The Pennsylvania Railroad

Machinery Examinations

Questions and Answers

FOR

Locomotive Firemen

1930
THE PENNSYLVANIA RAILROAD

NEW YORK ZONE
EASTERN REGION
CENTRAL REGION
WESTERN REGION

LONG ISLAND RAILROAD

Machinery Examinations
Questions and Answers

FOR
Locomotive Firemen

ISSUED ALTOONA, PA.
JULY 1, 1930

GENERAL NOTICE

The examinations contained herein and the answers pertaining thereto have been compiled with the view of establishing a uniform method of examination and rating for Locomotive Firemen.

Locomotive Firemen will be required to pass the examination and obtain not less than the minimum rating on the questions herein set forth.

W. Y. CHEERY,
General Superintendent Motive Power.
New York Zone.

R. G. BENNETT,
General Superintendent Motive Power.
Eastern Region.

H. W. JONES,
General Superintendent Motive Power.
Central Region.

T. W. DEMAREST,
General Superintendent Motive Power.
Western Region.

Approved:

J. F. PATTISON,
General Manager, New York Zone.

B. K. ROCHESTER,
General Manager, Eastern Region.

C. I. LEIPER,
General Manager, Central Region.

W. C. HIGGINBOTTOM,
General Manager, Western Region.
GENERAL DESCRIPTION

1. Fireman, when first employed, and those now in service, will be furnished a copy of the authorized Machinery Examinations. They must visit the Motive Power Instruction Room or Car where such facilities are provided and receive instructions, and where such facilities are not provided, they will receive their instructions from the Assistant Road Foreman of Engines or such other persons that may be assigned to do such duties. Firemen must continue to study the subjects outlined in the Examination Book to become well informed on mechanical appliances.

2. These examinations are on the progressive plan. The entire subject is divided into four parts; the first, the second, the third and the fourth, or promotion examination.

If fireman is to be promoted to engineman at the time he receives the third progressive examination, he will be required to take the fourth or promotion examination, otherwise, he will not be required to take the promotion examination until notified by the Road Foreman of Engines to prepare for promotion.

3. Fireman will receive the first progressive examination at the end of twelve (12) months extended to cover 365 days period of actual service. The second examination at the end of an additional twelve (12) months, extended to cover 365 days period of actual service, and the third examination after a succeeding period of twelve (12) months extended to cover 365 X days period of actual service. If furloughed, an extension of time will be given, extending to that extent the 365 days period. Ninety (90) days continuous service must be had preceding the several examinations.

4. This method of progressive examinations shall become effective three (3) months after date book is issued and each Fireman then in service will receive the progressive examination corresponding to his years of service. All Firemen who have been in the service over three years will take the third progressive exami-
nation. Firemen may, if they so desire, take their proper progressive examination in less than three (3) months above stipulated.

5. No further machinery examination will be required for promotion to the position of engineer unless promotion is deferred for one (1) calendar year after passing the third progressive examination, in which event Fireman will be required to pass a fourth machinery examination for promotion.

6. Engineers demoted to the position of Fireman and who have not have not been used as engineers for a period of two (2) years, will be required to pass the final or fourth machinery examination before permanently resuming duty as engineers.

7. The fourth examination is composed of fifty designated rating and six starred questions.

8. The required rating for the examinations will be as follows:

   First progressive examination...........80 per cent.
   Second progressive examination........80 per cent.
   Third progressive examination..........80 per cent.
   Fourth examination........................85 per cent.

9. Firemen failing to obtain the required rating will be promptly notified in writing, specifying by number, the questions in which they failed.

Firemen failing to pass the first examination for promotion to engineer will be allowed thirty days in which to prepare for a re-examination, and failing to pass the re-examination will be allowed an additional thirty days further to prepare themselves for a second re-examination. Firemen failing to obtain the required rating on the second re-examination of the several progressive examinations will not be permitted to resume duty until they pass. This opportunity is not to extend beyond nine (9) months and will be cancelled if the employee takes employment elsewhere. Reasonable transportation will be given the employe to visit the instruction room.
Failure to pass the promotion examination will be handled in accordance with promotion rule.

10. Examiner may require answers to other questions than those enumerated on the printed list in order to determine if the man thoroughly understands the entire subject on which he is being examined. The examiner is privileged to take the fireman to a locomotive and have him demonstrate that he fully understands the questions and answers. The fireman has the same privilege if he desires to avail himself of it.

11. When the introduction of new equipment requires it, engineers and firemen will be instructed on same and examined if considered necessary.

12. All examination will be oral and promotion examinations will be individual.

METHOD OF RATING

1. In order that an accurate record may be obtained showing the employees' general knowledge of the locomotive, suitable blanks have been printed, a facsimile of which is shown on pages Nos..................................

2. When the employee is being examined, the examiner will place an (X) mark on the number of all questions on which the employee fails, which will represent a total failure on that particular question, while a partial failure will be represented by one line drawn, crossing the square from diagonally opposite corners in which the number is enclosed.

3. Throughout the examinations, certain questions appear with a star in front of them, the star denoting that these questions are of such importance that they must be answered correctly; failure to pass one or more of them meaning an entire failure in the block of questions in which they appear. For rating purposes, marking questions, not including the starred questions, have been grouped on the rating sheets in blocks of ten (10). (Each of the ten (10) marking questions have a value of ten (10), for a full failure, and the
value of five (5) for a partial failure. In case of failure to answer a sufficient number of questions in any one of the blocks to obtain the required rating, a re-examination will be required of the entire block in which these questions appear.

4. After the examination has been completed, and the rating of each block of ten (10) questions is higher than required, the average rating will be obtained by adding the total ratings together and dividing by the number of blocks on which the employee is examined. The average rating, however, will not be considered as a passing mark, unless the specified minimum rating has been obtained on each of the several blocks.

5. Immediately after the employee is examined, the rating blank should be filled out and forwarded to the Road Foreman of Engines.

**EXAMINATION AFTER ONE YEAR’S SERVICE**

1. Q—What are the duties when reporting for service?
   
   A—Sign the register and examine the Bulletin Board for any new general orders, general notices or other instructions. Upon arrival at the locomotive the fireman should ascertain the amount of water in the boiler by looking at the glass water gauge and trying gauge cocks. He should try the blower, examine the firebox for leaks and give particular attention to the crown sheet and note the condition of the arch. He should examine the tools to see that the locomotive is supplied with a full set of serviceable equipment, should examine the lubricator to see that it is working properly, examine the ashpan and grates and if the locomotive is equipped with a stoker try it out. He should then prepare the fire for the trip.

2. Q—Where are the gauge cocks and glass water gauge located, and what are their functions?
A—On locomotives equipped with a water column the gauge cocks and glass water gauge are located on the water column. On locomotives not equipped with water column the gauge cocks and glass water gauge are located on the boiler head. The gauge cocks are for the purpose of ascertaining the water level in the boiler. The glass water gauge is an auxiliary to the gauge cocks, but must not be wholly depended upon.

*3. Q—What attention should be given the gauge cocks, and how do you know the difference between steam and water when operating the gauge cocks?
A—They must be kept open and used frequently. By looking and seeing what comes out of the drip pipes. Never trust to sound.

*4. Q—When should gauge cocks be tried?
A—Frequently when engine is working and immediately after shutting engine off.

*5. Q—What is the least amount of water that should be carried in the boiler?
A—The position of the engine should always be considered and a sufficient amount of water carried in the boiler to insure full protection to the crown sheet and flues.

6. Q—Name some causes for injector failing to prime.
A—No water in tank, tank valve partly or entirely closed, strainer stopped up, hose lining loose, hose kinked, leaks in feed pipe, tubes in injector out, limed up or out of line, leaking check valve, supply or inlet valve stuck open or overflow pipe obstructed.

7. Q—How would you prevent injectors, feed and branch pipes, steam heat pipes, etc., from freezing when not in use?
A—By closing overflow valve tight and permitting a small quantity of steam to blow back
through the tank hose; open drain cocks in branch pipe. Crack the valve at the steam heat hose and allow enough steam to pass through to keep the pipes warm.

8. Q—What is meant by steam pressure and how can you tell what steam pressure you have in the boiler?
   A—The pressure per square inch inside the boiler and is shown on the steam gauge.

