around the traction motor resistors in regular order as governed by operation of the controller.

Q-368. How many and where are the traction motor resistors located?

A-368. There are 16 traction motor resistors of the grid box type and are located in the rheostat compartment back of air compressor.

Q-369. What contactors are on the series-parallel switch and how are they operated?

A-369. Contactors 27 to 38 inclusive are on the series-parallel switch. They are operated by an air driven cam shaft electrically controlled.

Q-370. Where is the reverser located and what is its purpose?

A-370. The reverser is located under the cab floor on the fireman's side. It is an electro-pneumatic switching arrangement used for the purpose of reversing the direction of current flow through the traction motor fields, thereby determining the direction of travel for the locomotive.

Q-371. How can you tell when the reverser is in the "forward" position operating "A" or No. 1 end ahead?

A-371. The left No. 1, main contact will be in position to carry current and the hand lever on the outside of the case will be in the downward position.

Q-372. Where is the K. W. H. meter located and what is the number of the resistor in series with it? When may it not operate?

A-372. It is located in the contactor compartment at the right of the entry door. Its resistor is No. 46. It will not operate unless the main switch is "ON".

Q-373. With the controller on 1st notch forward trace the flow of power current from the trolley wire to ground through the traction motors in normal operation. (To be answered with the aid of drawing ED-1444 as follows)

A-373. Power current flows from the trolley wire through the pantograph, horn gap fuse, reactor, 200 ampere main switch and fuse, contactors No. 1 and 2, cable R21, resistors 1 to 11 inclusive, cable R26, contactor No. 36, cable R11, resistors 12 to 16 inclusive, cable R15, contactor 37, top trip coil of overload relay No. 60, armatures of traction motors No. 1 and 2, contactors No. 31, 32 and 33, armatures of traction motors Nos. 3 and 4, reverser contact, fields of traction motor Nos. 3 and 4, reverser contact, contactor No. 28, reverser contact, fields of traction motors Nos. 1 and 2, reverser contact, ammeter shunt, K. W. H. meter shunt, locomotive frame (ground), wheels, track and back to the substations.

Q-374. What contactors have interlocks and for what purpose?

A-374. Contactor No. 3 has an interlock which, when overload relay No. 60 trips keeps contactors Nos. 1 and 2 closed until No. 3 is open. Contactor No. 9 has an interlock which will cause contactors Nos. 4, 5 and 6 to open when No. 9 does and they cannot operate unless No. 9 is closed. Contactor No. 13 has an interlock which when overload relay No. 60 trips, keeps contactor No. 3 closed until No. 13 opens.

Q-375. Name the interlocks on the series-parallel switch and give their function.

A-375. The series interlock is closed when the switch is in the series position only. (When contactors 28, 31, 32, 33, 36 and 37 are closed.) Under this condition this interlock allows contactor Nos. 2 and 9 to close in regular operation in series. The parallel interlock is closed when the switch is in the parallel position. (When contactors 27, 29, 30, 34, 35, 37 are closed.) This allows contactors Nos. 2 and 9 to close in regular operation in parallel. The cutout interlock closes its Nos. 1, 2 and 3 contacts and opens its Nos. 4 and 5 contacts when the switch is in the cutout position only. (When contactors 27,

29, 30, 36 and 37 or 38 are closed.) This keeps contactor Nos. 3 and 8 from closing under this condition and allows contactors Nos. 2 and 9 to close in parallel notches of the controller.

Q-376. With the controller on the first notch forward trace the flow of control current from the controller switch to ground in normal operation. (To be answered with the aid of drawing No. ED-1444.)

A-376. Control current flows from the controller switch and 15 ampere fuse, through the blow out coils inside the controller to the second finger. When the controller is placed on the 1st notch current flows from the 2nd finger to the second ring thereby energizing the top section of the controller which is made up of three rings or segments. Current flows from the 3rd ring to the 3rd finger in contact with it and through a jumper from the 3rd to the 4th finger which being in contact with the 4th ring energizes all of the middle section of the controller from the 4th to 17th rings inclusive.

Current flows from the 1st controller finger on wire 17 through overload relay No. 60 setting coil to ground. Current flows from the 5th finger wire 16 to the 3rd and 1st fingers on the reverse drum, wire 8, forward magnet valve of the reverser to ground. When the reverser throws to the forward position it moves its interlock so that the first and 2nd interlock fingers connect wire 8 to wire 8A and current flows on wire 8A, through the operating magnet of contactor No. 1, wire 8B, 1st disc on overload relay No. 60, to ground.

Current also flows from the 6th controller finger, wire 1, 2nd disc of series interlock, wire 1B, operating magnets of contactor No. 2, wire 8B, overload relay No. 60, 1st disc to ground.

Current also flows from wire 1, 3rd disc of series interlock, wire 1C, operating magnet of contactor 9, wire 14, 18th finger of controller to ground.

Current also flows from wire 1, through the series magnet valve of the SP switch to ground.

EXAMINATION QUESTIONS ON EP-2 ELECTRIC LOCOMOTIVES.

Q-377. What is the arrangement of cabs, wheels and trucks on EP-2 locomotives?

A-377. The cab consists of three sections, the two end sections are similar and contain the high voltage equipment at their outer ends and the engineer's compartments at the rear. The middle section, containing the heating boiler, is supported between the two end sections.

There are 12 pairs of driving wheels and two pairs of guiding trucks, one at either end, contained in four trucks. The two end trucks consist of one pair of guiding trucks and two pairs of drivers, and the two middle trucks have four pairs of drivers each. The traction motor armatures are mounted direct on the driver axles and the field coils are mounted in the truck frame structures.

Q-378. Name the various equipment compartments with the principal equipment in them.

A-378. The A end contactor compartment contains the J. R. circuit breaker, roundhouse switch, line contactors, reverse current and lamp rheostat contactors, A, B and C switches, motor generator, rheostat and braking contactors, lightning arrester, traction motor and lighting panel resistors.

The A end engineer's cab contains air brake valves, controllers, reverser, tapper, train lighting and control generator regulator panels and main control switch.

The boiler compartment contains the train heating boiler with accessories, water and fuel oil tanks.

The B end engineer's cab contains, air brake valves, controllers, reverser, tapper, locomotive battery panel, auxiliary compressor and clothes lockers.

The B end contactor compartment contains the main air compressor and governor, auxiliary contactors, B and C switches, rheostat and braking contactors, traction motor resistors, and locomotive battery.

Q-379. State briefly how the wheels and bearings are numbered.

A-379. Beginning at the A end with odd numbers on the right side and even numbers on the left side, when facing the A end, guiding and driving wheels are numbered separately, the guiding wheels being designated with the prefix "T".

Q-380. How are the drawbars between trucks designated?

A-380. The drawbar between trucks on the A end by the letter "A" and the one on the B end by the letter "B". The one between the two ends by "A-B".

Q-381. What are the auxiliary air devices and what air pressure do they use?

A-381. The main whistles use main reservoir air, the bell ringers and pantographs use control air, the sanders and boiler accessories use main reservoir air through the auxiliary devices governor.

Q-382. What does the auxiliary devices governor do?

A-382. If the main reservoir pressure falls below 100 lbs. it cuts off the air to the sanders and boiler accessories.

Q-383. What is meant by control air and what does it operate?

A-383. The control air has a small separate reservoir on the A end supplied with pressure from the main reservoir reduced to 80 lbs. This air operates the bell ringers, pantographs, reversers, field tappers and A, B and C switches.

Q-384. What is the type of air brake system used on EP-2, locomotives?

A-384. Westinghouse type EL-14 modified.

Q-385. Name the various brake valves and explain briefly their purpose.

A-385. Engineer's brake valves to apply and release brakes. Transfer valves to operate brakes on both ends from one engineer's valve. Distributing valves to handle air to the brake cylinders. Regenerative interlock valves keep driver brakes from applying while locomotive is regenerating. Brake pipe vent valves hasten emergency application of brakes. Feed valves supply air at constant pressure to brake pipe. Straight air reducing valve supplies air at constant pressure to signal system and to brake cylinders when independent brake is operated. Y-valve operates regenerative interlock. V-valves open circuit breaker on emergency application of brakes.

Q-386. What is the brake rigging arrangement?

A-386. Each truck has a brake cylinder on each side which applies brake shoes to the wheels on the truck on each respective side. The hangers for the same pair of wheels are connected together with a cross bar.

Q-387. For what purpose are the brake pipe vent valves?

A-387. To hasten the action of an emergency brake application throughout the entire train.

Q-388. What do the regenerative interlock valves do?

A-388. They keep the driver brakes from applying in service when the locomotive is regenerating.

Q-389. What are the automatic control switches or "V" valves for?

A-389. They cause motoring or regeneration to cease whenever the Brake pipe pressure is reduced below 40 lbs. If regeneration ceases under this condition the driver brakes will apply also.

Q-390. How are air connections between the middle trucks designated?

A-390. On the right side are: The main reservoir, equalizing and brake pipe connections.

On the left side are: The signal, auxiliary, control and two sander hoses.

Q-391. Where are the pantograph air cutout cocks located.

A-391. Beside the engineer's seat backs in each cab.

Q-392. What pantograph control switches are there and for what purpose are they used.

A-392. One loose handle lever switch and two snap buttons in each operating cab. The lever switch is used on the operating end for both pantographs and the snap switches select the pantograph which it is desired to operate.

Q-393. How may the pantographs be locked down?

A-393. By means of the hooks on the left side to be handled with wooden switch pole.

Q-394. How may a pantograph be purposely disconnected and grounded?

A-394. By using a wooden switch pole to change its cutout switch to the grounding position.

Q-395. Operating from B-end cab how should the pantograph switches be set to use A-end pantograph?

A-395. The snap switches in the A-end cab should be ON and also the lower snap switch in the B-end. The loose handle should be on the lever switch and pushed forward in the B-end cab.

Q-396. For what purpose is the auxiliary air compressor provided and in case it does not operate what steps should be taken? What current does it use?

A-396. This compressor is used to supply air for raising the pantographs in cases where there is no other air supply. It pumps into the control air reservoir. In case it fails the pantographs may be raised with an insulated pole and held there until the main compressor pumps up the main reservoir. It uses 80 volt battery current.

Q-397. Where is the main air compressor governor located?

A-397. In the B-end contactor compartment near the Auxiliary Switch.

Q-398. How do you adjust the main reservoir pressure with the compressor governor?

A-398. The cut out or maximum pressure is obtained by means of the adjusting screws in the tops of the cylinder and the cut in or minimum pressure is regulated by means of the range pin in its bracket.

Q-399. Where are the air compressor contactors located and what are their numbers?

A-399. In the B-end contactor compartment near the braking contactors. They are numbered 54 and 55.

Q-400. Explain their operation in starting the compressor with resistor No. 55.

A-400. When the governor closes contactor No. 54, a heavy rush of current through resistor 55 goes into the dead compressor motor and also compresses a spring in contactor No. 55. The motor starting reduces this current and the spring closes contactor 55, thus cutting out the resistance.

Q-401. What is the effect on the compressor when contactor No. 55 does not close properly and how may this be repaired?

A-401. The compressor would not come up to full speed when starting. Contactor No. 55 should be adjusted to close 2 to 4 seconds after No. 54 under this condition.

Q-402. How are the steam cab heaters arranged?

A-402. They are supplied with steam from the train line. There are two coils under the floor on engineer's and fireman's sides, also a heater on the front wall of the engineer's cab. These have inlet and outlet globe valves and exhaust into two steam traps, on each end.

Q-403. What current is used by the engineer's electric cab heaters?

A-403. 80 volt, M. G. Set current.

Q-404. Name and give location of reactors.

A-404. Main reactor on roof of contactor compartment back of A-end bell.

Auxiliary reactor in same relative location on B-end.

Q-405. Where is the auxiliary switch located and what is its purpose?

A-405. The auxiliary switch is in the B contactor compartment. When opened it cuts off the 3,000 volt current to main air compressor, M. G. Set and traction motor blowers.

Q-406. What does the auxiliary interlock do and how does it operate?

A-406. The auxiliary interlock opens when the auxiliary switch is moved to OFF position. It thereby breaks the connection for control current to the operating magnets of the auxiliary contactors.

Q-407. If resistor No. 43 is open circuited, what apparatus will not operate?

A-407. All auxiliary 3,000 volt apparatus, i. e. main air compressor, M. G. Set and traction motor blowers.

Q-408. If resistor No. 43 is grounded what fuse will blow?

A-408. The auxiliary fuse will blow.

Q-409. What is the purpose of the motor generator?

A-409. The M. G. Set supplies low voltage current to the lanps, control and batteries of the locomotive and also supplies current for the train lighting system.

Q-410. In what order do the motor generator contactors close when it is being started?

A-410. First No. 56, second No. 58, third No. 57.

Q-411. What regulates the control generator voltage?

A-411. The regulator panel near the A-end engineer's seat in conjunction with the C. E. M. F. regulating generator on the rear end of the M. G. Set.

Q-412. What does the regulating generator do?

A-412. It permits more or less current to flow through the control generator field in order to hold its armature voltage constant as regulated by relay R-8 on Panel 116.

Q-413. For what purpose is relay CO-9 used?

A-413. This relay opens up the connection to the field of the control generator in case its voltage should

rise to a dangerous value of 150 volts or higher due to any reason such as failure of the regulator.

Q-414. If M. G. Set runs but does not generate, what may be done?

A-414. Touch a piece of wire jumper from CO-9 (closed) to wire L-14 on the extreme right hand stud at the bottom of the panel until the ammeter begins to indicate. If this does not cause the generator to build up, trip CO-9 and connect an insulated wire from the positive fuse over the boiler room door to the bottom of CO-9; then close the relay by hand after removing the wire.

Q-415. When starting up M. G. Set if the battery fuses blow what may be the cause of failure and how would you proceed?

A-415. The cause may be reversed polarity. If near a terminal the locomotive may be run in on the locomotive battery or train batteries for control current. Or the polarity may be corrected by holding Relay R-8 open with M. G. Set running.

Q-416. How may the locomotive be operated over the run if the M. G. Set fails? (Give details.)

A-416. Under this condition the locomotive control current may be obtained from the train batteries as follows:

1. Remove 400 ampere generator fuses.
2. Trip CO-9, block RC-10 to right, set lighting panel circuit breaker and insulate its auxiliary contacts.
3. Close generator and battery switches on lighting panel and open locomotive battery switch.
4. When discontinuing this operation close locomotive battery switch and open lighting panel switches.

Q-417. How many traction motor blowers are there and where located?

A-417. There are six, one for each two traction motors located on top of the truck frames.

Q-418. What fuse and resistor affect the traction motor blowers?

A-418. The auxiliary fuse and Resistor No. 43.

Q-419. Where should the traction motor blowers be run on the Coast Division and state whether on high or low speed.

A-419. Eastbound from Renton to Rockdale and from Ellensburg to Othello on LOW. Westbound from Beverly to Cedar Falls on LOW. With ten cars or more if the line voltage is below 2500 the blowers should be run on HIGH between Beverly and Kittitas

East or Westbound. The traction motor blower housing shutters should be shut to exclude snow and dust when needed. The Traction motor blowers should be run on LOW under this condition.

Q-420. What contactors control the traction motor blowers?

A-420. Nos. 59 to 62 inclusive.

Q-421. How many traction motors are there and what is their principal feature?

A-421. There are twelve traction motors whose armatures are gearless with two field poles each; thus classifying them as bi-polar, gearless type.

Q-422. What is the maximum trailing tonnage rating in passenger cars of EP-2 locomotives?

A-422. 960 tons on 2.2% grade.

Q-423. What is the trailing freight tonnage rating from Beverly to Boylston of these machines?

A-423. 700 tons.

Q-424. How would you detect a traction motor armature failure?

A-424. By the JR circuit breaker tripping or the line contactors flashing when the controller is shut off and the ammeters indicating zero when the controller is advanced as in regular operation.

Q-425. Operating from the B-end and with armature No. 10 grounded what could be done to make it possible to operate the locomotive on level track?

A-425. The B-end should be cut out and the controller advanced slowly with a man watching the upper ammeter in A-end cab to notify the operator if the current used is found to be excessive.

Q-426. What traction motors have their field current indicated on the lower ammeters in both cabs in high speed parallel connection?

A-426. Traction motors Nos. 7, 8 and 9.

Q-427. What traction motors have their current indicated on the upper line ammeter in the A-end cab and on what controller notches?

A-427. In series-parallel or 6-motor position of the controllers the current through the 6-motors on the A-end is indicated on the upper A-end line ammeter. In low speed parallel motor Nos. 4, 5, 6 and 3 and in high speed parallel motor Nos. 4, 5 and 6 have their current indicated on this instrument.

Q-428. How does the JR circuit breaker act under overload current?

A-428. It will open and cause the line and resis-

tance contactors to open, thus stopping motoring or regenerative braking action.

Q-429. In setting the JR circuit breaker electrically what is usually the cause when it pumps?

A-429. The JR circuit breaker will pump if there is no current in its holding magnet. This usually is caused by the brake pipe pressure being too low to set the V-valves.

Q-430. What should be done if the JR circuit breaker or resistor No. 1 are burned badly?

A-430. Drop pantographs immediately and use jumper from No. 1 switch to No. 2 contactor before proceeding.

Q-431. Give the names and numbers of relays in the contactor compartments.

A-431. In the A-end there are OV-2, OL-7, OL-4, OL-3, TR-5, TR-6 and UV-1.

In the B-end are OV-52, OL-57, OL-54, TR-56 and UV-51.

Q-432. For what tripping current are the overload relays set?

A-432. 450 amperes.

Q-433. At what voltage will the overvoltage relays trip?

A-433. 3800 volts.

Q-434. What do the pilot lights before the engineer's seat indicate?

A-434. That the tripping coil circuits on the overvoltage relays are in good condition.

Q-435. Give number and location of reversers and explain how they operate.

A-435. The two reversers are located under the floor on the left side of engineer's cab on each end. They are electro-pneumatic switches used to change the direction of current flow in the traction motor fields, thus determining the direction of locomotive travel.

Q-436. How can you tell which is the "Forward" position of either reverser?

A-436. The reversers are in the "Forward" position when the lever outside the frame is up as high as it normally travels.

Q-437. What contactor will not close electrically if the A-end reverser does not properly move corresponding to the controller position?

A-437. Contactor No. 2.

Q-438. What contactor will not function properly unless the B-end reverser follows the controller correctly in operation?

A-438. Contactor No. 3.

Q-439. Give number and location of tappers. Explain how they operate.

A-439. There are two tappers located under the floor at the middle of the engineer's cab on each end. They are electro-pneumatic switches used to cut out one half of the traction motor field winding for higher speed under light load.

Q-440. How can you tell if a tapper is in the tap field position?

A-440. The 1st, 3rd and 5th main contacts counting from the front end will be closed and the others open.

Q-441. Under what conditions and how may the traction motor fields be tapped?

A-441. When the traction motor current is less than 150 amperes and the main controller is on the 10th, 17th or 26th notches the fields may be tapped by pushing the braking controller lever forward.

Q-442. Give numbers of contactors which make up the A, B and C switches.

A-442. A-switch has contactors 4 to 11 inclusive.
A-end B-switch has contactors 13 to 27 inclusive.
B-end B-switch has contactors 63 to 76 inclusive.
A-end C-switch has contactors 41 to 50 inclusive.
B-end C-switch has contactors 91 to 100 inclusive.

Q-443. How are the A, B and C switches operated and what positions do they take under normal working conditions?

A-443. These switches are electro-pneumatically operated from the controller. The A-switch operates on the 11th notch, the B and C switches motoring on the 18th notch and the B-switch braking on the 11th notch high speed and the 4th notch low speed.

The A-switch has 6 and 12 motor positions.

The B-switches have 4 motor, 6 motor and braking positions.

The C-switches have 3 and 6 motor cut out positions.

Q-444. If the A-switch does not properly follow the movement of the main controller lever what apparatus will not function?

A-444. Relay TR-5 and rheostat contactors 30 to 36 and 80 to 86 inclusive.

Q-445. If the B or C switch on the A-end fails

to work properly what apparatus will not operate as it should normally?

A-445. Relay TR-6 and rheostat contactors except No. 87, 33, 83.

Q-446. If the B or C switch on the B-end does not function properly what apparatus will fail in operation?

A-446. Relay TR-56 and rheostat contactors except No. 37, 33, 83.

Q-447. What is meant by full series position of the controller?

A-447. Full series on the 10th controller notch is when all 12-motors are connected in series without the resistors in circuit.

Q-448. What is meant by full series-parallel position of the controller?

A-448. On the 17th controller notch the motors are connected into two groups of 6-motors each with no resistors in the circuits.

Q-449. What is meant by high speed parallel position of the controller?

A-449. When the braking controller handle is in upward position in normal operation and the main lever is on the 18th to 26th notches inclusive, the traction motors are connected into four groups of 3-motors each or high speed parallel position.

Q-450. What is meant by Low speed parallel position of the controller?

A-450. When the braking controller lever is in downward position in normal operation and the main lever is on the 18th to 26th notches inclusive the traction motors are connected in three groups of 4-motors each or low speed parallel position.

Q-451. Explain the purpose of contactors Nos. 2 and 3.

A-451. These contactors make or break connections for the 3000 volt current to the traction motors when the controller is moved ON or OFF.

Q-452. Give the numbers of the rheostat contactors and state where they are located on the locomotive.

A-452. The rheostat contactors are Nos. 28 to 40 inclusive on the A-end and 78 to 90 on the B-end. They are located in the forward end of each contactor compartment on the engineer's side.

Q-453. Give the numbers of the grid resistors and state where they are located on the locomotive.

A-453. Beginning on the A-end in front of the fireman's seat the grid resistors are numbered 1 to 5 inclusive toward the front, and on the engineer's side proceeding in order from front to rear, 6 to 22 inclusive. On the B-end in front of the fireman's seat the grid resistors are numbered 23 to 33 inclusive toward the front and on the engineer's side proceeding toward the rear, 34, to 43.

Q-454. For what purpose are resistors Nos. 19 and 23?

A-454. To regulate the field strength of the exciting motors when regenerating.

Q-455. What are the balancing resistors?

A-455. These are connected in series with armatures of the exciting motors when regenerating for the purpose of balancing their currents and reducing the voltage in each case.

Q-456. What are the equalizing resistors?

A-456. These equalize the field and line currents between the two exciting motors on each end of the locomotive.

Q-457. Give number and location of rheostat contactors.

A-457. On A-end the right side forward end contactor compartment are contactors Nos. 28 to 90.40. On B-end in same relative position are Nos. 78 to 90.

Q-458. Give the numbers of the braking contactors.

A-458. D1 to D6 inclusive on A-end and D51 to D56 inclusive on B-end.

Q-459. What is the main point of difference of the braking contactors compared to the others?

A-459. The braking contactors are opened by magnets and closed by gravity, but the other contactors are closed by magnets and opened by gravity.

Q-460. Explain the purpose of contactors 39 and 89.

A-460. These contactors cut out part of the balancing resistors during low speed regeneration.

Q-461. What resistors are in series with the locomotive K. W. H. and K. V. meters?

A-461. Resistor No. 52 for the K. V. meter and No. 53 for the locomotive K. W. H. meter.

Q-462. How many cells are there in the locomotive battery?

A-462. There are 36 cells in the locomotive battery.

Q-463. What is the only apparatus on the locomotive that will operate properly if a main control fuse is blown?

A-463. Lamps and auxiliary compressor.

Q-464. Name and give capacity of control switch fuses.

A-464. Main control switch two fuses of 60 ampere capacity. Main compressor control switch one fuse 10 ampere capacity. Motor generator control switch one fuse 10 ampere capacity. Controller switches two fuses each 40 ampere capacity.

Q-465. Explain the method of numbering and lettering the control wires.

A-465. Wires inside the controller are given plain letters like A or B. Wires from the controllers to the connection boxes and between connection boxes are given plain numbers like 1, 3, 5—etc. After any one of the numbered wires goes through a relay or coil it is lettered successively 1A, 1B, 1C, etc.

Q-466. Where are the control connection boxes and what are they for?

A-466. The control connection boxes are located in the enginemen's cabs near the hand brakes. They are used to connect the various branches of the control wires in systematic order.

Q-467. What control wires are in the control jumper which goes to the upper left coupler socket on the A-end?

A-467. 1 to 16 inclusive.

Q-468. What is the number or wires in the lower left control coupler socket on the B-end?

A-468. Three No. 40s and 51 to 63 inclusive.

Q-469. Where are the low voltage connection boxes and what wire numbers are in them?

A-469. The L. V. C. boxes are located in the engineer's cabs under the fireman's seats. Wires Nos. L1 and L2, K1 and K2, L8 and L9 are connected inside them.

Q-470. How do the controllers operate contactors?

A-470. The controller is a low voltage switching device which is used to energize or de-energize operating circuits of the various contactors and switches. The control wires are thereby energized in a systematic predetermined manner and the contactors operate accordingly.

Q-471. What procedure should be used in cutting in the train lighting panel and also in cutting it out?

CUTTING IN

A-471. 1. Move both lamp and generator rheostat handles toward the middle of the panel.

2. Have lamp, battery and panel light switches ON.

Have the circuit breaker closed.

3. When the gage lamps burn showing that the train jumper is in place the generator switch may be closed.

4. Put the volt meter plug in the holes marked "LAMPS" and move the **generator rheostat** to hold 70-75 volts on the lamps.

5. Let the panel remain this way until the "Loop switches" in the train are pulled as evidenced by the lamp ammeter changing but slightly when lamp rheostat lever is moved to the left one point.

6. Next, while maintaining 70 to 75 volts on the lamps by means of the **lamp rheostat** the **generator rheostat** may be gradually advanced to the right until the generator ammeter indicates around 200 amperes or the handle has reached its limit of travel.

7. The first important consideration is to hold 70 to 75 volts steady and uninterrupted on the lamp lines at all times. The train batteries can only be charged while doing this if the train loop switches are opened

CUTTING OUT

When discontinuing train lighting and battery charging the circuit breaker should be tripped, the generator lever switch opened and the rheostat handles moved to the center of the panel.

Q-472. If train lighting trouble develops what tests should be made on the lighting panel?

A-472. Insert the voltmeter plug in positions 1, 2 or 3 to see if the lamp, battery or generator lines are grounded. Try opening lamp switch leaving generator and battery switches "ON". If circuit breaker does not stay set try opening the battery switch leaving the lamp and generator switches "ON". If this does not work pull jumper to train and run baggage car dynamo.

Q-473. When lighting a train if the control or controller fuses blow twice, what should be done?

A-473. The train lighting panel switches should be opened and the jumper pulled between locomotive and train. The baggage car dynamo may be run for lighting the train.

Q-474. How is the RCC contactor interlock connected up to the lighting panel?

A-474. When the RCC contactor opens it closes an interlock which short circuits a 290-ohm resistor tube in series with the trip coil on the lighting panel circuit breaker. This increases the current to this coil causing it to open the breaker.

Q-475. Explain how you would make a stop and start up again while regenerating on descending mountain grade?

A-475. In making a stop:

1. Make a light initial reduction sufficient to hold the train speed constant and gradually shut off the braking controller as the air brakes take hold.

2. Watch the line ammeter and as the needle reaches zero shut off the main controller. The rest of the stop can be handled in regular manner with the air brakes.

In starting: Release brakes and notch out the main controller to the 11th notch, holding about 150 amperes accelerating current. Next advance the braking lever rapidly enough to cause the line ammeter to indicate braking and to increase the field current to about 250 amperes before the speed becomes too high. If necessary the speed should be checked by use of the air brakes.

Q-476. What should be done if tying up an EP-2 locomotive with no one left in charge?

A-476. The controller and controller switches should be shut off; also the M. G. Set, main compressor and traction motor blowers. The pantograph and reverse handles should be removed from their operating places and left above the ammeters in one cab. The locomotive battery switch should be opened before leaving the machine. All doors and windows should be shut and if standing on a grade the wheels should be securely blocked.

Q-477. Trace the flow of control current from the locomotive battery and back again on the first notch forward of B-end main controller.

A-477. (This question should be answered with the aid of wiring diagram No. E. D. 1364 as follows): Control current flows from the positive terminal locomotive battery, 75 ampere ribbon fuse, locomotive battery ammeter shunt, battery switch, wire L-1, B-end L. V. C. box, control jumper, A-end L. V. C. box, main control switch and 60 ampere fuse, wire K1, A-end L. V. C. box, control jumper, B-end L. V. C. box, B-end controller switch and 40 ampere fuse to the B-end controller blowout coil to the two top fingers and rings on the main controller which are

connected together. When the controller is on the first step the 1st, 2nd, 3rd, 5th, 7th, 20th, 23rd, 24th, fingers come into contact with their respective rings. The upper section of the controller drum from the 1st to 20th fingers is energized with positive control current and the lower section finger Nos. 21 to 23 inclusive is negative. Negative current from the controller on its return to the battery flows on wire K-2 through the controller switch and 40 ampere fuse to the B-end L. V. C. box, control jumper, A-end L. V. C. box, main control switch and 60 ampere fuse, wire L2, A-end L. V. C. box, control jumper, B-end L. V. C. box, locomotive battery switch, 75 ampere locomotive battery fuse, negative terminal of locomotive battery.