9. Q—How do you know the maximum working pressure allowed on a locomotive boiler?
   A—By looking at the badge plate located on the boiler head.

10. Q—What is the purpose of safety valves on locomotive boilers? Why is more than one used?
    A—to relieve the boiler of excess pressure. In case one fails or does not relieve the boiler of excess pressure fast enough, the other will assist.

11. Q—Is it important to know that the safety valves lift at the required pressure?
    A—Yes.

12. Q—What parts of the locomotive boiler are surrounded by water? Why?
    A—the tubes or flues and the fire box. To generate steam and prevent sheets from overheating.

13. Q—Name the parts of the fire box.
    A—Two side sheets, a crown sheet, a flue sheet, and a back sheet, in which the fire box door is located, together with arch tubes and syphon if used.

14. Q—What is meant by the water legs of a boiler?
    A—The space between the fire box sheets below the crown sheet and the outside sheets of the boiler.
15. Q—What parts of the boiler are most sensitive to sudden change of temperature?
   A—The flue sheet and flues.

16. Q—What attention should be given the lubricator before leaving a terminal?
   A—Should know that it feeds properly.

17. Q—How long before starting on trip should lubricator feed valves be opened?
   A—After cylinders have been drained of condensation and a few minutes before engine is to be moved. They should be set to feed the proper amount fifteen minutes before departure of train.

18. Q—How should the lubricator, steam and condensing valves be operated?
   A—Wide open and opened in the order named.

19. Q—When it is desired to stop lubricator, how would you do so?
   A—By operating the oil control valve on lubricators so equipped. On others by closing feed valves.

20. Q—Explain the oil control valve.
   A—It is a plug valve placed in the oil passage of the lubricator and is used to shut off the feed without disturbing the adjustment. When in the all-open position, or pointing down, all feeds are open. When half-way between the all-open and closed position, only the feed to the air pumps is open. When in the closed position or pointing up, all feeds are closed.

21. Q—Should the feed of lubricator be increased when nearing the end of day or trip, and what valves should be closed at the end of trip?
   A—No. The feed should remain constant and only in such quantity as is necessary to properly lubricate the engine. All valves should be closed at the end of the trip in
the following order: Feed valves, Condensing Valve and Steam Valve.

22. Q—What kind of oil should be used in a cylinder lubricator?
   A—Nothing but valve oil.

23. Q—What is one of the greatest single items of expense of a Railroad Company?
   A—Fuel.

24. Q—Who, then, is in position to help save fuel?
   A—The engineman and fireman.

25. Q—How should engineers and firemen work, in order to obtain best results?
   A—They should work together under the supervision of the engineman so as to prevent smoke and save fuel.

26. Q—What is combustion? Is air necessary to combustion?
   A—Another name for burning. Yes.

27. Q—What is one of the chief causes of imperfect combustion?
   A—Not enough air being admitted to the fire.

28. Q—How is the draft created through a fire?
   A—The exhaust steam from the cylinder passes up through the stack, carrying the air and gases out, and creates a partial vacuum in the air tight smoke box. Atmospheric pressure then forces the air through the ashpan openings, grates, fire and flues, thus creating a draft through the fire. Draft is also created in the same manner by the use of the blower.

29. Q—Describe a blower; its use and abuse.
   A—The blower consists of a steam valve located in the cab and a steam pipe coupled to it, leading to the smoke box where it is attached to the blower nozzle, which points upward toward the stack. Its use is to form a partial vacuum in the smoke box, which creates a forced draft on the fire when the
engine is not working. The abuse consists in using it too strongly when the fire is being cleaned, or while the fire box door is open, thus drawing cold air through the tubes or flues, causing them to contract and leak.

30. Q—What bad effect is produced if the smoke box is not airtight?
A—The amount of air that enters the smoke box through the openings (or leaks) would correspondingly reduce the amount of air that would pass through the grates, which results in reduced draft through the fire and causes poor steaming engines.

31. Q—Name some other causes for fire not getting enough air through the grates.
A—Restricted ash pan openings, heavy or dirty fire, flues or front end stopped up.

32. Q—How should you prevent black smoke while building up the fire?
A—By using the blower lightly, and adding a small amount of fuel at a time.

33. Q—What causes pull on fire box door?
A—The air that should be passing through the grates is being retarded by too heavy fire, dirt or clinkers.

34. Q—What is black smoke? Can these gases be burned?
A—Black smoke is unburned gases passing off from the fuel. Yes, by having engine in good condition and firing properly.

35. Q—What are the advantages of a brick arch in the fire box?
A—It induces more perfect combustion by retarding the gases in the fire box until they have reached the igniting point. It thus prevents, to some extent, black smoke by giving the fire time to consume the gases. It also partially heats the cold air before
it enters the tubes, and otherwise acts as a deflector on the fire.

36. Q—Name some of the conditions which will produce a red fire.
A—Grates becoming clogged with ashes and clinkers so that sufficient air cannot pass through the fire, flues stopped up or trouble in the smoke box.

37. Q—What is the effect of putting too many shovelfuls of coal on a bright fire? Is this a waste of fuel?
A—Adding too much coal to a fire at one time reduces the temperature in the fire box below the igniting point, with the result that combustion is stopped until this fresh coal is heated to the burning point. During this time, there has been heat enough in the fire box to drive off the gases, and the draft has forced these gases out through the stack unconsumed. This causes the engine to fall back in steam, and also causes a waste of those unburned gases which is a waste of fuel.

38. Q—Why should the fireman anticipate the work the engine is about to do?
A—He must have his fire in proper condition to meet the work as it develops.

39. Q—If an engine should slip, how can damage to the fire be prevented?
A—By partly opening the fire door, thus permitting the air to be drawn over the fire for the instant, instead of through it.

40. Q—If fire is clean and draft appliances are right, and fire does not burn uniformly over the grates, where is the trouble?
A—in the flues. When the fire is not burning brightly, some of the flues are stopped up.

41. Q—Which is the best way to fire a locomotive?
A—To carry a level fire, and it must be a little
heavier on the sides, to keep the air from coming through it near the sheets as rapidly as in the center of the fire box. Fire as lightly as possible; maintain uniform pressure, and avoid unnecessary black smoke and a waste of steam through the safety valves.

42. Q—What is the estimated waste of coal for each minute a safety valve is open on a modern engine?
A—Thirty pounds.

43. Q—Why should the fireman be familiar with the grades, locations of stations, etc.?
A—This is very important, as the engine must be fired according to the work it is called upon to do.

44. Q—Why should the gangway, deck, and steps be kept clear of coal?
A—Coal falling from an engine endangers the lives of persons along the track and is a waste of fuel.

45. Q—Why can firing be done more intelligently when the water level is closely observed?
A—Because intelligent firing can only be accomplished by closely observing the water level and the way the engine is being handled and pumped.

46. Q—When should the grates be shaken?
A—Often enough to keep the dead ashes off the grates to insure the proper amount of air passing through the fire. Grates should be shaken, if possible, when not using steam.

47. Q—Why is a feed water heater used on an engine?
A—For the purpose of heating the water before it enters the boiler, by heat from the exhaust steam.

48. Q—How is the water heated and delivered to the Boiler?
A—Water is taken from tender through suction line by cold water pump and delivered to
heating chamber where it comes in contact with exhaust steam from locomotive cylinders. The combined steam and heated water then passes through the hot water pump, and is delivered to boiler through discharge pipe and check.

49. Q—In cold weather what must be done to prevent feed water pump and water line from freezing?
   A—Crack valve on steam heat line to suction pipe. Valve should not be opened too wide as too much steam will cause pump to become steam bound.

50. Q—How can you determine if the pump is operating?
   A—A delivery indicator connected to suction pipe is placed in a convenient location in the cab. The movement of the plunger indicates that the pump is operating.