If the JR circuit breaker is not set when the controller is placed on the first notch, positive control current flows from the 20th main controller finger, wire 20, A and B-end C. C. boxes and No. 3 control jumper to fifth JR interlock finger, wire 20A, JR relay operating magnet, wire 20B, interlock on No. 2 contactor with the contactor open, wire 24, A-end control connection box, 12th stud of 2nd vertical row, No. 3 control jumper, B-end control connection box, 15th finger of the braking controller, 14th finger of braking controller, wire B, 1st finger of reverse drum to 3rd, wire 40, 23rd and 24th fingers of main controller on B-end and on negative wire K2 back to locomotive battery. This flow of current causes the JR relay to close its contacts and then current flows from positive wire K1 through JR relay, the reset coil of the circuit breaker to negative wire K2 and back to the locomotive battery. When the circuit breaker closes it opens its 5th interlock finger thus allowing the JR relay to open and cut off the current to the reset coil.

The JR holding coil holds the circuit breaker closed in normal operation and the current through it may be traced as follows: From the locomotive battery to positive wire K1 as explained above, JR holding coil, calibration rheostat, wire K7, relay OV-2, wire K8, OL-7, wire K9, OL-4, wire K10, OL-3, wire K11, V valve, wire 57, A-end C. C. box 6th stud on 4th row, No. 4 control jumper, B-end C. C. box 6th stud, 4th row, V valve, wire K12, OL-57, wire K13, OL-54, wire K14, OV-52, wire K2 and back to locomotive battery as above. From the 3rd finger of the main controller current flows on wire A, 7th finger of reverse drum, to the 8th finger of the reverse drum, wire 8, to the B-end C. C. box 1st row 8th stud, to the forward magnet valve of the B-reverser, wire No. 40, B-end C. C. box, 23rd and 24th fingers of main controller to the negative and back to

the locomotive battery as above. This current causes the B-end reverser to move into the forward position and set its interlock so that current also flows from wire 8, 1st reverser interlock finger to the second finger, wire 55, B-end C. C. box 4th stud of 4th row, control jumper No. 4, A-end C. C. box, 4th stud of 4th row, contactor No. 3 operating magnet, wire No. 24B, 1st JR interlock finger, wire 24A, 2nd JR interlock finger, wire 24 and back to the locomotive battery as above.

Current also flows on wire 8, B-end C. C. 8th stud of 1st row, No. 2 control jumper, A-end C. C. 9th stud of 1st row, wire 0, reverse magnet valve of A-end reverser to wire 40, A-end C. C. box, control jumper No. 4, B-end C. C. box, 23 and 24 fingers of B-end main controller to the negative and back to the locomotive battery as above.

When the A-end reverser throws to the reverse position its interlock connects its 3rd and 2nd fingers, wire 0 and 8A together; and current flows from wire 8A to contactor No. 2 operating magnet, wire 24B and back to the locomotive battery as above. From the 5th finger of the main controller current flows on wire 3 to the B-end C. C. box 3rd stud 1st row, No. 2 control jumper, A-end C. C. box 3rd stud 1st row, 19th interlock finger of A-end B-switch in the 6 and 4 motor position, 20th interlock finger of the A-end B-switch in 6 and 4 motor position, wire 53, A-end C. C. box, 4th row, 2nd stud, control jumper No. 4, B-end, C. C. box, 4th row, 2nd stud, 20th interlock finger of B-end B-switch 6 and 4 motor position to 19th finger of B-end B-switch interlock, wire 1, B-end C. C. box 1st row, 1st stud, No. 2 control jumper, A-end C. C. box 1st row, 1st stud 5th interlock finger on the A-switch in the 12 motor position, 6th interlock finger on the A-switch, wire 2A, operating magnet of relay TR-5 wire 24B and back to the locomotive battery as above.

From the 7th finger of the B-end main controller current flows on wire 5 to the B-end C. C. box 1st row, 5th stud, 13th interlock finger on B-end B-switch in 6 motor position, 14th interlock finger of B-end B-switch wire 5N, 4th finger of interlock on B-end, C-switch in 6 motor position, 5th finger of B-end, C-switch, wire 1N, operating magnet of TR-56, wire 40, B-end C. C. box, 23 and 24 fingers of B-end main controller and back to locomotive battery as outlined above. The current also flows from wire 5 in the B-end C. C. box through No. 2 control jumper, A-end C. C. box 1st row 5th stud, 13th interlock finger on A-end B-switch in 6 motor position, 14th interlock finger A-end B-switch wire 5-A, 4th finger A-end C-switch in 6 motor position, 5th finger of

interlock of A-end, C-switch wire 1B, operating magnet of TR-6 wire 40, A-end C. C. box, control jumper No. 4, B-end C. C. box, 23 and 24 fingers of B-end main controller and back to the locomotive battery as above.

Q-478. With the controller on the first notch forward motoring on full field trace the flow of power current from the wire to the rails through the traction motors.

A-478. (This question should be answered with the aid of wiring diagram No. ED-1364 as follows): On the first controller notch full field normal motoring operation, current flows from the trolley wire through the main reactor, through switch No. 1, JR circuit breaker, contactor Nos. 2 and 3, cable R-11, grid resistors Nos. 3, 4, 5, 12, 13, 14, 15 and 16, cable R-16, contactor Nos. 41 and 27, cable R-21, grid resistors Nos. 6 to 11 inclusive, trip coil on relay OL-4, traction motor armature Nos. 4, 5 and 6, contactor Nos. 45 and 44, traction motor armature No. 3, contactor No. 23, traction motor armature No. 2, cable R-31, resistors Nos. 21, 20, cable R-33 and 34, resistors Nos. 18 and 17, cable R-36, contactor No. 16, traction motor armature No. 1, contactor No. 18, A-reverser contact, A-tapper contact, two field coils of traction motors No. 1 and 2, two field coils, tractions motors No. 2 and 1, A-reverser contact, contactor No. 15, A-reverser contact, A-tapper contact, four field coils of traction motor No. 3, A-reverser contact, contactor No. 48, A-reverser contact, A-tapper contact, two field coils each on traction motors Nos. 4, 5 and 6, two field coils each on traction motors Nos. 6, 5 and 4, A-reverser contact, contactor Nos. 50, 7, 8 and 9, cable R-61, grid resistors Nos. 31 to 24 inclusive, cable R-66, contactors No. 91 and 76, cable R-71, grid resistors 32 to 37 inclusive, cable R-75, trip coil relay OL-54, traction motor armature Nos. 9, 8 and 7, contactor Nos. 95 and 94, traction motor armature No. 10, contactor No. 73, armature No. 11, cable R-81, resistors 42, 41, cables R-83 and 84, resistors 40 and 39, cable R-86, contactor No. 66, traction motor armature No. 12, contactor No. 68, B-reverser contact, B-tapper contact, two field coils each on traction motor Nos. 12 and 11, two field coils each on traction motor Nos. 11 and 12, B-reverser contact, contactor No. 65, B-reverser contact, B-tapper contact, four field coils of traction motor No. 10, B-reverser contact, contactor No. 98, B-reverser contact, B-tapper contact, two field coils on each traction motor Nos. 9, 8 and 7, two field coils on each traction motor Nos. 7, 8 and 9, B-reverser contact, contactor No. 100, field ammeter shunt, line ammeter shunt, K. W. H. meter shunt,

locomotive frame (ground) through wheels to the rails and back to the substation.

Q-479. Trace the flow of pantograph control current from wire K1 to K2 operating from the A-end with B-end pantograph only.

A-479. On wire K1 current flows from the L. V. C. box on the A-end through the loose handle pantograph control switch and the lower snap switch in the A-end operating cab, wire L9, A-end L. V. C. box, control jumper No. 1, B-end L. V. C. box, lower pantograph control snap switch in B-end cab, wire L54, operating magnet of B-end pantograph valve, wire L55, upper pantograph control snap switch in B-end cab to wire K2.

Q-480. Trace the flow of control current for the M. G. Set from wire K1 to K2.

A-480. Current flows from the B-end L. V. C. box, wire K1, through the M. G. Set control snap switch and fuse, wire L7, operating magnet of contactor No. 56, wire L64, auxiliary switch interlock, wire K2.

Q-481. Trace the flow of power current from the trolley wire to the rails through the M. G. Set when it is first starting.

A-481. Power current flows from the trolley wire through a pantograph and its cut-out switch, through the roof cables, auxiliary reactor on B-end, auxiliary switch and fuse, cable R-101, resistor No. 43, cable R-102, contactor No. 56, M. G. Set motor armature No. 1, M. G. Set motor shunt field, K. W. H. meter shunt to locomotive frame (ground), locomotive wheels and to the rails. Another part of the current, after flowing through armature No. 1 flows through armature No. 2 of the M. G. Set, the compensating, commutating and compound series fields of the motor of the M. G. Set, resistor Nos. 57 and 58, operating magnet of contactor No. 58, auxiliary ammeter shunt, K. W. H. meter shunt to ground.

Q-482. Explain the flow of M. G. Set power current as the machine speeds up and the starting resistance is cut out.

A-482. When the M. G. set speeds up after starting, the spring on contactor No. 58 closes it and current flows as in A-481, excepting that it goes through resistor No. 57, operating magnet of contactor No. 57, contactor No. 58, holding magnet of contactor No. 58 to the auxiliary ammeter shunt, etc. With further increase of speed in starting, the spring on contactor No. 57 closes it and the current then flows as above, excepting that it goes through contactor

No. 57 and its holding coil instead of resistor No. 57 and operating magnet of contactor No. 57.

Q-483. Trace the flow of control current for the main air compressor from wire K1 to K2.

A-483. Current flows from the B-end L. V. C. box, wire K1, main compressor control snap switch and fuse, wire L57, compressor governor contacts, wire L58, operating magnet of contactor No. 54, wire L64, auxiliary switch interlock, wire K2.

Q-484. Trace the flow of power current through the main air compressor when it is just starting, and also when it is up to full speed.

A-484. Power current flows as given in A-481 through resistor No. 43, cable R-102, contactor No. 54, resistor No. 55, operating magnet of contactor No. 55, No. 1 armature and field, No. 2 armature and field of the main air compressor motor, auxiliary ammeter shunt, K. W. H. meter shunt to ground. After the compressor gets started the spring on contactor No. 55 closes it and the current flows as above excepting that it goes through contactor No. 55 and its holding magnet instead of resistor No. 55 and the operating magnet of contactor No. 55.

Q-485. Trace the flow of power current through the traction motor blowers operating on low speed (Series).

A-485. The power current flows through resistor No. 43 as shown in A-481, then through contactor No. 59, armature and field of T. M. B. motor Nos. 6, 5 and 4, contactor No. 61, T. M. B. motor Nos. 3, 2 and 1, T. M. B. ammeter shunt, K. W. H. meter shunt to ground.

Q-486. Trace out the field current to the control generator and explain how the voltage of this machine is regulated.

A-486. When the control generator begins to generate, current flows from its armature on wire L17, through 400 ampere copper ribbon fuse, wire L16, generator ammeter shunt on panel 116, wire L15, relay CO-9 contacts, wire L13, Reg. Gen. C. O. switch, series field and armature of the regulating generator, (C. E. M. F. Gen.), Reg. Gen. C. O. switch, wire L14, field of the control generator, wire L18, to the control generator armature.

Current also flows from wire L17 through a 90 ohm tube resistor through one-half of the shunt field on the regulating generator, wire L12 to the negative, so as to cause it to generate in a direction to assist the above flow of current. Current also flows from wire L13 through a 100 ohm tube through

the operating magnet coil of relay R-8 to the negative. Also through the contacts on R-8 through two 30 ohm tubes to the negative. This flow of current does no useful work. Also current flows through a 250 ohm tube and the tripping magnet on relay CO-9.

Current also flows from wire L15, through a 100 ohm tube, through the shunt coil on relay RC-10 to the negative. And also from wire L14, through a 150 ohm tube, through the speed winding on relay R-8 to the negative.

When the control generator voltage rises a trifle above 81 volts the operating magnet on relay R-8 increases its pull enough to overcome the spring on this relay and so open its contacts. Therefore, the flow of current through them is cut off and another flow starts from wire L13, through the shunt field of the regulating generator, wire L12, three 30 ohm tubes to the negative. This flow of current through the regulating generator field is in a direction to cause its armature to generate a pressure in opposition to the flow of current through it to the control generator field. This back pressure decreases the control generator field current and the voltage of its armature lowers to a trifle below 81 volts when the spring on R-8 can close its contacts again. This process may be repeated with great rapidity as influenced by the speed winding on relay R-8 so that no great variation in control generator voltage is perceptible.

EXAMINATION QUESTIONS CLASS EP-3
ELECTRIC LOCOMOTIVES

Q-487. What is the arrangement of cab, wheels and trucks on class EP-3 locomotives?

A-487. There is one cab structure mounted on two main trucks, each of which consists of one engine truck, three pairs of drivers and one pair of trailers. The two pairs of trailers are in the middle of the locomotive at the rear of each main truck. (Locomotive 10301 consists of two cabs, each mounted on a main truck which has an engine truck at each end.)

Q-488. Name the various equipment compartments and indicate the principal equipment in each.

A-488. The No. 1 operating cab contains the No. 79 M. G. Set field rheostat, brake valves, pantograph controller, controller, No. 1A and 1B panels.

Next to this is the A-compartment containing line contactors Nos. 1 to 10, lightning arrester and fuse, balancing relay No. 45, M. G. contactor No. 50, overload relay Nos. 60, 60A, 60B and 60C, overvoltage relay No. 57, main and auxiliary switches, reactor, traction motor blower, field shunt blower, auxiliary fuses and protective resistors.

Next is the C-compartment in which is located the train heating boiler and accessories.

Next is the D-compartment in which is located the air compressor, train lighting panel together with their immediate accessories; also the stabilizing resistors, the axle generator balancing resistor, stabilizing resistor switches, auxiliary change-over switch, regeneration change-over switch, No. 87-B switch and axle generator armature fuses.

Next is the E-compartment with four motor contactors, combination switches, traction motor reverser, field shunt switches, traction motor cut-out switches and field shunt blower.

Lastly the No. 2 operating cab with similar equipment to No. 1, with the exception of the No. 78 axle generator motor operated rheostat and panels 2A and 2B.

Q-489. State briefly how the wheels and bearings are numbered.

A-489. Beginning on the No. 1 end on the engineer's side odd numbers 1, 3, 5, etc., are used. The truck wheels have the prefix "T" before their number. The trailers and the drivers are given odd numbers only.

On the fireman's, or left hand side, the wheels are numbered in like manner from front to rear with even numbers. The armature and suspension bearings, gears, journals, journal boxes, box

liners, and brake shoes are numbered for convenience like their adjacent wheels. (The armature bearings have the letters A and B added in reference to their position with the No. 1 end.)

Q-490. What are the auxiliary air devices and what air pressure do they use?

A-490. The main whistles and sanders use main reservoir air at 110-130 pounds pressure. The bell ringers and pantographs use control air at 75 pounds pressure. The boiler accessories use main reservoir air pressure given above, through the auxiliary devices governor.

Q-491. What does the auxiliary devices governor do?

A-491. It cuts off the air to the boiler accessories if the main reservoir pressure falls below 100 pounds.

Q-492. What is meant by control air and what does it operate?

A-492. The control air is fed through a reducing valve, strainer and cut-out cock from the main reservoir into a small reservoir at a pressure of 75 pounds. This air is used to operate the bell ringers, cam switches and contactors, and pantographs.

Q-493. What type of air brake equipment is used on EP-3 locomotives?

A-493. Westinghouse type EL-14 modified.

Q-494. Name the various brake valves and explain briefly their purpose.

A-494. The engineer's brake valves apply and release brakes; the transfer valves operate brakes on both ends from one engineer's valve; the distributing valves handle air to the brake cylinders; regenerating interlock valves keep driver brakes from applying while regenerating; brake pipe vent valves hasten emergency application of brakes; feed valves apply air at standard pressure to brake pipe; straight air reducing valves supply air at constant pressure to signal system or to brake cylinders when independent application is made. The automatic control switch No. 89 permits the driver brakes to apply in emergency while in regeneration.

Q-495. What is the brake rigging arrangement?

A-495. At the rear of each main truck there are two brake cylinders arranged with levers so that when operating they apply brake shoes to the three pairs of respective drivers.

Q-496. Where are the pantograph air cut-out cocks located?

A-496. At the top of the 1B and 2B panels.

Q-497. State briefly how pantographs are controlled by means of the pantograph controllers for each position.

A-497. The pantograph controller on the non-operating end should be placed on position "B". The pantograph controller in the operating end may then be placed on "F" for the front pantograph and "R" for the rear pantograph or "B" for both pantographs. When it is desired to lower the pantograph, the operating end pantograph controller must be moved to "D". This drops the pantograph. If either one of the handles of the pantograph controllers is removed neither pantograph can be raised electrically, nor can the M. G. Set be started.

Q-498. How may the pantographs be locked down and grounded?

A-498. With both pantographs in the down position, the locking and grounding switches provided for that purpose may be closed.

Q-499. How may the pantographs be disconnected?

A-499. By opening up the disconnect switch at rear of each pantograph with the wooden switch pole provided for this purpose.

Q-500. Where is the air compressor governor located?

A-500. In the No. 2 operating cab in front of the fireman's seat.

Q-501. How do you adjust the main reservoir pressure with this governor?

A-501. To adjust the governor to cut-out at higher or lower pressures close the cut-out cock to governor, turn snap switch "OFF", remove cap from regulating head of left valve (facing governor) turn the adjusting screw to right to cut out at higher pressure; turn adjusting screw to left to cut out at lower pressure.

To adjust governor to cut in at higher or lower pressure close the cut-out cock to governor, turn snap switch "OFF", remove cap from regulating head of right valve (facing governor), turn the adjusting screw to right to cut in at higher pressure, turn adjusting screw to left to cut in at lower pressure.

Q-502. Where are the compressor fuses located and what is their type and capacity?

A-502. These fuses are ribbon type, 350 ampere capacity, and located in boxes adjacent to air compressor motor.

Q-503. Give location and function of the main reactor.

A-503. It is located in the "A" compartment and in conjunction with the lightning arrester prevents lightning discharges from entering electrical apparatus.

Q-504. Where is the auxiliary switch located and what is its purpose?

A-504. It is located in the "A" compartment by the side of the main switch. It is for the purpose of connecting the motor generator motor and various meter resistors to the pantograph supply.

Q-505. Give number and location of the auxiliary change-over switch, also its purpose.

A-505. Switch No. 42 is located in the left side of compartment "D". It is used to connect the traction motor blowers and air compressor to the axle generators when motoring or coasting and to the generator of the motor generator set and batteries during regeneration, slow running or at stand still.

Q-506. How is this switch controlled and what are its positions?

A-506. It is controlled by No. 75 relay. It has two positions, "motoring or coasting" and "standing or regeneration."

Q-507. Give the contacts closed on this switch in its two positions.

A-507. The contacts are lettered "A" to "I" inclusive of which "A" to "D" are closed during motoring or coasting and "E" to "I" are closed during regeneration, slow running or at stand still.

Q-508. What resistor is in series with the motor generator motor permanently and what is its purpose?

A-508. It is a grid resistor located in the "A" compartment between the auxiliary fuse and auxiliary switch No. 85. Its purpose is to limit the flow of current to the motor generator set motor and afford protection in case of overload and flash-overs.

Q-509. For what purpose is the motor generator set?

A-509. The motor generator set supplies low voltage current for charging the locomotive battery, for running the air compressor when standing still or regenerating; for supplying current for train lighting and various control circuits on the locomotive. It also supplies alternating current for use of the headlights and certain cab lights.

Q-510. In what order do the motor generator contactors close when it is being started?

A-510. 1st: Contactor No. 51; 2nd: Contactor No. 49; 3rd: Contactor No. 50.

Q-511. What regulates the generator voltage?

A-511. It is regulated by relay No. 72 located in the No. 1A panel. This relay controls motor operated rheostat No. 79, which regulates the current in the shunt field of the generator. The setting of relay No. 72 is determined by the position of rheostat No. 80, manually operated on the train lighting panel.

Q-512. What do the travel limit switches on motor operated rheostat No. 79 do?

A-512. The travel limit switches are for the purpose of stopping the motor operated rheostat when it reaches its "all in" or "all out" positions. Another switch lights the green M. G. pilot lamps in the operating cabs excepting when the rheostat reaches its "all out" position.

Q-513. What should be done when the line voltage falls below 2400 volts for ten minutes?

A-513. The train lighting panel should be shut down.

Q-514. What should be done when the line voltage falls below 1800 volts for five minutes, and why?

A-514. The motor generator set should be shut down because the generator will operate as a motor off of the locomotive battery.

Q-515. What other indications will there be beside the ampere-hour meter reading which will give necessary information as to the condition of the locomotive batteries?

A-515. When the battery voltage drops to 60 volts with the compressor not running off of the battery it is an indication that the batteries are about discharged.

Q-516. What would be the normal rate of discharge on the batteries when operating with defective motor generator set, for control, headlight, boiler blower and compressor?

A-516. 30 ampere-hours per hour for control, headlight and boiler blower, and 5 ampere-hours per minute for the compressor.

Q-517. How many traction motor blowers are there and how operated?

A-517. There are two traction motor blowers, one for each set of three traction motors. They run on the motor generator and locomotive battery or axle generator current and may be started by turning on the snap switch at the engineer's seat in each operating cab.

Q-518. What contactor controls the traction motor blowers and where is it located?

A-518. Contactor No. 87 located in the B compartment on the auxiliary panel.

Q-519. What is the purpose of the traction motor blower switch No. 87-B and where located?

A-519. It is located in compartment D over the train lighting fuses. It is for the purpose of connecting the T. M. blower motors to the motor generator set while standing or regenerating.

Q-520. How many traction motors are there and what is their principal feature?

A-520. There are six traction motors. Each traction motor has two armatures with one pinion each, driving one gear mounted on each quill and driving axle.

Q-521. Give location and numbers of the traction motor cut-out switches. What circuit and what traction motors may be cut out with each, and how are they operated?

A-521. They are located in the right side of switch compartment "E" over traction motor blower, facing the aisle. They are operated by raising the cross bar in front of the barrier interlocks, then opening the barrier interlock in front of switch to be opened. Then use the insulated handle provided for the purpose and open the knife blade switches. Replace the cross bar to hold all other interlock barriers in place.

The barrier interlock opens the control circuit to the operating coil of the motor contactor located on the positive side of the motors to be cut out. The knife blade switch opens the negative side of the field of the motor to be cut out. Interlock barrier 99a and switch 99A cut out T. M. 1. Interlock barrier 99b and switch 99B cut out T. M. 2 and 3. Interlock barrier 99c and switch 99C cut out T. M. 4 and 5. Interlock barrier 99d and switch 99D cut out T. M. 6.

Q-522. What is the maximum tonnage rating of EP-3 locomotives in passenger cars?

A-522. On 2.2% grade, 960 tons.

Q-523. How many passenger cars will these locomotives handle with a pair of motors cut out on 1%, 1.7% and 2% grade?

A-523. 1% grade or less, 10 cars; 1.7% grade, 7 cars; 2% grade, 6 cars. But there must not be less than 15 minutes between acceleration periods.

Q-524. What is the car limit for handling freight trains with these locomotives?

A-524. 50 cars.

Q-525. What freight tonnage can be handled with one pair of motors cut out?

A-525. One-half the rated tonnage for the grade in question.

Q-526. When regenerating in freight service what probable trouble may occur and how should it be overcome?

A-526. The stabilizing resistors should be watched closely and if they become overheated, air brakes should be used to assist in controlling the train.

Q-527. With traction motors 2 and 3 cut out what ammeters would indicate the current through traction motors 1 and 6 and what ammeters for traction motors 4 and 5 in the third combination?

6A-527. Upper ammeters for motors 1 and 6. No ammeters for motors 4 and 5.

Q-528. With traction motors 1 and 6 cut out which ammeters will read the current on the remaining traction motors in the third combination?

A-528. Lower ammeters will indicate for 2 and 3 motors. No ammeters for motors 4 and 5.

Q-529. With traction motors 4 and 5 cut out which ammeters will indicate the current to the remaining traction motors in the third combination?

A-529. Upper ammeters for motors 1 and 6; lower ammeters for motors 2 and 3.

Q-530. What is the purpose of the overload relays and what is their normal setting?

A-530. No. 60 overload relay limits the maximum current through all the traction motor circuits to 1500 amperes. No. 60A, 60B and 60C overload relays are each connected in one traction motor circuit and in the third combination limit the current in each circuit to 650 amperes.

Q-531. What is the purpose of over-voltage relay No. 57 and what is its setting?

A-531. This relay is for the purpose of disconnecting the traction motors from the line and stopping regenerative action if the traction motor voltage should exceed 3800 volts.

Q-532. How may the O. L. and O. V. relays be reset after having been tripped?

A-532. By returning the controller to the "OFF" position.

Q-533. How may it be known that the O. V. relay tripping coil is energized for operation and how is this arranged?

A-533. The operating coil of Relay No. 56 is connected in series with tripping coil of No. 57 and when energized will light the pilot light over the front door in each operating cab.

Q-534. Give the number and location of the traction motor reverser and for what purpose is it?

A-534. The reverser is No. 36, an electro-pneumatically operated switch located in the "E" compartment. It is used to change the direction of current flow in the traction motor fields, thus determining the direction of locomotive travel.

Q-535. What contacts are closed with the reverser in the forward position? In the reverse position? (Considering No. 1 end the head end.)

A-535. For forward position, contacts A-C-E-G-I-K-M-O are closed. For reverse position, contacts B-D-F-H-J-L-N-P are closed.

Q-536. Under what conditions only, would it be permissible to reverse a locomotive while in motion?

A-536. In extreme emergency with failure of brakes, to avoid serious accident or personal injury.

Q-537. What contactors and relay will not close electrically if the reverser does not properly move corresponding to the controller position?

A-537. Contactors 1, 2, 3, 4, 76 and 77; and relay No. 53.

Q-538. How are the field shunting switches numbered and where are they located?

A-538. Switches Nos. 37 and 38 are located in compartment "E".

Q-539. How are the field shunt switches operated and what do they do?

A-539. They are electro-pneumatic switches. No. 37 is operated on the 15th controller notch and No. 38 is operated on the 17th controller notch. These switches connect inductive shunts around the traction motor field windings, by-passing a portion of the armature current through the shunt, thus causing the motors to speed up under light load conditions.

Q-540. Under what conditions may the traction motor fields be shunted?

A-540. When the full field current is 300 amperes or less.

Q-541. Where are the No. 34 and 35 switches located, how are they operated and what is their function?

A-541. These switches are located in the "E" compartment and are electro-pneumatically operated

from the controller. In the first combination with contacts A-B-C-D-E on switch No. 34 closed and contacts A-B-C-D-E-F on switch No. 35 closed all 12 of the traction motor armatures are connected in series. In the second combination with contacts F-G-H-I on switch No. 34 closed and contacts A-B-C-D-E-F on switch No. 35 closed two groups of six traction motor armatures are in series. In the third combination with contacts F-G-H-I on switch No. 34 closed and contacts G-I-H-J-K-L-M-N-O on switch No. 35 closed, three groups of four traction motor armature in series are connected to the trolley.

Q-542. What is the effect on the locomotive if switch No. 34 does not properly follow the controller when running?

A-542. The locomotive remains in the first combination and No. 35 switch will not throw when going into the third combination.

Q-543. Explain the purpose of contactor Nos. 1 to 10 inclusive.

A-543. These are line contactors for the purpose of closing and opening the main motor circuits in normal operation of the locomotive; also for opening these circuits in case an excessive flow of current or an excessively high voltage should cause any of the relays No. 57, 60, 60A, 60B or 60C to trip.

Q-544. Explain the purpose of contactors Nos. 28 to 33 inclusive.

A-544. They are for the purpose of assisting the motor combination switches in making a smooth transfer from one motor combination to another. They also open in conjunction with the main motor cut-out switches No. 99A to D to cut out any pair of motors.

Q-545. Give the numbers of the T. M. rheostat contactors, their location on the locomotive and their function.

A-545. The rheostat contactors are numbers 11 to 27 inclusive. They are located in the "B" compartment and are for the purpose of cutting out resistance in the traction motor circuits in order, as the controller is operated.

Q-546. Give the numbers of the traction motor resistors and their location on the locomotive.

A-546. The traction motor resistors are numbers 1 to 62 inclusive, and are located in the "B" compartment.

Q-547. Where are the stabilizing resistors located and what is their function?

A-547. They are located in compartment "D" on the right and left side over switches No. 39 and 40. In regeneration the total current through the field and armatures of the traction motors flows through the resistors in each case, for the purpose of improving the stability of these currents and causing the braking effort to hold nearly constant.

Q-548. Where is stabilizing resistor switch No. 39 located and what is its use?

A-548. It is located in compartment "D". It is used to connect the stabilizing resistors in the traction motor circuits during regeneration in number 1 and 2 combinations.