51. Q—What type of stokers are used on our locomotives at the present time?
   A—Duplex and Standard.

52. Q—How should the Duplex stoker be oiled?
   A—Put one-fourth pint of oil in sight feed oil cup at intervals; put one-eighth pint engine oil in right and left elevator casings, which can be done by lifting the pawl shifter on top of elevator head casing and dropping oil into the small holes in elevator pawl cover. Fill oil box on right and left elevator casings and refill them every two or three hours. Slide support bearings and universal joints are oiled from cups in casing under cab deck. Stoker should be fed two or three drops of oil per minute from lubricator. Valve oil only should be used in the stoker engine cylinder. Engine oil should be used for other parts except conveyor gear casing where soft grease should be used.
53. **Q—**How should the Duplex stoker be started?
   **A—**To start the stoker engine, place the operating lever in central or running position. Place conveyor reversing lever in forward position. Open throttle valve which allows the steam to pass to the stoker engine and starts stoker running. Emergency valve should be kept closed except when necessary to crush hard lumps of coal, then it is opened to rapidly increase steam pressure in stoker cylinder. As soon as heavy duty crushing is completed, emergency valve should again be closed and stoker operated with steam through throttle valve.

54. **Q—**How should the Duplex stoker be operated?
   **A—**First open main valve at steam turret, then open starting valve, next open branch line jet valve which allows the steam to flow to the distributing jet line. Right and left feed valves which regulate steam pressure on the jets should be left set when stoker is stopped so that when stoker is started these valves are already open at about the right pressure—from 8 to 20 lbs.; also, always see that steam is flowing through jets before starting stoker engine.

55. **Q—**How should the Duplex stoker slide plates in the tank be operated?
   **A—**Open the front slide plate in the tank by pulling it ahead with a hoe, allowing coal to feed to the stoker conveyor. Slide plate should not be opened full length, but just far enough to feed coal at the proper rate to conveyor. For lump coal it is necessary to open slide plate wider than for slack coal. Stoker should be run slowly at first, just feeding enough coal to supply fire for work being done. On light runs the stoker will frequently have to be shut off part of the time.
56. Q—How should the Duplex conveyor be handled arriving at terminals?
   A—When nearing terminal close slide plates and run driving engine long enough to remove all coal from conveyor. Before leaving engine place conveyor reverse lever in central or neutral position and run vertical screws to empty vertical pipe and close all valves except the two jet valves.

57. Q—How should the Standard stoker be oiled?
   A—Before starting stoker, fill the 4-compartment oil cup located in bulkhead of tender with engine oil and apply a few drops to the universal and slip joints. These parts when in service should be oiled once every eight hours unless the bearings indicate that they are running dry, also note if engine bed has sufficient oil. Oil should show when the pet cock on side of engine bed is open. Feed about two or three drops per minute to stoker engine from lubricator while running. Inspect the visible parts to see that stoker is in good condition.

58. Q—How should the Standard stoker be started?
   A—First open the distributor jet valves; then slowly open the main control valve; next open the small throttle valve. Place the control lever in the operating position and give the stoker engine sufficient steam to run at the desired speed.

59. Q—How should the Standard stoker engine be operated?
   A—Open the front slide in the tank and when the coal begins to overflow the vertical conduit in fire box, adjust the pressure on the distributing jets so as to get an even distribution of coal over the entire grate area, then the stoker engine should be throttled so it will supply just enough coal for the work being done.
60. Q—What is the purpose of the Booster throttle valve on the Standard stoker?
A—To use when necessary to crush hard lumps of coal by rapidly increasing the steam pressure in stoker cylinders, and should be closed as soon as the heavy duty is completed.

61. Q—How should the Standard stoker conveyor be handled arriving at terminals?
A—Before arriving at the terminal close all tender troughs and slides and run coal out of conveyor. Run the stoker in reverse position a few revolutions so as to back the coal into the vertical conduit. Then place the operating lever in neutral position. Close the stoker engine throttle valve, but leave the distributor valve slightly cracked.

62. Q—How should the fire be built up on stoker fired locomotives?
A—Fire should be built up light, even and in good condition by hand, and stoker should not be operated until leaving with train.

63. Q—How should fire be carried by stoker firing compared with hand firing?
A—Fire should be carried much lighter by stoker firing. Close attention should be given the fire to see that the coal is evenly distributed over the grates.

64. Q—What care should be exercised in observing the stoker at work?
A—Keep wrought iron, wood, waste and other foreign matter from passing through the conveyor.

65. Q—What can be done if the stoker becomes inoperative?
A—Fire by hand.

66. Q—If the stoker engine stalls, what action should be taken?
A—Reverse the engine, using the booster or operating valve if necessary.
67. Q—If Duplex stoker should stall due to foreign matter, how would you locate obstruction?
A—Shut off throttle, place operating lever in lowest position, place tender conveyor lever in center position, place right elevator pawl shifter in neutral position, raise operating lever to center position, open throttle valve sufficiently to run left elevator. If left elevator operates, cut in right elevator by lowering pawl shifter without increasing steam pressure. If stoker stops obstruction is in right elevator; if it operates the obstruction is in tank conveyor. Conveyor screw must not be run backwards more than three revolutions.

68. Q—How would you reverse the Duplex stoker conveyor screw in tank?
A—Place handle on operating rod on boiler head in lowest position, move screw conveyor reverse lever to back or reverse position, and raise handle on operating rod to center position.

69. Q—How is Duplex stoker conveyor screw in tank stopped?
A—Place conveyor reversing lever in center position.

70. Q—How would you reverse the right or left elevator screw of Duplex stoker?
A—Raise elevator pawl shifter at top of vertical shaft to upper position. (Conveyor screw must be stopped before reversing elevator screw or stoker will be jammed with coal.)

71. Q—How is right or left elevator screw of Duplex stoker stopped?
A—By raising elevator shifter at top of elevator to middle position. (Conveyor screw must be stopped before stopping elevators, or stoker will be jammed with coal.)
72. Q—What should be the condition of the fire and what are the duties of the fireman on arrival at terminal?

A—Engine should be brought to the pit as near the maximum steam pressure as possible and with a light bright fire so that it can be cleaned without waste of fuel. The tools and other equipment should be properly put away, missing or defective tools should be reported.

EXAMINATION AFTER TWO YEARS' SERVICE

101. Q—Describe the glass water gauge.

A—A glass gauge connected at both ends to the boiler so that the water level in the boiler can be seen. It is located on either water column or the boiler head, the bottom of the glass being about on the level with the first gauge cock.

102. Q—How must the glass water gauge and water column be tested when taking charge of the engine?

A—Blow out glass water gauge by closing the top valve, leaving the bottom valve wide open allowing the water to blow out which indicates that the bottom valve is free from obstruction. Close the bottom valve and open the top valve wide allowing the steam to blow through glass gauge until glass is clear. Close drain cock, open bottom valve wide and the glass water gauge is ready for service. The water column should be blown out through the drain cock.

103. Q—What is the effect of a leak in top joints or unions of glass water gauge? Bottom joints or unions?
A—The glass water gauge may register a higher level than the water in the boiler. The glass water gauge may register a lower level than the water in the boiler.

104. Q—What particular attention should the glass water gauge drain valve receive?
A—Must see that it is properly closed: a leak at this point will cause the glass water gauge to register untrue water level.

*105. Q—When you find the gauge cocks registering one gauge of water and the glass water gauge shows full, what is the cause?
A—This indicates that top valve is closed or top passageway stopped up and not having the same steam pressure on top of the water in the glass gauge as there is in the boiler, the pressure in the boiler forces the water to the top of the glass water gauge.

106. Q—How does the water in the glass water gauge act when gauge is in good working order?
A—The water in the glass water gauge will move up and down with the movement of the engine.

*107. Q—When the engine is in motion and water in glass water gauge shows a stationary reading, what is wrong?
A—The bottom passageway is stopped up, or the bottom valve is closed and steam condensation will gradually fill the glass water gauge with water.

108. Q—Do the gauge cocks and glass water gauge always show the same water level when engine is working?
A—No. The gauge cocks show the agitated condition of the water at the point where they are located. The water in the glass water gauge passing through the connections may not show the agitated or foaming condition of the water in the boiler.
109. Q—If an engine started to work water, and gauge cocks showed three gauges of water and glass water gauge registered a much lower reading, what would be wrong and what should be done?

A—Boiler is foaming and throttle should be closed slowly and cylinder cocks opened to prevent damaging cylinder and the water supply increased. Note level of water by use of gauge cocks and glass water gauge and if water falls below bottom gauge cock immediately open throttle wide. On arrival at terminal, report that boiler foamed and should be washed and tank cleaned.

110. Q—If glass water gauge is out of order, how would you detect a foaming boiler?

A—If an engine started to work water, or, if gauge cocks showed a higher reading than I thought they should, would immediately ease off throttle, trying gauge cocks continually until throttle was entirely closed, and if water dropped too far, would know boiler was foaming.

111. Q—Explain the action of the water in the boiler, when engine is started ahead?

A—Water surges to back head of boiler and causes the gauges to show a higher water level. Just the opposite occurs when the engine is started backwards.

112. Q—Why is the knowledge of the action of the water in a boiler necessary?

A—The water gauges only register the water at the point where they are located and the knowledge of the action of the water with the action of the engine will prevent damage. Allowance must be made when on other than level track.

113. Q—If you shut your engine off at any point and water should disappear from bottom gauge cock, what would you do?
A—Immediately ascertain if boiler is foaming. Would shut off at intervals, or, until gauge cocks registered solid water with engine shut off. During the remainder of trip throttle should be closed frequently and water level ascertained.

114. Q—What is the result if the crown sheet is overheated?

A—If slightly overheated the crown bolts and probably the seams will be loosened, causing them to leak; if greatly overheated the crown sheets and crown bolts will soften and the boiler pressure on the crown sheet will then force off the heads of the crown bolts or force them through the crown sheet and also probably rupture the crown sheet.

115. Q—How is the water taken from the tank into the lifting injector and non-lifting injector?

A—In the lifting injector a jet of steam passing through the steam nozzle exhausts the air from the body of the injector and-feed pipe, creating a partial vacuum therein. Atmospheric pressure on the water in the tank forces the water up into the injector. The non-lifting injector is located below the level of the water in the tank and the water flows directly from the tank to the injector.

116. Q—Name the principal valves and tubes of the injector?

A—The valves and tubes are: Steam Valve, Water Valve, Steam Nozzle, Combining and Delivery Tubes, Overflow and Waste Valves and Line Check.

117. Q—How is water from the injector forced into the boiler against the same or higher pressure?

A—The steam combining with the water gives the water velocity. This moving water
passes freely out the overflow until it has gained sufficient velocity to force its way into the boiler against the stationary mass of water in the boiler.

118. Q—Where is the emergency valve in a Simplex injector, and how is it operated? How can you tell whether it is open or shut?

A—Just above the inlet valve. Should the inlet valve stick or break, the emergency valve should be closed, then injector should start to work. On the key attached to the valve are the letters (O) and (S). When (O) is up, it is open, and when (S) is up, it is shut.

*119. Q—Name some of the causes why an injector will not work after it is primed?

A—Insufficient water or steam supply, tubes out of line or badly cut, boiler check or line check stuck shut, overflow valve not properly open, overflow pipe obstructed, combining or delivery tubes stopped up.

*120. Q—Name some of the reasons which cause an injector while working, to spill or waste water or steam at overflow.

A—Too much water; steam not all condensed due to too much steam or insufficient water, tubes cut or worn or partially stopped up.

121. Q—If an engine steams poorly while working, but gains steam rapidly when shut off with blower applied, what is the trouble?

A—This condition usually indicates that steam is leaking into the smoke box, destroying the vacuum, which may be due to leaking steam pipe joint, or loose exhaust pot or nozzle, and with a super-heater engine, it may be a leaking unit.

122. Q—If engine steams poorly while working and does not gain steam rapidly when shut off with the blower applied, where is the trouble?
A—Usually in the front end. Smoke box might be full of cinders, or the netting or flues stopped up; if practicable, smoke box should be opened and front end or netting cleaned.

123. Q—What is saturated steam?
   A—Steam at the same temperature as the water in the boiler. Any reduction in temperature causes condensation.

124. Q—What is superheated steam, and how is it superheated?
   A—Steam, heated to a higher temperature that the water in the boiler. The steam, after leaving the dry pipe, enters the superheater header on one side of a partition wall in the header, then passes through the superheater units to the other side of the superheater header partition, and from there through steam pipes to the steam chest. The hot gases from the fire box, passing through the large flues coming in contact with the superheater units, heat the steam in the superheater units on its way to the cylinder, with the result that it is of much higher temperature than when it left the boiler.

*125. Q—What are the advantages in the use of superheaters in locomotives?
   A—Sufficient heat is added to saturated steam passing through the superheater units to about equal the heat losses in the cylinders and steam passage, thereby preventing condensation when engine is working. This addition of heat also increases the volume of the saturated steam about twenty per cent.

126. Q—How does superheater save water and fuel?
   A—The increase in volume and the reduction or total elimination of condensation reduces the water consumption by about twenty per cent, and, as the water consumption is less, it follows that the coal consumption is also less.
127. **Q—**Why is it important that the fireman should understand the functions of a superheater?

**A—**The success of the superheater depends largely upon the performance of the fireman. A heavy or humped short flame fire may produce maximum boiler pressure, but a high temperature is not developed around the superheater units, with the result that the steam enters the steam chest at a very low degree of superheat. A light, bright, long flame fire not only produces maximum boiler pressure, but maintains a very high temperature around the superheater units with the result that when the steam enters the steam chest it is at a very high degree of superheat, which has increased its volume and results in a saving of water, fuel and labor.

128. **Q—**Describe the fire box.

**A—**It consists of two shells. The inner shell is composed of side sheets, a crown sheet, a back sheet, and a flue sheet from which the flues run to the front flue sheet or front end. The inner shell is surrounded by an outside shell.

129. **Q—**Describe the most common type of staybolt?

**A—**A bolt having a screw thread cut on each end and screwed through both the inside and outside sheets with its ends riveted over.

130. **Q—**What is the object of hollow staybolts?

**A—**To indicate by the escape of steam and water that the bolt is cracked or broken.

131. **Q—**How is the boiler of a locomotive connected to the frame?

**A—**Front end of the boiler and cylinder saddles are securely fastened to the frame. The fire box end is carried on the frame by expansion plates, as the case may be and is free to move backward or forward on the
frame as expansion and contraction takes place. Boiler should always be kept securely fastened to the frame.

132. Q—To what strain is the inner shell of fire box subjected?
A—The fire box is subject to crushing strains and those of unequal expansion and contraction.

133. Q—To what strain is the boiler subjected?
A—Expansion and contraction; internal pressure and vibration.

134. Q—How is the boiler sometimes abused?
A—By allowing the steam pressure to drop and then blowing the boiler hot quickly; over-pumping the boiler, thereby reducing the steam pressure and then allowing the pressure to rise quickly, improper firing, causing sudden changes in the fire box temperature.

135. Q—Why do boilers have steam domes?
A—Steam domes are provided in order that the openings of the main and auxiliary steam pipes may be placed as high as possible so that they will be supplied with dry steam.

136. Q—Trace the flow of steam from the boiler to the cylinders and thence to the atmosphere.
A—In a saturated steam locomotive the steam passes from the boiler to the throttle valve, to the dry pipe, to the steam pipes in the front end to each steam chest; thence, through the steam port into one end of the cylinder, forcing the piston to the opposite end of cylinder, after which it goes back through the same steam port into steam chest through the exhaust port into exhaust pipe and through the stack to the atmosphere.

In a superheated steam locomotive the flow of steam is the same, excepting that after it leaves the dry pipe it must first go
through the superheater header and superheater units before being admitted to the steam chest.

137. Q—What is the effect of leaky steam pipe joints in the front end?
A—Steam leaks in the front end decrease the vacuum in the smoke box, this in turn, decreases the draft through the fire, with the result that engine will not steam freely.

138. Q—Why is it important that there be no holes through the smoke box?
A—There should be no possible chance for the admission of air through any part of the smoke box. Leaks decrease the vacuum necessary to create proper draft on the fire and also cause combustion to take place in the cinders in the smoke box. This warps the sheets of the front end.

139. Q—What causes the exhaust to issue from one side of the stack?
A—The exhaust pipe, lift pipe, or stack, is out of plumb.