Q-549. Where is stabilizing resistor switch No. 40 located and for what is it used?

A-549. In compartment "D". It is used to connect the stabilizing resistor in the traction motor circuits during regeneration in No. 3 combination.

Q-550. What is the number of the regenerative change-over switch, where is it located and what is its function?

A-550. Regenerative change-over switch No. 41 is located in compartment "D". In the motoring position contacts lettered A to D inclusive are closed and connect the traction motor fields to the K. W. H. shunt, to ground. In the regenerative position its contacts E to H inclusive are closed and connect the axle generators as exciters in circuit with the traction motor fields.

Q-551. Where are the resistors for K. W. H. and K. V. meters located?

A-551. The resistor for the K. W. H. meter is located in compartment "A" near contactor No. 50. The resistor for the K. V. meters is located in compartment "A" over relay No. 57.

Q-552. How many cells are there in the locomotive battery and what is its voltage and ampere ratings?

A-552. There are 38 cells located in two boxes suspended underneath the cab below compartment "C". They are rated 80 volts, 84 amperes for 4½ hours or 400 ampere-hours.

Q-553. Where are the locomotive battery fuses located and what is their type and capacity?

A-553. These fuses are located by the auxiliary panel in compartment "B". They are the copper ribbon type and are rated 350 amperes.

Q-554. Where are the control fuses and what is their capacity and function?

A-554. The control fuses are located on the auxiliary panel in the "B" compartment and are 35 ampere capacity. They protect all control circuits except the compressor and No. 72 and 81 relays.

Q-555. Give method of cutting in the train lighting panel and also in cutting it out.

CUTTING IN TRAIN LIGHTING PANEL

A-555. 1. Have the lamp rheostat No. 95 moved to the right as far as it will go. Have the battery rheostat No. 94 turned to the left as far as it will go.

2. Have lamp, battery and panel light switches "ON" and close the circuit breaker.

3. When the pilot lamp burns, showing that the train line jumper is in place and with the generator rheostat No. 80 set for proper voltage the generator switch may be closed.

4. Put the voltmeter plug in the holes marked "lamps"; with the meter transfer switch No. 58 in either position and move battery rheostat No. 94 to hold the lamp voltage between 70 and 75 volts.

5. Wait until the "loop" switches in train are opened as evidenced by lamp ammeter changing but slightly when the lamp rheostat is moved to the left one point.

6. While maintaining 70 to 75 volts on the lamps by means of the lamp rheostat the battery rheostat may be gradually advanced to the right until the generator ammeter indicates around 200 amperes or the handle has reached its limit of travel.

7. The first important consideration is to hold 70 to 75 volts steady and uninterrupted on the lamp lines at all times. The train batteries should also be charged while doing this if the train "loop" switches are open. (Note: Any change made in the generator voltage by means of rheostat No. 80 in regulation of the locomotive battery charging rate, must be followed by carefully readjusting both train, lamp and battery voltage.)

CUTTING OUT TRAIN LIGHTING PANEL

8. To shut down the train lighting panel open the circuit breaker and move handle of lamp rheostat No. 95 to the right as far as it will go. Next open generator switch and turn battery rheostat No. 94 to the left as far as it will go. Always shut off lighting panel before shutting down the motor generator set.

Q-556. At what speeds is regeneration in the first combination used and how may it be started?

A-556. At speeds of 15 miles per hour or less. With the main controller shut off and speed increased to 8 miles per hour, if on grade of 1½% or over, and 12 miles per hour if on grades of 1% or less, set the combination lever in position No. 1, move the regeneration lever to regenerative position and wait until regeneration lamp above the voltmeter lights. When the speed has increased to slightly above the given values move the main controller to the first notch. If everything is operating properly the field current in traction motors should immediately increase and the line ammeters will show some motoring. Leave the controller on the first notch until the line ammeter goes to zero, then advance the lever rapidly to the 16th notch. The speed may then be controlled by using the notching relays.

Q-557. At what speed should regeneration in the second combination be used and how started?

A-557. When speeds between 15 and 30 miles per hour are desired, regeneration in the second combination should be started as follows: With the main controller "OFF" and the speed increased above 15 miles per hour on grades of 1½% or over and 25 miles per hour on grades of 1% or less, the combination lever should be moved to the second position, the regenerative lever to the regenerative position until the regeneration light burns. When the speed has increased to five miles per hour above these values the main controller should be advanced to the first notch and operated the same as the first combination.

Q-558. At what speeds should regeneration in the third combination be used and how started?

A-558. With the main controller "OFF" and speed increased to 30 miles per hour on grades of 1½% or more, and 40 miles per hour on grades of 1% or less, the combination lever should be moved to the 3rd position and the regenerating lever to the regenerating position until the regeneration light lights. When the speed has increased to five miles per hour above these values, advance the main controller to the first notch and operate the same as for the first combination. (Note: The position of the combination lever should not be changed unless the regenerative lever is in the motoring position.)

Q-559. Can regeneration be started with a pair of motors cut out?

A-559. No, it is not good practice.

Q-560. How would you energize an EP-3 locomotive and prepare it for service?

A-560. In addition to general instructions: Have battery cut-out and control cut-out switches open,

main controllers "OFF", double cut-out cock on non-operating end in No. 2 position, and pantograph controller on this end in "B" position. Take air brake handles and reverse lever to operating end, put cut-out cock in No. 1 position. See that main and auxiliary switches are closed. Close compressor motor switch just above compressor governor. At auxiliary panel close battery cut-out switch. Close control cut-out switch. Turn air compressor control snap switch "ON". When air pressure has reached 50 lbs. give warning, raise pantograph, go to auxiliary panel and shut down compressor and start M. G. Set and then start compressor. Note condition of locomotive batteries and adjust M. G. Set voltage to proper value.

Q-561. With all traction motors in service in what combination should the locomotive be started?

A-561. 1st combination.

Q-562. Explain how you would operate in first combination.

A-562. Have regeneration lever in motoring position. Reverse lever in forward or reverse, as desired, notch main controller out to 14th notch running position.

Q-563. May the shunt notches be used in 1st, 2nd and 3rd combinations and at what amperes?

A-563. Shunting may be done in all combinations at 300 amperes or less.

Q-564. How would you change from the first to second combination?

A-564. Move combination lever back from first to second position, then move main controller lever to first notch and wait for switches to throw, then notch out to 14th notch running position.

Q-565. How would you change from second to third combination?

A-565. Move combination lever from 2nd to 3rd position and main controller lever back to the 4th notch, wait for switch to throw and notch out to the 14th notch running position.

Q-566. What must be watched particularly when accelerating a train?

A-566. The ammeters must be watched so as not to exceed the maximum current rating of 300 amperes under normal conditions.

Q-567. When accelerating at 300 amperes or less, how long is it permissible to take from the "off" position to the 14th notch?

A-567. 15 minutes. Main controller must not be on one notch more than 2 minutes.

Q-568. When accelerating at 300 to 400 amperes, how long is it permissible to use in going from the "off" position to the 14th notch?

A-568. 10 minutes, but controller must not be on any one notch more than 1 minute.

Q-569. If handling a train that required above current and time how long would you wait before changing from 1st to 2nd and 2nd to 3rd combination, and why?

A-569. 10 minutes, to allow resistors to cool.

Q-570. If a train could not be accelerated in the above time and current rating, what would you do?

A-570. A helper must be obtained or train reduced.

Q-571. If necessary to maintain over 300 amperes to keep train moving, would you use shunt before transferring from first to second combinations?

A-571. No, but transfer at as high speed as possible.

Q-572. Is it permissible to move controller more than one notch at a time in accelerating?

A-572. Positively not.

Q-573. On what notch must main controller be when combination lever is moved from one combination to the next higher one?

A-573. 14th notch.

Q-574. Where should the combination lever be left?

A-574. On the notch of combination in which motor is working until it is desired to change to another combination.

Q-575. How would you change from a high to a lower combination?

A-575. Shut main controller completely off and then put combination lever in No. 1 combination.

Q-576. How would you change from second to first combination on ascending mountain grade in freight service?

A-576. Move combination lever from second to first combination while main controller lever is on the 14th notch, then move main controller lever to "off" position gradually and notch out rapidly to the 14th notch again.

Q-577. Is it permissible to change motor combination lever from a high to a lower combination and then notch main controller off part way?

A-577. No. It would overheat the resistors.

Q-578. What notches on main controller may be used and for how long when switching?

A-578. The 5th notch and beyond for 30 minutes, providing not over 150 amperes are used.

Q-579. How would you know if power went off line?

A-579. Would be indicated by low voltmeter reading, M. G. Set slowing down and green pilot lights going out.

Q-580. What would you do with the controller under this condition?

A-580. Shut it off at once either motoring or regenerating.

Q-581. What would you do to avoid slipping of drivers and what effect does it have on traction motors?

A-581. Sand the rail a locomotive length before a stop is made and watch for slipping when starting and accelerating. Slipping damages motors and gears mechanically and is liable to cause flash-overs.

Q-582. What is the maximum speed permissible with EP-3 locomotives?

A-582. 60 miles per hour, except 10301 which has a maximum speed of 50 miles per hour.

Q-583. What are the traction motor capacities with blowers running?

A-583. 1 minute rating, 550 amperes.
5 minute rating, 400 amperes.
1 hour rating, 375 amperes.
Continuous rating, 300 amperes.

Q-584. What are the traction motor capacities with blowers not running?

A-584. 1 minute rating, 400 amperes.
5 minute rating, 350 amperes.
1 hour rating, 300 amperes.
Continuous rating, 225 amperes.

Q-585. How long in case of emergency is it permissible to run an EP-3 locomotive without blowers, at 375 amperes starting cold?

A-585. One hour.

Q-586. How many amperes for 2 hours?

A-586. 300 amperes.

Q-587. When should the traction motor blowers be used?

A-587. When traction motor current exceeds 375 amperes for 30 minutes or over, the traction motor

blowers must be used, except in emergency when the limits described above shall apply.

Q-588. What tonnage should an EP-3 and EF-1 locomotive handle in the same train on a grade of 1.7%?

A-588. 2,000 tons.

Q-589. On 2% grade?

A-589. 1,600 tons.

Q-590. What combination on an EP-3 locomotive corresponds to series operation on EF-1 locomotive?

A-590. First combination.

Q-591. What combination on an EP-3 locomotive corresponds to full parallel operation on EF-1 locomotive?

A-591. Second combination.

Q-592. Do the above rules apply alike to motoring and regenerating?

A-592. Yes.

Q-593. Explain how you would shut down an EP-3 locomotive to be left with no one in charge.

A-593. Remove reverse lever, open controller switch No. 93, shut down M. G. Set, remove pantograph controller handle and lay it on pantograph controller, turn compressor control snap switch above governor to off position, open control cut-out switch on auxiliary panel, open snap switch marked "lights" on auxiliary panel, open battery cut-out switch on auxiliary panel, see that tools and supplies are in place.

Q-594. Would you set hand brakes and block wheels if on a grade?

A-594. Yes.

Q-595. What is required before leaving the locomotive at end of trip or day's work?

A-595. Inspect and report condition of locomotive on the approved form, 602-EL-Rev.

Q-596. If an unusual condition exists on the locomotive, what are you required to do?

A-596. Report it and if being relieved by another crew to acquaint them with the condition.

Q-597. Should a condition exist wherein it would be dangerous to move the locomotive, what are you required to do?

A-597. Notify dispatcher of this condition.

Q-598. Where do you leave work reports when relieved by another crew?

A-598. On the locomotive in proper receptacle.

Q-599. When arriving at terminal where repairs are made how must work reports be handled?

A-599. All work reports that have been left on locomotive must be turned in at Roundhouse by the incoming engineer, together with a report made out by himself.

Q-600. What is the correct voltage for the axle generators?

A-600. Between 85 and 90 volts.

Q-601. If the axle generator voltage goes above 90 volts, what should be done?

A-601. If trouble cannot be located No. 61 switch should be opened.

Q-602. What should be checked frequently on the axle generators?

A-602. Their comparative load current and voltage.

Q-603. What is important when taking these readings?

A-603. Make sure that traction motor blowers and compressor are running off of axle generators.

Q-604. What should be done if the readings show a difference of 100 amperes?

A-604. It must be reported.

Q-605. If it was found that one axle generator was not delivering any current, what should be done?

A-605. Open No. 61 switch and report trouble.

Q-606. If an M. G. Set failure occurs and the axle generators have been cut out, or have to be cut out on account of one being defective, what repairs can be made to use the one good axle generator for running the air compressor only?

A-606. When checking the axle generator ammeters if it is found that No. 2 axle generator is carrying all of the load, remove the 400 ampere fuse in No. 1 axle generator armature circuit and proceed with No. 2 axle generator working.

If the 400 ampere fuse in circuit to No. 2 axle generator armature should blow when operating in this manner, the fields must be cut out of the circuit to No. 1 axle generator by changing the connections in the 2B panel as follows:

Remove the strap from stud F1 and connect it to stud A; remove the strap from stud F1 and connect it to stud A. (Leave the wires on their respective studs; the straps only are to be shifted.)

The 400 ampere fuse must be removed from the axle generator armature circuit in all cases when cutting out the fields of the respective axle generator. The work of cutting out axle generator fields as above described can be done while locomotive is moving provided all blades of switch No. 61 are open.

Do not neglect to close switch No. 61 after repairs have been made.

2nd. When checking the axle generator ammeters and if it is found that there is no load on either axle generator when the compressor is running, it indicates that No. 42 switch is not thrown to motoring and coasting position. Therefore, check the axle generator voltage and if found correct, see that No. 75 relay has picked up. If it is up, press middle disc contacts together firmly and rotate it on the threaded studs to insure good contact, then check ammeters again to see that No. 42 switch has thrown.

3rd. When checking axle generator voltage if there is no indication, test the 65 ampere fuses in the axle generator field circuit. If field fuses are found to be blown, replace them and also check the 400 ampere fuse in the armature circuit of No. 2 axle generator. If any are blown, open all blades of switch No. 61 before replacing them. If still no voltage is indicated see if No. 2 axle generator 400 ampere fuse has blown again and if it has, stop and examine No. 1 axle generator 400 ampere fuse. Remove it if not blown and replace No. 2 axle generator fuse, close No. 61 switch and proceed. If the 400 ampere fuse to No. 1 axle generator was found to be blown, replace it and leave the fuse out of No. 2 and cut out fields of No. 2 axle generator as follows:

Remove strap from stud F2+ and connect it to stud D.

Remove strap from stud F2+ and connect it to stud D.