140. Q—Why should draft appliance defects be reported in detail?
A—The engineer and fireman are in the best position to determine the cause of engine not steaming and the M. P. 62 Reports should furnish detailed information, specifying just where, in their opinion, the trouble is, so that the enginehouse force will not be compelled to draw the fire and make expensive tests unnecessarily, which holds the engine out of the service.

141. Q—What is lubrication and what is its purpose?
A—The placing of a thin layer of lubricant between moving surfaces of metal so that they do not actually touch each other thus preventing friction and wear.

142. Q—Where is the cylinder lubricator located and why?
A—The hydrostatic cylinder lubricator is located in the cab at as high an elevation as possible in order to induce the oil to flow more readily to the steam chest.

143. Q—Where is the condensing chamber located, what is it for, and how is it connected to the oil reservoir?
A—Condensing chamber is directly above the oil reservoir connected at upper end to a steam pipe leading from the boiler. It is used to condense steam for the purpose of keeping the oil reservoir constantly full. It is connected to the oil reservoir by a water or condensing valve and water pipe leading to the bottom of the oil reservoir.

144. Q—How does the oil get from the oil reservoir to the sight feeds?
A—Oil being lighter than water the weight of the water in the condensing chamber raises the oil to the top of the reservoir and forces it through the oil passage to and through the sight feed.

145. Q—How does the oil get from the feeds to the steam chest?
A—The steam from the top of the condensing chamber passes through a circulating pipe to a chamber around and directly above the sight feed, to top of which chamber, oil pipe is connected. Condensation fills this chamber with water to the level of the oil pipe. Oil being lighter than water it passes from the feed to the surface of the water, from there, steam from the circulating pipe and gravity, carries it through the oil pipe to the steam chest.

146. Q—If lubricator feeds faster when throttle is closed than wide open, what is usually wrong?
A—Choke plug holes are too large.
147. Q—If valve should appear dry while using steam and lubricator is working right, what should be done?
A—Ease off throttle a few seconds to reduce the steam chest pressure. Oil that is being held above choke plugs will then flow to the steam chest. If that does not correct trouble, oil pipe is stopped up.

148. Q—Why is it bad practice to carry water too high in the boiler?
A—The water is carried over through the dry pipe reducing the superheating, destroying lubrication, causing cutting of valve and cylinder walls, damaging cylinder packing, retarding the action of the engine and causing a considerable waste of fuel.

149. Q—Why should engine oil be kept away from the boiler in warm weather?
A—To keep it from becoming too hot. Hot oil runs off of bearings and is wasted.

150. Q—What should be observed when oiling the machinery?
A—that all oil holes are open and that the oil goes to the bearings. Only enough oil should be used to lubricate the parts.

151. Q—What results are obtained by proper lubrication?
A—Proper lubrication prevents friction and reduces wear and consumption of coal and water.

152. Q—What are engine springs for?
A—the springs lessen the amount of shock imparted to the frames and engine, and might be termed shock absorbers.

153. Q—How is the weight of the frames and boiler suspended on the driving wheel springs?
A—the driving boxes rest on the axles and the springs are carried by the saddles, which rest on the boxes, and the frames are suspended from the spring by hangers and equalizers.
154. Q—What is the purpose of the equalizers?
A—The equalizers are used to equalize or distribute the weight between the boxes or bearings.

155. Q—How are the driving boxes held, so that they will not move forward or backward?
A—By means of shoes and wedges bearing against the jaws of the frame.

156. Q—Where is the wedge located, and what is it for?
A—The wedge is located behind the driving box and is an adjustable liner used to take up the lost motion between the box and pedestal jaw of frame.

157. Q—What effect is produced when wedges are set up too tight?
A—The up-and-down movement of the driving box will be retarded which will interfere with the action of the springs and the engine will ride hard.

158. Q—How do you ascertain if engine is equalized?
A—The springs and hangers should be level and straight, and there must be clearance between the frames and top of driving boxes, also, between the bottom of the boxes and pedestal caps.

159. Q—Why is clearance above and below the driving box necessary?
A—To prevent the frame from striking the top of driving box or the pedestal cap from striking the bottom of the driving box. The frame and pedestal cap coming in contact with the driving box will knock nuts, bolts, and other parts loose, and will cause engine to ride hard.

160. Q—What should be minimum clearance between the pedestal caps and driving boxes?
A—Not less than one inch.

161. Q—Describe a slide valve?
A—It is rectangular in shape and is located in the steam chest, it moves backward and forward admitting steam to first one end of the cylinder and then to the other. It has a cavity which allows exhaust steam to pass from the cylinders to the exhaust.

162. Q—Describe a piston valve?
A—It is cylindrical or spool-shaped, having packing rings on both ends and it operates in a cylinder called the valve chamber, performing the same function as a slide valve.

163. Q—How many ports are in a slide valve seat and what are they for?
A—Three. The front port is to admit live steam to and exhaust steam from the front end of the cylinder. The back port is to admit live steam to and exhaust steam from the back end of the cylinder. The middle port is to provide a means of escape of the exhaust steam through the exhaust cavity of the valve to the atmosphere.

164. Q—Name the principal parts of the Stephenson valve gear?
A—Reverse lever, reach rod, reversing arm, tumbling shaft, lifting arm, link hanger, link saddle and pin, link block and pin, eccentric and strap, eccentric rod, rocker arm, valve rod, valve yoke and valve. On certain types of engines transmission bar and hanger are used. The valve yoke is used only in connection with the slide valve.

165. Q—Name the principal parts of the Walschaert valve gear?
A—Reverse lever, reach rod, reversing arm, tumbling shaft, lifting arm, radius rod, lifter or suspension arm, slip block, eccentric rod, eccentric crank, link and trunnion, link block and pin, valve stem, valve cross-head and guide, valve stem, lap and lead lever, lap and lead connector, and cross head arm.
166. Q—How should cylinders be warmed up before engine is started?
A—Cylinder cocks must be opened, brakes applied, throttle opened and steam admitted alternately to each end of both cylinders until dry steam appears at all cylinder cocks.

167. Q—When warming up or blowing water out of engine, how should throttle be operated?
A—It should be opened up slightly or just cracked. If too much steam is permitted to enter the superheater, accumulated water in the units is driven with great force against the superheater bends which might cause them to leak.

168. Q—What is liable to occur if an engine is moved with water in the cylinders?
A—Water is incompressible and if trapped in cylinders when piston is moving toward cylinder head it is liable to crack or knock out the cylinder head, crack or loosen the cylinder or bend or break the rods or pins.

169. Q—Does damage of this kind sometimes occur and the damage not become apparent at once?
A—Yes, parts affected and fractures started may hold and not fail until later.

170. Q—Where is the piston rod packing located?
A—In a gland in the cylinder head.

171. Q—Where is the cylinder packing located?
A—The cylinder packing is in the grooves of the piston head.

172. Q—Why should all packing be in good condition and well fitted?
A—To eliminate, as far as possible, the loss of power, due to steam blowing by the packing. Steam leaks of any kind are objectionable; they not only reduce the power of the engine, but obscure the vision, and, in addition, increase the fuel consumption.
173. Q—Does efficient braking save fuel?
A—Yes.

174. Q—What qualifications are necessary to successfully practice economical engine operation?
A—A thorough knowledge of the machine; willing co-operation between the engineer and the fireman; correct handling of the throttle, reverse lever, brake valve, and injectors. Fuel can be saved by using good judgment when drifting, and an engine should be pumped and fired so that water can be supplied to the boiler after engine is shut off to avoid waste of steam through the safety valves.

175. Q—Describe how and when the boiler feed pump should be operated.
A—The boiler feed pump should be run continuously while the locomotive is in operation at the speed necessary to maintain the proper water level in the boiler. The pump must be used only when the locomotive throttle valve is open.

176. Q—When a locomotive equipped with a boiler feed pump throws water from the stack what should be done?
A—Stop the pump and use the injector for a time in order to see if the locomotive stops throwing water; if it does, then start the pump and see if the throwing of water starts again. If so, stop the pump and use the injector for the remainder of the trip. Upon arrival at terminal report water is thrown from stack while pump is working.

177. Q—If boiler feed pump does not start promptly, what should be done?
A—Open and close pump throttle several times. If this does not start pump, increase lubricator feed temporarily and repeat the above. If the pump will not then start, close pump
throttle, remove top covers from auxiliary valve chest and oil valves. After replacing valve chest covers and opening pump throttle, if the pump will not start, proceed, using the injector.

178. Q—If boiler feed pump does not supply boiler what is the cause?
A—A partly closed tank valve, a clogged tank hose or strainer, defective discharge or suction valves.

179. Q—Should there be an excessive discharge of water from vent pipe while the boiler feed pump is in operation, what would it indicate?
A—That the piston packing of the lower or hot water cylinder needs renewal, or that the valves require attention.

180. Q—What is meant by a boiler feed pump becoming steam bound and what is the best method of overcoming this difficulty?
A—A boiler feed pump becomes steam bound when it loses its cold water suction and cold water pump becomes filled with air and later with steam. This may occur when the water in tank gets too low, or cold water suction valves are in bad condition. Proceed with train to nearest water stop, using injector, and when tank is again filled with water pump should be tried. If it then fails to work it is an indication that the suction valves are defective or suction line or strainer obstructed.

EXAMINATION AFTER THREE YEARS' SERVICE

201. Q—What are the qualifications in general that an engineer should possess?
A—He must be a man of good habits, trustworthy, faithful and intelligent. He must understand the rules and obey them. He
must understand the engine, not only as to the care and handling, but what to do in case of break-down and emergencies.

**202. Q—What is the first duty of an engineer when taking charge of an engine?**

**A—** He must see that there is sufficient water in the boiler by operating the gauge cocks and seeing what comes out of the drip pipes. He must know that they are open and working freely. He should examine and test the glass water gauge. He should examine the fire box and flues. He must know that the injectors and boiler feed pump are working properly.

**203. Q—Would you attach any more importance to the top row of flues leaking than if the bottom rows were leaking?**

**A—** Yes. A leak at that point indicates that the flues might have been damaged by low water.

**204. Q—When examining firebox and flue sheets for leaks, how should the blower be operated?**

**A—** Just strong enough to clear smoke. Strong draft created by operating blower valve wide open will draw leaking water through flues and will dry the flue sheet. This destroys evidence of leaking flues.

**205. Q—How do leaking flues affect the steaming qualities of an engine?**

**A—** Water from leaking flues evaporates into steam in the firebox and flues. This steam coming in contact with the hot gases lowers their temperature and also partly fills the vacuum in the front end, thus lessens the draft through the fire.

**206. Q—Name and explain the various appliances in the smoke box or front end.**

**A—** Pipes to carry steam to the steam chest; exhaust pot to conduct exhaust steam from exhaust cavity of cylinder saddle towards the
stack, exhaust nozzle, a continuation of the exhaust pot and which creates greater or less draft on the fire by decreasing or increasing its size; blower to create a draft when the locomotive is not working; lift or petticoat pipe, an internal extension of the stack; the diaphragm, which is used to equalize the draft through the flues; the netting which prevents large sparks from passing out through the stack; superheater header, to which the dry pipe is connected, used to convey steam from the dry pipe to the superheater units, thence to the steam pipes; and the superheater damper which, when open, permits hot gases to pass through superheater flues and when closed prevents hot gases from passing through superheater flues.

207. Q—What inspection should be made of an engine?
A—While engine is being prepared, the engine and tender should be inspected for defects. See that all important bolts, nuts and cotter pins are in place. See that there are no loose bolts, nuts, tools, etc., lying on running board, frames, etc. See that whistle and bell ringer are in good condition and that the sand pipes are open and sanders are operating.

208. Q—How is the fire box end of the boiler stayed?
A—The inside and outside sheets are held together by staybolts. The crown and roof sheets are held together by crown bolts.

209. Q—What is meant by circulation in a boiler?
A—Circulation in a boiler is the movement of water within the boiler. It is caused by heat. The water in contact with the fire box sheets and flues absorbs the heat from the fire and rises. As the heated water rises it is replaced by water of a lower temperature. This movement is termed circulation.
210. **Q—How is good circulation insured by the fireman?**  
**A—By firing a light, bright, long flame fire over the entire firebox the greatest amount of heat is produced, thus insuring good circulation.**

211. **Q—How can an engineer aid or hamper circulation?**  
**A—He can aid circulation by intelligent pumping. Water should be added to the boiler according to the boiler pressure and condition of the fire. Water, as it enters the boiler, is at a low temperature and feeding the boiler too fast retards circulation, and steam pressure is not increased promptly.**

212. **Q—What is the function of the valve gear?**  
**A—To transmit the motion of the eccentric or eccentric crank arm to the valve causing it to move backward and forward.**

213. **Q—What is an eccentric? An eccentric crank arm?**  
**A—An eccentric is a circular device fastened out of center on the axle. The eccentric crank arm is fastened to the main pin in such a way that the eccentric crank pin is out of center with the axle.**

214. **Q—What is meant by a balanced slide valve?**  
**A—It is one where a certain percentage of the steam pressure on top of the valve has been removed. This is accomplished by a pressure plate fastened to the steam chest lid. The top of the valve is grooved for four snugly fitting strips, which are held against the pressure plate by springs which make a steam tight joint and prevent pressure from reaching a portion of the top of the valve.**

215. **Q—Why is there a hole in the top of the valve?**  
**A—To permit any steam that leaks past the balancing strips to escape through the exhaust.**

216. **Q—What is the effect of a broken valve strip spring and how can it be detected?**
A—With the throttle open there will be constant blow at the exhaust with the reverse lever in any position and the reverse lever will handle hard.

217. Q—What is meant by inside or outside admission?

A—Inside admission means that the steam enters the port from the inside edge and is exhausted from the outer edge of the valve. Outside admission means that the steam enters the port from the outside edge and is exhausted from the inner edge of the valve.

218 Q—How is the travel of the valve regulated.

A—The motion of the eccentric is transmitted to the link and the distance which any point of the link travels always remains the same. When working in full gear, the link block is at the end of the link and the valve travels its maximum distance. As the reverse lever is hooked up, the link block is moved closer to the middle of the link and this decreases the travel of the valve.

219. Q—What is outside lap and its purpose?

A—Outside lap is the distance the valve overlaps the steam ports when the valve is on the center of its seat, earlier cutoff is thus obtained, than without lap, which permits the steam in the cylinders to be worked expansively.

220. Q—What is meant by cut-off?

A—Cut-off is the closing of the steam port by the valve before the piston has reached the end of its stroke. A 25 per cent cut-off means that the steam to the cylinders has been shut off when the piston has traveled one-quarter of the length of the stroke.

221. Q—How is cut-off obtained?

A—The travel at the center of the link is less than at the end. When the link block is close to the center of the link, the valve
closes the steam port earlier than when the block is at the end of the link. Steam thus held pushes the piston to the end of its stroke by expansion.

222. Q—At what cut-off should the valve be worked in order to obtain the most economical results?
A—As short as the engine will handle the train at the required speed, but not less than 25 per cent. When cut-off is less than 25 per cent, poor steam distribution results. Some engines are equipped with limited cut-off designed for the most economical operation. For full gear operation a small port is provided which is only large enough to be effective at slow speed.

223. Q—At what cut-off should the valve be placed when drifting, starting or moving at slow speed?
A—To insure proper lubrication and uniform wear of valve, valve seats or bushings, the valve gear should be in almost full travel.

224. Q—What is a snifting valve?
A—The snifting valve is located in the side of the steam chest of steam passageway; when the engine is drifting it is open and prevents air, hot gases, etc., from being drawn from the smoke box into the steam chest and cylinders.

225. Q—What is the bad effect of leaking main valve or cylinder packing?
A—Steam blowing past the main valve or cylinder packing is wasted, and causes back pressure in the opposite end of cylinder and destroys lubrication.

226. Q—What attention must be given the Power Reverse Gear?
A—See that it is properly lubricated and works freely in all positions so that the proper cut-off can be maintained.
Q—If, for any reason, the Power Reverse Gear fails on a locomotive equipped with the Walschaert type of valve gear, what should be done?

A—On all locomotives on which the link block operates in the lower portion of the link for forward motion, remove the bolt in connection to the tumbling shaft arm, which permits the link block to drop to the bottom of the link and the locomotive can be run ahead. To run backward, block the link block in the top of the link. On locomotives on which the link block operates in the upper portion of the link for forward motion the above described operation should be reversed.