With this condition leave switch No. 61 open when locomotive is standing, block No. 75 relay up and be sure that the middle and top discs make good contact. Proceed with train and when locomotive has reached a speed of 5 to 10 miles per hour close switch No. 61. When stopping, open switch No. 61. This will allow switch No. 42 to throw back to standing position which will connect compressor motor to locomotive batteries. The operation of the air compressor may be controlled by the snap switch above governor to conserve battery current.

The above information is given for the purpose of handling a passenger train in case an M. G. Set failure occurs enroute and it is evident that the locomotive cannot handle train to destination on battery cur-

rent alone. Do not attempt to regenerate, and if the above repairs are not successful in getting axle generators to work, advise dispatcher to furnish another locomotive before the batteries become completely discharged.

Q-607. Where should the combination lever be placed when starting a train with a locomotive on which one or more traction motors are cut out?

A-607. 3rd combination.

Q-608. How should the controller be handled under the above conditions?

A-608. Very carefully after reaching the 7th notch because the current increase will be 100 amperes per notch.

Q-609. To what value under the above conditions should the current drop before advancing the controller another notch?

A-609. Between 300 and 350 amperes.

Q-610. What should be done when the trolley wire is frosty, dirty or covered with ice, as evidenced by severe arcing?

A-610. Use both pantographs.

Q-611. Should these locomotives be turned on a wye?

A-611. Not without an order to do so from the dispatcher.

Q-612. Explain how a messenger should prepare a locomotive to be towed in train.

A-612. Place double cut-out cock on operating end in No. 3 position and on non-operating end in No. 2 position. Place both brake valves in running position and open cut-out cock in dead engine feature located under engineer's side of cab No. 1 outside. Have traction motor reverser set for general direction the locomotive is to move. Open all traction motor cut-out switches and interlock barriers 99. Open control cut-out switch. Remove the handles from both pantograph controllers. Remove reverse lever, keep boiler fired up in cold weather and all steam heat equipment warm. In warm weather when boiler need not be fired up the battery cut-out switch may be opened.

Q-613. Must messenger be on the locomotive at all times when moving?

A-613. Yes.

Q-614. What must be done to conserve battery current on a dead locomotive?

A-614. Lamps must be used in moderation.

Q-615. If batteries discharge to 150 ampere-hours what should the messenger do?

A-615. Raise pantograph, start M. G. Set and charge battery.

Q-616. How long may the locomotive be run on the 14th notch in any combination?

A-616. Indefinitely, if within rated traction motor current limits.

Q-617. Why may it not be run in any notch from 1st to 13th for long periods of time?

A-617. Because resistance in the circuit is not all cut out until the 14th notch is reached.

Q-618. Why is it important to watch the ammeter indications, while operating, at all times?

A-618. To observe that all apparatus is functioning properly and that resistance is cutting in or out at the proper time and that current ratings on traction motors are not being exceeded.

Q-619. What are the duties of a fireman on EP-3 locomotives?

A-619. Read the K. W. H. meter, watch operation of locomotive, patrol frequently and watch for hot bearings and such other duties that he may have to perform to assist the engineer, or that may be assigned to him. When possible to do so, the motor should be patrolled not less frequently than once each 10 minutes for the purpose of keeping a check of heating boiler equipment, lighting panel epuipment, axle generator load, voltage and balance; and locomotive battery conditions and any other conditions.

Q-620. What is the function of the 9th, 10th, and 11th fingers, aisle side, of the interlock on No. 41 switch?

A-620. They are to prevent the shunt switches from closing during regeneration.

Q-621. What is the function of the interlock on No. 2 contactor?

A-621. To prevent No. 34 and No. 35 switches from returning from P to S position unless line contactors are open.

Q-622. What is the function of the interlock on No. 11 contactor?

A-622. It is to prevent No. 34 switch from moving from S to P position before main resistance has been inserted by moving the main controller lever back to the first notch.

Q-623. What is the function of the interlock on No. 14 contactor?

A-623. It is to prevent No. 34 and 35 switches from moving from the S to P position before most of the main resistance has been inserted by moving the main controller lever back to the 1st or 4th notch with contactors 11 or 15 not dropping out.

Q-624. What is the function of the interlock on No. 15 contactor?

A-624. It is to prevent No. 35 switch from moving from the S to P position before main resistance has been inserted by moving the main controller lever back to the 4th notch.

Q-625. What is the function of the 1st and 2nd fingers of the interlock on No. 1 contactor?

A-625. It is for the purpose of obtaining open circuit transition during regeneration and a shunt circuit transition in motoring when changing over from No. 1 to No. 2 or No. 2 to No.3 motor combination.

Q-626. What is the function of the 8th and 9th fingers, aisle side, of the interlock on No. 41 switch?

A-626. To operate in conjunction with 1st and 2nd finger on No. 1 contactor to obtain an open circuit transition during regeneration and a shunt circuit transition in motoring when changing over to the 2nd or 3rd motor combinations.

Q-627. What is the function of the 8th and 9th fingers, aisle side, of the interlock on No. 34 switch?

A-627. They are to prevent No. 35 switch from throwing over to P position until No. 34 is in the P position.

Q-628. What is the function of the interlock on No. 29, 31 and 32 contactors?

A-628. The interlock on No. 29 and 32 contactors is to insure the main contacts on No. 35 switch not opening until contactors 29 and 32 are open, and that the main contacts on No. 35 will not close before No. 29 and 32 are closed. The interlock on No. 31 is to insure that the main contacts on No. 34 switch will not open until contactor 31 is open and that the main contacts on No. 34 will not close unless contactor No. 31 closes.

Q-629. What is the function of the 1st and 2nd fingers, aisle side, of the interlock on No. 34 switch?

A-629. They are to complete the control circuit of the magnet valve for P side of No. 34 switch until No. 31 contactor is opened.

Q-630. What is the function of the 1st and 2nd fingers, aisle side, of the interlock on No. 35 switch?

A-630. They are to complete the control circuit

of the magnet valve for P side of No. 35 switch until No. 29 contactor and No. 32 contactor are opened and to again complete the circuit when the switch is near the P position and No. 32 contactor closes.

Q-631. What is the function of the 4th, 5th and 6th fingers, center side, of the interlock on No. 36 switch?

A-631. They are to prevent the line contactors from closing until the reverser is fully thrown in either the Forward or Reverse position, corresponding to the position of the reverser drum No. 90B.

Q-632. What is the function of the 7th and 8th fingers, center side, of the interlock on No. 35 switch?

A-632. They are to prevent the closing of the line contactors unless No. 35 is fully closed in one of the operating positions.

Q-633. What is the function of the 1st, 2nd and 3rd fingers, center side, of the interlock on No. 34 switch.

A-633. The first and third fingers are to prevent the closing of the line contactors unless No. 34 is fully closed in one of the operating positions.

The 2nd finger, when No. 34 is in the P position completes the circuit from 8C wire to the 8F wire so that the line contactors can be closed on the first notch in the 2nd or 3rd combinations.

Q-634. What is the function of the interlock on No. 3 contactor?

A-634. It is for the purpose of establishing a holding circuit for the line contactors so that they will not be opened during transitions by interlocks on Nos. 34 and 35 switches.

Q-635. What is the function of the 1st, 2nd and 3rd fingers, center side, of the interlock on No. 36 switch?

A-635. They are to prevent No. 76 contactor from closing until the field contacts have been made on the reverser.

Q-636. What is the function of the 5th and 6th fingers of the interlock on No. 4 contactor?

A-636. They are to insure that No. 77 contactor will not close before the line contactors are closed during regeneration.

Q-637. What is the function of the 6th and 8th fingers, top row, on No. 47 tripping drum?

A-637. They are to weaken the axle generator fields whenever the overload or overvoltage relays operate during regeneration by opening No. 77 contactor.

Q-638. What is the function of the 7th and 9th fingers, aisle side, of the interlock on No. 41 switch?

A-638. They are to prevent the axle generator fields from being weakened when overload relays operate during motoring.

Q-639. What is the function of the four fingers, aisle side, of the interlock on No. 36 switch.

A-639. They are for the purpose of reversing the axle generator shunt fields at the same time the traction fields are reversed.

Q-640. What is the function of the 4th and 5th fingers, center side, of the interlock on No. 41 switch?

A-640. They are to prevent the Nos. 39 and 40 switches from operating on the motoring connections.

Q-641. What is the function of the 6th, 7th and 8th fingers, aisle side, of the interlock on No. 35 switch?

A-641. Fingers 6 and 7 are to prevent No. 39 switch from closing unless No. 35 switch is in the S position. Fingers 7 and 8 are to prevent No. 40 switch from closing unless No. 35 is in the P position.

Q-642. What is the function of the 3rd and 4th fingers of the interlock on No. 4 contactor?

A-642. They are to insure that the regenerative interlock valves No. 88 will not operate unless the line contactors are closed.

Q-643. What is the function of the 3rd ,4th and 5th fingers, aisle side, of the interlock on No. 35 switch?

A-643. They are for the purpose of opening contactors 29, 30 and 32 after contacts G, H, I and J are closed and before the contacts A to F, inclusive, on No. 35 switch are open.

Q-644. What is the function of the 3rd, 4th and 5th fingers, aisle side, of the interlock on No. 34 switch?

A-644. No. 3 and 4 fingers are for the purpose of opening contactors No. 32 and 33 after F and G contacts of No. 34 switch are closed and before the C, D and E contacts are open. They are so arranged that when No. 34 reaches P position they are again closed which closes contactor Nos. 32 and 33, but not before contacts H and I are closed. 5th finger is for the purpose of opening contactor 31 before C, D and E contacts open.

Q-645. What are the functions of the 1st, 3rd and 4th fingers, center side, of the interlock on No. 41 switch?

A-645. They are to prevent the motor contactors 28 to 33 from closing until No. 41 switch is fully closed in either motoring or regeneration position, corresponding to the position of the regeneration drum No. 90D.

Q-646. What is the function of the 4th, 5th 6th 7th and 8th fingers, bottom row, on No. 47 tripping drum?

A-646. They establish the reset circuit for the overload and overvoltage relays. No. 7 and 8 fingers after No. 47 is reset, establish the holding circuit of No. 47 tripping drum.

Q-647. What is the function of the 28th and 29th fingers of the 90A controller drum?

A-647. To insure that the overload and overvoltage relays and No. 47 tripping drum will not reset unless the main controller lever is in the OFF notch.

Q-648. What is the function of the 1st and 2nd fingers of the interlock on No. 26 contactor?

A-648. They are for the purpose of closing rheostat contactors 23, 24 and 25 on the first notch regenerating, in the 2nd or 3rd combination.

Q-649. What is the function of the 3rd and 4th fingers of the interlock on No. 26 contactor?

A-649. They are to prevent contactors 5 to 10, 26 and 27 from closing on the first notch in the 2nd or 3rd combination, but after once closed establishes a holding circuit for these contactors so that they will not be opened during motoring transition.

Q-650. What is the function of the 3rd and 4th fingers of the interlock on No. 1 contactor?

A-650. They are to prevent contactors Nos. 5 to 10, 26 and 27 from closing before contactors 1 to 4 close.

Q-651. What is the function of the 4th and 6th fingers, center side, of the interlock on No. 41 switch?

A-651. They are to cut out the action of No. 45 relay during motoring.

Q-652. What is the function of the 1st and 2nd fingers of the interlock on No. 4 contactor?

A-652. They are to insure that No. 45 relay will not be operative unless the line contactors are closed.

Q-653. What is the function of the 1st and 2nd fingers of the interlock on No. 22 contactor?

A-653. They are for the purpose of cutting out the action of No. 45 relay on the 13th notch of the main controller lever in regeneration position.

Q-654. What is the function of the 9th and 10th fingers, top row, of the interlock on No. 47 tripping drum?

A-654. They are to prevent relay 45 from energizing the S1 or W1 wires while No. 78 motor operated rheostat is being returned to weak field position whenever the overload or overvoltage relays operate during regeneration.

Q-655. What is the function of the 4th, 5th and 6th fingers of the interlock on No. 22 contactor?

A-655. They prevent the operation of the notching relays until the main resistance has been cut out of the main circuit and until No. 45 relay has been cut out.

Q-656. What is the function of the 1st, 2nd, 3rd and 4th fingers, aisle side, of the interlock on No. 41 switch?

A-656. They are to prevent operation of No. 78 motor operated rheostat from main controller drum during motoring.

Q-657. What is the function of the 1st and 2nd fingers, center side, of the interlock on No. 41 switch?

A-657. They are to cut out the action of No. 44 relay during regeneration.

Q-658. What is the function of the 10th and 11th fingers, center side, of the interlock on No. 41 switch?

A-658. They are for the purpose of de-energizing the operating coil of No. 75 relay during regeneration.

Q-659. What is the function of the 6th and 7th fingers, aisle side, of the interlock on No. 34 switch?

A-659. They are to insure that No. 34 switch after having started to move, will complete its movement independent of the interlock on No. 14 contactor, which interlock opens as soon as the controller is again moved forward.

Q-660. What is the function of the 5th and 6th fingers, center side, of the interlock on No. 35 switch?

A-660. They are to insure that No. 35 switch after having started to move, will complete its movement independently of the interlock on No. 15 contactor which interlock opens as soon as the controller is again notched out.

Q-661. What is the function of the 4th and 6th fingers, top row, on No. 47 tripping drum?

A-661. They are for the purpose of opening No. 73 relay when No. 47 trips out.

Q-662. What is the function of the 7th and 6th fingers, top row, on No. 47 tripping drum?

A-662. They are for the purpose of opening line contactors No. 1 to 4 whenever the overload or overvoltage relays operate.

Q-653. What is the function of the 1st, 2nd and 3rd fingers, of the interlock on No. 12 contactor?

A-663. The 1st and 2nd fingers are to insure prompt action of contactors 1 to 4 when the overload or overvoltage relays trip out in the first two notches of the controller.

The 2nd and 3rd fingers are to insure that the line contactors No. 1 to 4 will open in case the overload or overvoltage relays trip and No. 47 tripping drum fails to operate.

Q-664. What is the function of the 9th and 10th fingers, bottom row, on No. 47 tripping drum?

A-664. They start to return No. 78 motor operated rheostat to weak field position as soon as No. 47 is tripped.

Q-665. What is the function of the interlock on No. 20 contactor?

A-665. They insure that the load will not be thrown on the axle generators until a speed of about 12 miles per hour has been reached.

Q-666. What is the function of the interlocks on No. 50 contactor?

A-666. One interlock establishes a holding circuit for No. 49 contactor. One establishes a holding circuit for itself, and one, made in open position of the contactor, to trip the train lighting circuit breaker.

TRACING OF CIRCUITS, EP-3 LOCOMOTIVES

Trace and explain the following and any additional circuits from drawing number ED-1401:

Q-667. Trace the circuit from battery and return through the operating coil of No. 52 compressor motor contactor, give name of each apparatus through which the current passes.