Q—What is the effect of reversing an engine while running?

A—After the piston moves a short distance, the cylinder is then in communication with the exhaust port, with the result that air is drawn from the smoke box through the exhaust into the cylinder almost the entire stroke, and on the return stroke is compressed to an excessive pressure into the steam chest, steam pipe and dry pipe, producing resistance on the piston. In addition to the air, hot gases and cinders from the smoke box being drawn into the cylinders, destroying lubrication.

Q—How tight should a driving box wedge be adjusted?

A—Enough to make up the lost motion, but not tight enough to cause box to stick. Self adjusting wedges accomplish the same purpose.

Q—What position should engine be in when wedges are being adjusted?

A—Place engine so that both main crank pins are in the upper eighth position, one for-
ward and the other back of the center of stroke. Block wheels, preferably ahead of engine truck wheels, place reverse lever in forward motion and use steam to pull the boxes against the shoes on all wheels. Set up wedges fairly tight, then pull them down not to exceed ½ inch. This work should be done on straight and level track.

231. Q—What is meant by the dead center?
A—When the crosshead is at either the front or back end of the stroke and the pins and rods are on a line with the center of the wheels.

232. Q—Why should engine be placed on center after wedges have been adjusted?
A—In order to determine that the rod bushings are free on the pins and do not bind when passing center.

233. Q—What is the effect if the driving wheel pins are not the same distance apart as the length of the side rod?
A—Side rod bushings bind on pins when passing center, causing them to run hot.

234. Q—When should driving box wedge be lined?
A—When the wedge has been forced up to the limit of its travel and lost motion still appears between wedge and box.

235. Q—When should driving box shoes be lined?
A—The shoe should be lined when the side rod prevents box being forced against shoe.

236. Q—What trouble is likely to occur when a wedge bolt is broken?
A—Wedge is likely to stick to the box and be pulled up, causing the box to stick and run hot.

237. Q—When unable to pull down tight wedge, what should be done?
A—Run wheel over a large nut which will sometimes loosen wedge.
238. Q—What is meant by engine out of tram?  
A—An engine is out of tram when the distance between centers of any two wheels on one side is not the same as the distance between the centers of the corresponding wheels on the opposite side.

239. Q—Why is it necessary to keep rod brasses keyed and how should it be done?  
A—To prevent pounding which results in loosening nuts and heating and breaking of rod brasses. Set screws should be loosened, drive the key down lightly until the brasses are closed, see that the brasses are free on the pin and tighten set screws.

240. Q—In what position should an engine be placed to key the back end main rod brasses? The front end main rod brasses?  
A—For the back end, place the side of the engine upon which the work is being done on the upper forward eighth, as this position presents the greatest diameter of the pin to the rod brasses. For the front end, place the engine on the bottom quarter.

241. Q—When should rod brasses be reported closed, or reduced?  
A—When they are keyed brass to brass and still pound.

242. Q—What are some of the usual causes of pounding?  
A—Loose or worn brasses, loose wedges, driving box shells worn or loose, piston rod loose in its crosshead, loose cylinders, worn guides or crossheads, main rod too long or too short, loose nut on main piston rod, pedestal bolts loose, broken frame or flat tires.

243. Q—How can a pound be located?  
A—By placing the main pin on top quarter, then blocking the driving wheels, giving the cylinder a little steam, and reversing the engine under pressure, observing the different parts.
244. Q—If an engine develops a cylinder pound when drifting, what does it usually indicate, and what should be done?
   A—Loose piston head or main rod too long or too short, causing the piston to strike the cylinder head. Throttle should be kept slightly open to form a cushion in the cylinder.

245. Q—When an engine using steam is running ahead, is the pressure on the guide upward or downward?
   A—Upward.

246. Q—When running with the reverse lever in full forward gear and reverse lever knocks and rattles but ceases when the engine is hooked up a notch or two, what is wrong?
   A—The top of link is riding on link block, usually caused by the reach rod being too long.

247. Q—If steam issues from cylinder cocks with throttle shut off and engine is standing, what does it indicate?
   A—If lubricator is shut off, it is usually either a leaking throttle or dry pipe.

248. Q—Is this always true with a superheater engine?
   A—No. Steam may be coming from the water which has accumulated in the superheater units. In this case it will cease when all the water in the units is evaporated.

249. Q—What is back pressure and how does it affect an engine?
   A—While the exhaust is open, it is the pressure that is on the exhaust side of the piston which is the wrong side, and retards the engine.

250. Q—What is compression and its effect?
   A—After the exhaust is closed, the steam trapped in the cylinder is compressed by the moving piston and acts as a cushion.
251. Q—How should an engine be started to avoid jerks?
A—Slowly, until all slack is out of the train.

252. Q—How should the throttle be closed when hauling a long train?
A—The throttle should be eased off slowly to allow the slack in the train to gradually run in.

253. Q—How should sand be used?
A—A slipping engine should not be caught on sand nor should sand be used on one side only. Rods, pins and axles are liable to break. Sand should only be used in sufficient quantity to prevent slipping and by so doing coal, water and labor can be saved.

254. Q—If for any reason water in boiler cannot be maintained at a safe level what should be done?
A—Fire should be deadened or drawn.

255. Q—What should be done in case throttle valve becomes disconnected while valve is closed?
A—Engine is powerless and assistance must be obtained.

256. Q—What should be done if throttle valve fails to seat after throttle lever is in closed position?
A—Engine must be controlled by reverse lever and brakes and steam pressure reduced.

257. Q—How can a broken valve yoke, or stem, be located?
A—Open the cylinder cocks, admit steam to the steam chest, then reverse engine several times, and if steam does not flow alternately from each cock the throttle is on that side. The side being tested should be on or near quarter.

258. Q—If an engine with a broken valve yoke, or stem, blows badly, what does it indicate?
A—The valve has moved ahead far enough to open the exhaust port.
259. Q—With a broken valve yoke, or stem, what can be done?
A—If blow is such that engine cannot be moved, assistance is necessary. If exhaust port is not open main rod should be taken down, piston blocked all the way ahead and can then proceed on one side.

260. Q—If an eccentric gets hot, what should be done to avoid breaking the straps?
A—Oil it well, using valve oil if very hot. If the strap is so tight that it cannot be cooled down by the use of valve oil, then loosen the bolts, apply liners and tighten the bolts.

261. Q—What should be done if a forward motion eccentric, eccentric strap, or eccentric rod is broken?
A—To run ahead on one side, take off broken parts, cover ports and clamp main valve. Engine can be run backward at slow speed using both sides by unclamping valve and placing reverse lever in a position that will put the eccentric rod in line with the link block.

262. Q—What should be done if the back motion eccentric, eccentric strap, or eccentric rod is broken?
A—Remove the broken parts. Engine can be run ahead at slow speed using both sides, by placing the reverse lever in position to bring the forward motion eccentric rod in line with the link block. If cut off is desired to run ahead on one side, connect the forward motion eccentric rod to the bottom of the link, cover the ports and clamp the valve. To run backwards, remove the link hanger.

263. Q—Why are piston valve engines more liable to damage by water in cylinders than slide valve engines?
A—On a slide valve engine the water will force
the valve off its seat and escape through the exhaust. On a piston valve engine the water cannot get past the valve packing rings.

264. Q—What should be done if a front cylinder head is broken or knocked out?
A—Disconnect valve rod, cover ports, clamp valve, and proceed on one side.

265. Q—What should be done if valve stem is broken outside of steam chest?
A—Take off broken parts, cover ports, clamp valve, and proceed on one side.

266. Q—What should be done if reverse lever, reach rod, or reversing arm or tumbling shaft is broken?
A—The failure of any one of these parts causes the link to drop down on the link blocks. Engine can be run ahead carefully, if cut-off is desired, rise links by blocking between top of link and link block. To run backward, raise links to backward motion and use longer block.

267. Q—What should be done if a link hanger is broken?
A—Link on that side drops on link block. Engine can be run ahead, if cut-off is desired, raise link by blocking between top of link and link block. To run backward, raise link to backward motion and use longer block.