Q-668. Trace the circuit from battery and return through the compressor motor give name of each apparatus through which the current passes.

Q-669. Trace the circuit from battery and return through the operating coils of the pantograph magnet valves with the pantograph valves in B position. Give name of each apparatus through which the current passes.

Q-670. Trace the circuit from battery and return through the operating coils of Nos. 51, 49 and 50 contactors when No. 48 M. G. starting switch is in the 1st, 2nd and 3rd positions. Give name of each apparatus through which the current passes.

Q-671. Trace the circuit from battery and return through the operating coils of Nos. 49 and 50 contactors after No. 48 M. G. starting switch has been brought into the 3rd position and then released. Give name of each apparatus through which the current passes.

Q-672. Trace the circuit from battery and return through the M. G. Set generator and shunt field when No. 51 contactor closes. Give name of each apparatus through which the current passes.

Q-673. Trace the circuit from battery and return through the M. G. Set generator and shunt field when No. 49 contactor closes. Give name of each apparatus through which the current passes.

Q-674. Trace the circuit from trolley to ground through the motor of the M. G. Set when No. 50 contactor closes. Give name of each apparatus through which the current passes.

Q-675. Trace the circuit which returns the arm of the No. 79 motor operated rheostat to the "All Out" position. Give name of each apparatus through which the current passes.

Q-676. Trace the circuit which turns the arm of No. 79 motor operated rheostat towards the "All In" position. Give name of each apparatus through which the current passes.

Q-677. Trace the circuit from battery and return through the shunt field of the motor of the M. G. Set. Give name of each apparatus through which the current passes.

Q-678. Trace the circuit from battery and return through the operating coil of No. 87 contactor. Give name of each apparatus through which the current passes.

Q-679. With No. 87-B switch closed, trace the circuit from the M. G. Set generator and return through the traction motor blowers. Give name of each apparatus through which the current passes.

Q-680. Trace all circuits from battery and return which are energized by the 17th finger of 90B when No. 90B is in either the Forward or Reverse position and No. 90A is in the OFF position. Give name of each apparatus through which the current passes.

Q-681. Trace all circuits which are energized by the 20th finger of 90B when 90B is in either the Forward or Reverse position and No. 90A is in the OFF position. Give name of each apparatus through which the current passes.

Q-682. Trace all circuits which are energized by the 15th finger of 90B when 90B is in either the Forward or Reverse position and No. 90A is in the OFF position. Give name of each apparatus through which the current passes.

Q-683. Trace all circuits which are energized by the 16th finger of 90B when No. 90B is in either the Forward or Reverse position and No. 90A is in the OFF position. Give name of each apparatus through which the current passes.

Q-684. Trace all circuits which are energized by the 22nd finger of 90B when No. 90B is in the Forward position and No. 90A is in OFF position. Give name of each apparatus through which the current passes.

Q-685. Trace all circuits which are energized by the 14th finger of 90B when No. 90B in in the Reverse position and No. 90A is in the OFF position. Give name of each apparatus through which the current passes.

Q-686. When Nos. 76 and 77 contactors are closed, trace the current from battery and return through the axle generator shunt fields when the No. 36 reverser is in the Forward position. When the No. 36 reverser is in the Reverse position. Give the name of each apparatus through which the current passes.

Q-687. With the No. 90B in the forward position, the No. 90C in the first position and the No. 90D in the motoring position, trace all circuits that are energized when No. 90A is in the first notch. Give name of each apparatus through which the current passes.

Q-688. With the No. 90B in the reverse position, the No. 90C in the first position and No. 90D in the motoring position, trace all circuits that are energized when No. 90A is in the first notch. Give name of each apparatus through which the current passes.

Q-689. Trace all circuits that are energized by No. 90A from the 2nd to 17th notch inclusive. Give name of each apparatus through which the current passes.

Q-690. Trace all new circuits energized after the No. 90C has been moved to the 2nd position and the No. 90A has been returned to the 1st notch. Give name of each apparatus through which the current passes. What wires are de-energized and what contactors drop out? How are contactors 1 to 4 held closed? How are contactors 5 to 10, 26 and 27 held closed?

Q-691. Trace all new circuits energized after the No. 90C has been moved to the 3rd position and the No. 90A has been returned to the 4th notch. Give name of each apparatus through which the current passes. Do contactors 1 to 10, 26 and 27 drop out? What wires are de-energized and contactors drop out? out?

Q-692. Trace all circuits energized with the controller drums in the position as follows: No. 90A in the OFF position, the No. 90B in either Forward or Reverse position, No. 90C in the 3rd position and No. 90D in the "regeneration" position. Give name of each apparatus through which the current passes. What circuits are de-energized?

Q-693. With the 90B, 90C and 90D as in above question, trace all the new circuits energized with the No. 90A in the first notch. Give name of each apparatus through which the current passes.

Q-694. With the 90B, 90C and 90D as in above question, trace all new circuits energized with the 90A in the 15th notch, 16th notch and the 17th notch. Give name of each apparatus through which the current passes.

Q-695. Trace all new circuits that are energized when the 90A is in the OFF position, the 90B in either the Forward or Reverse position, the 90D in the motoring position and the 90C is in the 2nd posi-

tion. Give name of each apparatus through which the current passes.

Q-696. Trace all new circuits that are energized when the 90A is in the OFF notch, the 90B in either Forward or Reverse position, the 90D in the motoring position, and the 90C is in the 3rd position. Give name of each apparatus through which the current passes. What circuit is de-energized?

Q-697. Trace the circuit from trolley to ground through the traction motor circuit with the 90B in the Forward position, the 90C in the 1st position, the 90D in the motoring position and 90A in the 1st notch. Give name of each apparatus through which the current passes.

Q-698. Trace the circuit from trolley to ground through the traction motor circuits with the 90B, 90C and 90D as in above question and with 90A in the 2nd to the 17th notches inclusive.

Q-699. Trace the circuit from trolley to ground through the traction motor circuits with 90B in the Forward position, the 90D in the 2nd position and 90A in the first notch. Give name of each apparatus through which the current passes.

Q-700. Trace the circuit from trolley to ground through the traction motor circuits with 90B, 90C, 90D as in above question and with the 90A in the 2nd to the 17th notches inclusive.

Q-701. Trace the circuit from trolley to ground through the traction motor circuits with 90B in Forward position, 90D in motoring position, 90C in the 3rd combination and 90A in the 4th notch. Give name of each apparatus through which the current passes.

Q-702. Trace the circuit from trolley to ground through the traction motor circuits with 90B in Reverse position, 90A in the first notch, 90C in the 1st position and 90D in the motoring position. Give name of each apparatus through which the current passes.

Q-703. Trace the circuit from positive side of the axle generators to negative side of the axle generators through the compressor motor and through the traction motor blower motors. Give name of each apparatus through which the current passes.

Q-704. Trace the circuit from the positive side to the negative side of the axle generators through the traction motor fields when operating in the 1st and 2nd combination regenerating. Give name of each apparatus through which the current passes.

Q-705. Trace the circuit from the positive side to the negative side of the axle generators through the traction motor fields when operating in the 3rd combination regenerating. Give name of each apparatus through which the current passes.

Q-706. Trace the circuit from trolley to ground through the motor of the M. G. Set. Give name of each apparatus through which the current passes.

FAILURES AND REPAIRS

In answering questions on failures and repairs, it will be optional with the examiner to require the answers to be made by actual explanation of the necessary details on a locomotive.

Q-707. With the compressor control snap switches "ON" what different causes will prevent the air compressor from starting? (Locomotive standing still.)

A-707. Battery cut-out switch open, control cut-out switch open, the air compressor governor may be stuck or not making contact, or air pressure may be above that for which the governor is set to close, compressor cut-out switch open, battery fuses blown, compressor fuses blown, No. 52 contactor not closing properly contacts B and D on No. 42 switch not closing properly OR SOME FOREIGN SUBSTANCE WHICH WOULD PREVENT GOOD CONTACT.

Q-708. What is the trouble if the air compressor fails to start after the locomotive has come to a full stop or after starting regenerating? How would you correct it?

A-708. No. 42 switch fails to throw to the standing or regenerating position. If the switch does not throw properly it can be moved into correct position with a wrench.

Q-709. If, when checking the axle generator ammeters while the compressor is running and neither one shows any load, what defects may cause this and how can it be corrected?

A-709. No. 42 switch not thrown to the motoring or coasting position. No. 75 relay not picking up. Poor contact on the 10th and 11th fingers, center side of interlock on No. 41 switch, middle disc no No. 75 relay not making contact, No. 61 switch open or not making good contact. If poor contacts are found they should be cleaned or repaired.

Q-710. What is the trouble if the air compressor runs too fast or too slow while operating off of the axle generator? How would you correct this trouble?

A-710. The axle generator voltage may be too high or too low, due to relays No. 44 or 46, or motor operated rheostat No. 78 not operating properly. Check axle generator voltage and if found too high or too low, see if the top disc on No. 75 relay is making contact, also see if the travel limit switches on motor operated rheostat No. 78 are clean and the commutator and brushes on motor operated rheostat No. 78 motor are clean. If this does not clear the trouble No. 61 switch should be opened.

Q-711. What is the trouble if No. 42 switch see-saws when the compressor load is thrown on the axle generators and the traction motors blowers are not running? How would you correct this trouble?

A-711. The No. 1 axle generator armature fuse may be blown or there may be an open circuit to the armature of the generator. In this case No. 61 switch should be opened.

Q-712. What is the trouble if No. 75 relay does not pick up and there is no voltmeter reading on the axle generator when the locomotive is in motion motoring?

A-712. No. 2 axle generator armature fuse may be blown or there is an open circuit to the armature of No. 2 axle generator. No. 61 switch should be opened.

Q-713. How can you determine when the batteries are being overcharged? How would you correct it if unable to reduce the generator voltage?

A-713. By a strong acid odor. Correction could be made by pulling out No. 61 switch.

Q-714. What is the trouble if, when the M. G. Set is running, the battery will not start the air compressor or the M. G. Set and when attempting to start the air compressor or the M. G. Set the cab lights become very dim and the pantographs drop, and what would you do to correct the trouble?

A-714. The batteries have a partial open circuit in the cells or are discharged so low that they will not supply enough current for the compressor or to start the M. G. Set. To correct the trouble it may be necessary to start the M. G. Set directly off the line.

Q-715. Describe the necessary work to start the M. G. Set directly off the line.

A-715. Have battery cut-out and control cut-out switches open, clamp the contacts of No. 49 and No. 50 contactors closed with the clamps provided, close the battery cut-out and control cut-out switches, turn the compressor control snap switch to "ON" position and have the pantograph controller in the proper position. If there is no air on locomotive, raise the pantograph and hold against the wire by means of the long pole that is on the locomotive until sufficient air has been pumped up to hold the pantograph against the wire.

Q-716. If the auxiliary fuses blow when attempting the operation described in the preceeding answer, how could the operation be handled to prevent blowing the auxiliary fuses?

A-716. By having the Dispatcher reduce the trolley voltage to about 1500 volts. After the M. G. Set has started the Dispatcher can again be notified to raise the voltage to the proper value.

Q-717. Name the various causes for the boiler blower motor not running.

A-717. Battery cut-out switch open, boiler blower switch open or not making contact, boiler blower fuses blown, open circuit in rheostat, open circuit in auxiliary resistor, brushes on the commutator dirty or stuck, boiler blower motor bearings stuck, open circuit in wiring to motor, screen on intake fan stopped up with grease, waste or other foreign material.

Q-718. How would you handle a contactor in the traction motor circuit which was grounded or badly burned?

A-718. By disconnecting it from the circuit and providing a circuit around the damaged contactor. Examiner may require practical demonstration on the locomotive.

Q-719. How many of the line contactors can you jump out at one time?

A-719. Not more than two.

Q-720. Name the causes if there is no indication on the ammeters when the main controller is brought to first notch, motor running, with the control cut-out switch closed, all motors cut in and motor combination lever in first combination and the M. G. Set has stopped running or runs at slow speed?

A-720. Control fuses are blown or the power has gone off the line, which would be indicated by the voltmeter.

Q-721. What is the trouble if the motor generator set is running and the pilot light in the circuit with contacts of No. 56 relay is not burning when controller is brought to the first notch, first combination, with all motors cut in and there is no ammeter reading and there is no flash on No. 1 to 4 contactors when the controller is shut off? How would you correct the trouble?

A-721. No. 36 reverser may not be thrown to the position corresponding to that of the reverse lever and the motor combination switch No. 34 may not be in series position; regenerative change-over switch No. 41 may not be thrown to motoring position; line contactors Nos. 1 to 4 may not be closing. See that the magnet valves are operating properly by throwing them by hand and that the control circuits to the magnet valves are in good condition.

Q-722. Give the method to check the discs of relays Nos. 57 and 60's.

A-722. Take the reverse lever to No. 1 end and put it in a position to correspond with the traction motor reverser, then with the main control drum in the "OFF" position see if the No. 47 tripping drum is in the re-set position. If so, then move the main controller lever to the first notch and if No. 47 relay trips out it will indicate that some of the discs on relays 57, 60, 60A, 60B and 60C are not making contact or one or more of the relays have not reset; also if you attempt to back the locomotive and you find that No. 36 reverser will not throw to the reverse position, it is an indication that the relays are causing the trouble. To insure that the discs on the 57 and 60's relays are making good contact press firmly down on the disc and rotate it on the threaded studs.

Q-723. Name the various causes, if with the M. G. Set running and the pilot light burning when the main controller lever is brought to the first notch, first combination and there is no ammeter reading and there is no flash at contactors Nos. 1 to 4 when the controller is shut off, and what would you do to correct it?

A-723. No. 73 relay may not be closing. If unable to locate the cause this relay may be tied in. Contactors No. 28 to 33, one or more, not closing; or open circuit in the traction motor circuit between No. 25 contactor and ground. See that the magnet valves are in operating condition by trying them by hand and see that the control circuits to the magnet valves are in good condition.

Q-724. What is the trouble, if when making the transfer from the No. 1 to No. 2 motor combination, the locomotive goes dead? What would you do to correct it?

A-724. The 3rd and 4th fingers of interlock on No. 3 contactor not making contact. Clean the fingers of the interlock.

Q-725. What is the trouble if the ammeters do not indicate a normal increase in current as the controller is notched out in the first combination with all motors cut in? What would you do to correct?

A-725. No. 53 relay may not be closing or the contact finger of No. 53 relay may be dirty and not making good contact. If unable to locate the cause this relay may be tied in.

Q-726. What is the trouble if the ammeter indication does not increase when the main controller lever is moved from one notch to the next and one

bank of motor resistance is found to be unusually hot? What would you do to correct?

A-726. The contactor that short circuits the hot resistor on that notch is not closing and should either be repaired or its contacts temporarily short circuited for the remainder of the trip.

Q-727. What is the trouble if the line ammeter on the lower panel indicates on the first notch of the first combination and what would you do to correct it?

A-727. No. 35 switch is stuck in parallel position. If unable to locate the trouble locomotive should be operated in 3rd combination.

Q-728. What is the trouble, if when making the transfer from 1st to 2nd motor combination and the controller lever is moved back to the first notch, the ammeters drop back to a very low value and the train slows up even when the controller is notched out several notches? What would you do to correct?

A-728. The motor combination switch No. 34 may not be thrown to parallel position due to its magnet valves not operating, or the control circuits to its magnet valves not in good condition. Contactors Nos. 26 and 27 may not have closed or contactors Nos. 5 to 10 may not have closed. These contactors may not have closed due to the magnet valves not operating, or the control circuit to their magnet valves not in good condition.

Q-729. What is the trouble, if when making the transfer from No. 1 to No. 2 motor combination, the controller lever is moved back to the first notch and both upper ammeters drop back to and remain at zero, and the lower field ammeter indicates a normal transfer? What would you do to correct?

A-729. No. 32 and 33 contactors have failed to close due to the 3rd and 4th finger, aisle side, of the interlock on No. 34 switch not making contact.

Q-730. What is the trouble, if when making the transfer from the 2nd to the 3rd motor combination, and the main controller lever is moved back to the 4th notch, upper ammeters drop back to zero and lower ammeters indicate normal load? What would you do to correct?

A-730. No. 30 and 32 contactors fail to close due to the 3rd and 4th finger, aisle side, of the interlock on No. 35 switch not making contact. Clean interlock fingers and see that they make good contact.

Q-731. Name the various causes of trouble, if when making the transfer from the 2nd to the 3rd motor combination, the main controller lever is moved

back to the 4th notch and the ammeters drop back to a very low value and the train slows down even when the controller lever is notched out several notches? What would you do to correct?

A-731. Motor combination switch No. 35 may not have thrown to parallel position due to failure of the magnet valves or the control circuit to its magnet valves not in good condition. See that the magnet valves operate properly by trying them by hand and that the control circuits to the magnet valves are in good condition by inspecting and cleaning interlock fingers in the circuit. If unable to correct the trouble operate locomotive in 2nd combination.

Q-732. What is the trouble when the ammeters indicate normally on the 1st and 2nd notches of the main controller but drop to zero when going into the 3rd notch on any motor combination? What would you do to correct?

A-732. Line contactor Nos. 1 to 4 may be opening on the 3rd notch due to the 2nd and 3rd fingers of interlock on No. 12 contactor not making contact or the 6th and 7th fingers, top row, on No. 47 tripping drum not making contact. See that these fingers are making good contact.

Q-733. What is the trouble, when the ammeters do not indicate on the 1st and 2nd notches of the main controller in any motor combination but indicate on the 3rd notch? What would you do to correct?

A-733. Line contactors Nos. 1 to 4 may not close until the 3rd notch due to 1st and 2nd finger of the interlock on No. 12 contactor not making contact. Start the locomotive by using the 2nd or 3rd combination.

Q-734. What is the trouble if contactors or switches close out of proper order after locomotive is coupled to the train and train lighting circuits are connected up? How would you correct?

A-734. Ground or short circuit in the control circuit on locomotive, or ground in the train lighting circuit. Open the train lighting jumper. If this does not correct the trouble turn off cab light snap switch which is located on the M. G. Set panel. If this does not clear up the trouble pull out the No. 61 switch and the traction motor shunt blower motor switches which are located in the 1B and 2B panels. If the above does not clear up the trouble the enginemen are expected to make an effort to locate the trouble by looking for smoke from burning insulation on the control apparatus and take necessary steps to clear the trouble.

Q-735. If there is no indication on one field ammeter and line ammeter indicates when main controller lever is brought to the 1st notch regenerating, how would you handle the locomotive?

A-735. Regeneration must not be attempted.

Q-736. If there is no line ammeter indication but field ammeters indicate after locomotive starts with main controller lever in the 1st notch regenerating, 1st motor combination, all motors cut in, how would you handle the locomotive?

A-736. Do not attempt regeneration.

Q-737. What is the trouble if the line ammeter continues to indicate motoring current with constant low field current as the controller lever is notched out while regenerating in any motor combination and how would you handle the locomotive?

A-737. The arm of the motor operated rheostat No. 78 remains in the weak field position. Do not attempt to regenerate.

Q-738. What is the trouble if the field ammeters indicate very high or go off the scale when the main controller lever is brought to the first notch, regenerating in any motor combination, and how would you handle the locomotive?

A-738. Relay No. 45 is inoperative. Do not attempt regeneration.

Q-739. If, after the 16th notch, regenerating in any motor combination and the proper operation of the main controller lever fails to increase or decrease the field ammeter indication, how would you operate the locomotive?

A-739. Do not attempt regeneration.

Q-740. What would cause the regenerative interlock magnet valves No. 88 to fail to operate and what precaution must be taken in case of such failures?

A-740. The 3rd and 4th fingers of the interlock on No. 4 contactor not making contact. Contacts on No. 89 valve not making contact. Watch carefully and do not permit brake cylinder pressure to be built up while regenerating.

Q-741. If locomotive goes dead, with controller on motoring in any combination, and when shutting off controller and again notching out in first combination, there is no indication on any ammeters and volt meters show that there is power on the line, what tests would you make to locate the trouble?

A-741. If pilot light burns, the trouble will be an open circuit between contactor 25 and ground, due

to relay No. 73 not closing or any one of contactors No. 28 to 33 not closing or an open circuit in any one of the traction motors. Try the third combination and if normal ammeter readings are obtained, proceed. If no ammeter reading is obtained leave controller on first notch and have fireman see if No. 73 relay is closed. If found not closed, close it by hand and tie it closed. If No. 73 relay is found to be closed see that it is making good contact.

If pilot light does not burn it may be due to an open circuit or ground in traction motor circuit between main switch and ground. To determine whether an open circuit or ground, bring controller to the third notch, then shut off and note if there is an arc at line contactors. If there is an arc it indicates a ground which may be tested for by alternately cutting out traction motors and testing the locomotive in third combination each time until all traction motors have been tested. If there is no arc at line contactors when shutting off controller it indicates an open circuit between the main switch and contactor No. 25. See that line contactors Nos. 1 to 4 are closing. If contactors No. 1 to 4 are not closing see that the No. 47 tripping drum is in reset position. If No. 47 tripping drum is not in reset position then check the discs on No. 57 and No. 60's relays. (Note: If the locomotive goes dead motoring the above tests should be made.)

Q-742. Describe the proper method to employ to locate an open circuit in the traction motor resistors.

A-742. Raise pantograph; open all motor cut-out switches; notch out main controller lever notch by notch until the notch is reached where pilot light burns. When pilot light burns on a certain notch find which contactor closes on this notch and block it closed but if contactor has an interlock attached to it connect a jumper from top terminal to bottom terminal of contactor.

Q-743. After shutting off the controller from regeneration, and when notching out controller in motoring, if there is no ammeter indication, what is the trouble and how should it be corrected?

A-743. No. 41 regenerating change-over switch has not thrown back to the motoring position or the 3rd and 4th fingers on center side of No. 41 interlock not making contact. Test out both magnet valves to see that they apply and release the air properly. See that the contacts on 3rd and 4th fingers of No. 41 interlock are clean and making good contact. Switch may be thrown with a wrench.

Q-744. After shutting off controller after regen-

eration, and notching out motoring, if it is found that the line ammeters show a very high reading and the field ammeters show little, if any, reading, what is the trouble and how should it be corrected?

A-744. Stabilizing resistance switches No. 39 or No. 40 have not thrown back to the "OFF" position. Test the magnet valves by hand to see that they apply and release air properly. If the switch does not throw back to the "OFF" position it may be thrown with a wrench.

Q-745. What precaution must be taken before attempting to throw any air operated switches with a wrench?

A-745. Lower pantograph and close the cut-out cock to the control pressure air reservoir and drain all control air pressure off. This will allow the switch to be thrown freely and avoid danger of sudden movement of switch that might cause injury. When switch has been properly thrown the air must again be cut into control reservoir.

Q-746. Name the various causes for M. G. Set not starting when the M. G. starting switch No. 48 is moved to the first position?

A-746. Battery cut-out switch open.

Battery fuses blown.

M. G. stop button No. 86 not making contact.

Fingers on pantograph controllers No. 92 may not be making contact or the controllers may not be in proper position.

Control cut-out switch open.

Control fuses blown.

Fingers on No. 48 starting switch not making contact.

Battery discharged too low.

No. 79 rheostat in "All in" position or the contacts on the arm not making contacts.

Operating coil of No. 51 contactor may be open circuited.

Q-747. Name the causes for the M. G. Set not starting when No. 48 starting switch is moved to second position.

A-747. In addition to the above causes the operating coil of No. 49 contactor may be open circuited. Can be remedied by opening battery cut-out switch then clamping No. 49 contactor closed with clamps provided for that purpose after which battery cut-out switch may be closed. In closing down M. G. set, first open battery cut-out switch quickly and remove clamps.

Q-748. What is the trouble if the battery fuses blow when starting the M. G. set and No. 48 switch is moved to second position? How would you correct the trouble?

A-748. Contact on arm of No. 79 motor operated rheostat not making contact.

No. 79 motor operated rheostat in "all in" position due to 15 ampere rheostat fuses blown. Left hand travel limit switch on No. 79 motor operated rheostat not making contact.

Brushes on No. 79 motor operated rheostat motor not making contact.

Contacts on Nos. 72 and 81 relays not making contact. Remove the two 15 ampere fuses and turn arm of No. 79 motor operated rheostat to "all out" position. After M. G. set has started, regulate voltage by moving rheostat arm by hand.

Air compressor running, No. 48 switch notched out too fast.

Shut down air compressor while starting M. G. set. Poor contacts should be repaired if causing any trouble.

Q-749. What is the trouble if the M. G. set starts up but stops after No. 48 switch is released? How would you correct the trouble?

A-749. Fingers on bottom interlock No. 50 contactor dirty or making poor contact. Inspect the interlock contacts and clean them if necessary. (Caution: Before inspecting this interlock, open the control cut-out and battery cut-out switches. This to avoid a possibility of M. G. set starting up when the No. 50 interlocks are closed.)

Q-750. What is the trouble if M. G. set starts up but does not increase in speed when No. 48 switch is moved to the third position and continues to run after the switch is released? How would you correct the trouble?

A-750. Power off line.

Pantographs down.

Pantograph disconnecting switches open.

Auxiliary fuses blown.

Open circuit in auxiliary circuit resistor, which may be repaired.

Correction: See that pantograph disconnecting switch is closed, that pantograph is up and that auxiliary fuses are replaced.

Q-751. What is the trouble if the M. G. set runs at normal speed but the voltage cannot be properly regulated? How would you correct the trouble?

A-751. Trouble is due to voltage regulating relays not operating. For correction pull out the two 15

ampere No. 79 motor operated rheostat fuses and adjust the No. 79 motor operated rheostat by hand to maintain a voltage of approximately 85 volts. This adjustment should be watched closely on account of trolley voltage variations.

Q-752. What might cause the motor of the M. G. set to flash over and blow the auxiliary fuses?

A-752. Traction motors flashed over. M. G. set commutators dirty. M. G. brushes stuck in holders or too short. M. G. motor grounded.

Q-753. How may the locomotive be operated over the division if the motor generator set fails? (Give details.)

A-753. Do not regenerate. See that the axle generators are in operating condition. Do not change the adjustment of compressor governor or train line feed valve, and handle the air brakes the same as if operating in normal condition. Remove the 15 ampere fuse in 1A panel. Open the shunt blower motor switches. Disconnect one lead at terminal on M. G. field rheostat. If at night, apply auxiliary headlight. The above are done for the purpose of saving the battery current as much as possible.

Q-754. If operating on mountain grade, how should you proceed when operating with defective motor generator set but with axle generators in operating condition?

A-754. Proceed to operate off of locomotive batteries if mountain grade can be passed before batteries have been discharged below 200 ampere-hours.

Q-755. If operating on mountain grade with defective motor generator set, what should be done if the axle generators are not in operating condition?

A-755. Stop immediately and apply all hand brakes on locomotive and cars. Advise dispatcher to send another locomotive. Shut off angle cock back of locomotive. Keep air pumped up on locomotive, independent brake applied and keep boiler going if weather conditions warrant. The only exception to this would be if less than five miles from the foot of the mountain grade and the batteries did not show more than 50 ampere-hour discharge.

Q-756. (a) On locomotives having "A" compartment changed, how are the auxiliary fuses reached?

(b) On locomotives with the original construction?

A-756. (a) By using pantograph control handle to unlock a small slide door on aisle side of left side of "A" compartment.

(b) By using pantograph control handle to open the door in passage-way leading to "A" compartment.

Q-757. Give causes for pantographs not raising.

A-757. No air to pantograph operating cylinders due to control cut-out switch open, control fuse blown, pantograph controllers not in proper position or fingers not in contact, operating coil of pantograph valve open circuited.

If unable to locate this trouble remove cover off of bottom of pantograph valve and block up piston in such a manner that the blocking can be removed easily in case it is desired to drop pantograph suddenly.

Q-758. If overload relays trip more than twice when operating in the 3rd combination, give a quick method for locating the defective circuit.

A-758. Before shutting off controller, open the controller switch, drop pantographs and inspect overload relays.

If No. 60 is found tripped, trouble may be in traction motor resistors or their contactors.

If No. 60A is found tripped, trouble may be in traction motor Nos. 2 and 3.

If No. 60B is found tripped, trouble may be in traction motors Nos. 4 and 5.

If No. 60C is found tripped, trouble may be in traction motors Nos. 1 or 6.

Q-759. When a grounded traction motor is cut out, what reverser contacts should be insulated for motors 1, 2 and 3, 4 and 5, 6? (Considering No. 1 end ahead.)

A-759. If motor No. 1, reverser forward, E-G. In reverse, F-H.

If motor No. 2 and 3, reverser forward, A-C. In reverse, B-D.

If motor No. 4 and 5, reverser forward, M-O. In reverse, N-P.

If motor No. 6, reverser forward, I-K. In reverse, J-L.

Q-760. With a grounded resistor box what work is it necessary to do and why?

A-760. The ground must be cleared and a circuit provided around the trouble. Examiner may require practical demonstration on locomotive.