268. Q—What should be done if link block pin is broken?
A—The movement of the valve on that side is lost. Disconnect valve rod, cover ports, clamp valve, pull rocker arm to clear and proceed on one side.

269. Q—What is the transmission rod for, and where is it connected?
A—It is the rod which makes the connection between the link block and lower rocker arm and is held in position by a hanger. It
transmits the movement of the link block to the rocker arm.

270. Q—What should be done if a transmission rod is broken?
   A—Remove broken part if necessary, cover ports, clamp valve and proceed on one side.

271. Q—What should be done if a transmission bar hanger is broken?
   A—Transmission bar will drop down and rest on axle, and if engine is linked up high it would be in back motion. Place engine in full forward gear and proceed on both sides.

272. Q—What should be done if main rod is broken?
   A—Remove broken parts, block crosshead at back end of guide or between locking bolts, disconnect valve rod, cover ports, clamp valve and proceed on one side. On engines equipped with crosshead locking bolts, remove the bolts, reverse the washers so that the heads of the bolts enter the hollow faces of the washers.

273. Q—What should be done if a guide is broken or lost, or a piston is bent?
   A—Take down main rod, block crosshead, disconnect valve rod, cover ports, clamp valve and proceed on one side.

274. Q—Why are knuckle joints provided in side rods?
   A—To provide vertical flexibility thereby relieving the up-and-down bending strain on side rods.

275. Q—If the back section of a side rod is broken or a knuckle pin lost out of a six or eight-wheel connected engine, what should be done?
   A—Take down the broken rod and the corresponding rod on the opposite side.

276. Q—If the front section of a side rod on a six-
wheel connected engine is broken, what should be done?
A—Take down all side rods.

277. Q—If the front section of a side rod of an eight-wheel connected engine is broken, what should be done?
A—Take down broken rod and corresponding rod on the opposite side. The L-1-s engine can not be operated under its own steam. Both main rods must be taken down and crossheads must be secured between the two locking bolts.

278. Q—If the front section of side rod of a ten-wheel connected engine is broken what should be done?
A—Take down the broken rod and the corresponding rod on the opposite side. The I-1-s and N-1-s engines can not be operated under their own steam. Both main rods must be taken down and the I-1-s crossheads must be secured between the two locking bolts, and the N-1-s crossheads must be secured in the full forward position.

279. Q—If the back intermediate section of side rod of a ten-wheel connected engine, should break, what should be done?
A—Remove broken parts and corresponding rod on opposite side, also both back sections of side rods.

280. Q—If the middle section of an eight-wheel connected engine is broken, what should be done?
A—Take down all side rods.

281. Q—What should be done if the main pin is broken off close to the hub?
A—Remove all side rods and main rods on both sides of the engine. It is sometimes the practice to move engine with main and side rods on one side only, but it should be remembered that when brakes are applied nine or rods are liable to be bent or broken.
282. Q—What should be done if an engine running on one side stops on dead center?
A—If the main rod is not disconnected unclamp the valve, move it off center, and give engine enough steam to move the good side off the center.

283. Q—What is the effect of removing the main rods or side rods from a locomotive?
A—It destroys the counterbalance and engine in such condition should be handled at slow speed in order to avoid damage to track.

284. Q—When an engine truck spring or front driving wheel spring or hanger is broken what should be done?
A—See that the pilot clears the rail properly and if not, the front end of the engine should be raised and blocking placed between the driving box and the frame.

285. Q—What should be done if a spring hanger is broken?
A—If wheels do not rub the boiler, air pipe, etc., and pilot clears the rails, engine can be run carefully. If necessary, the engine frame should be raised and blocks placed between the frame and top of driving box.

286. Q—Without jacks, how can the engine frame be raised off of driving box?
A—Block between frame and top of driving box next to disabled point. Then run the blocked wheel up on blocking and block between frame and top of driving box at disabled point. If this does not raise the frame enough, repeat the operation.

287. Q—What should be done if a driving wheel tire is broken?
A—If it is necessary to swing the disabled wheel, that pair of wheels must be raised and blocking placed between pedestal cap and bottom of driving boxes.
288. **Q—** Without jacks, how can a disabled wheel be swung clear of the rail?

**A—** Run the disabled wheel up on blocking and block between pedestal cap and driving box; also block between the frame and top of adjacent driving boxes.

289. **Q—** When covering ports, if steam issues from front cylinder cock on inside admission engine, which way should valve be moved to cover port?

**A—** The valve should be moved back.

290. **Q—** On a Walschaert valve gear engine, what controls the movement of the valve?

**A—** The movement of the valve is controlled by the motion of one eccentric arm and the crosshead.

291. **Q—** What should be done if a Walschaert valve gear eccentric arm is broken?

**A—** To run on one side remove broken parts, disconnect radius rod, lap and lead lever, tie radius rod to clear, cover ports, damp valve and proceed; or disconnect bottom of lap and lead lever from crosshead, tie it ahead, cover ports and proceed.

292. **Q—** If a Walschaert valve gear eccentric arm or eccentric rod is broken when handling a light train, can both sides be used?

**A—** Yes. To start the engine it will be necessary to place the reverse lever in about 25 per cent cut off. After making part of a revolution, the reverse lever must be placed in position so that the link block will be at the center of the link. In this position the back end of the radius rod will be held firmly and the valve will receive its movement from the crosshead, which is sufficient to admit steam to the cylinder. Starting assistance may be necessary.

293. **Q—** With the eccentric rod disconnected and using both sides, should reverse lever be
placed in any other than center position?
A—No. If reverse lever is moved off center, steam will be trapped in cylinder and considerable damage will result.

294. Q—If a breakdown, not due to defective Wal-schaert valve gear, necessitates totally destroying the movement of the valve, what should be done?
A—Disconnect the front end of the radius rod from the lap and lead lever and clamp the valve or take off the eccentric rod and disconnect the bottom of the lap and the lever.

295. Q—When running on one side, with both main rods up, how should the dead cylinder be lubricated?
A—Remove test plugs and oil through holes. To prevent churning air and heating cylinder, leave test plugs out or remove the cylinder cocks.

296. Q—What break in steam chest or cylinder will cause the engine to blow so badly that it will be disabled?
A—Broken valve, valve yoke, valve seat, main piston, or cylinder packing.

297. Q—If trouble is in steam chest, can you proceed on one side?
A—No. But if trouble is in cylinder can proceed on one side.

298. Q—What tests should be made to locate a blow in steam chest or cylinder?
A—To test the valve place engine on quarter on side to be tested, place reverse lever in center, open cylinder cocks, apply the brakes, open the throttle, and if no steam appears at cylinder cocks the valve is tight. To test cylinder let engine stand in same position as when testing the valve, and with brakes applied and cylinder cocks open move reverse lever to full forward or backward mo-
tion, open throttle, and if steam does not appear at both cylinder cocks, packing is tight.

299. Q—What is meant by valves out of square?
A—This means that the engine has a greater port opening at one end of the cylinder or that one side is working stronger than the opposite side.

300. Q—What is the effect of main valve being out of square?
A—Distribution of steam is uneven, and the efficiency of the engine is reduced.

301. Q—How do you know when the main valves are out of square?
A—The sound of the exhaust is uneven and the time elapsing between the exhaust is not the same.

302. Q—If a hot pin or bearing develops, or a failure or breakdown occurs, what should be done?
A—to correct hot parts, or repair defects, all stops should be made, if practicable, clear of main track, or at a point where trains will not be delayed. Prompt and correct information should be furnished the Superintendent.

303. Q—What attention should the stoker receive in regard to lubrication?
A—Before starting the Standard stoker the four compartment oil cup located in bulkhead of cistern should be filled with engine oil, apply a few drops to the universal and slip joints. These parts when in service should be oiled once every eight hours, unless the bearings indicate they are running dry. Note if engine bed has sufficient oil—oil should show when pet cock on side of engine bed is open. Start Hydrostatic lubricator and feed about three drops per minute to stoker engine while running. With Duplex stoker, fill the sight feed oil cup
with engine oil, and one-eighth pint of engine oil in right and left elevator casings. This can be done by lifting pawl shifter; drop oil into small holes in pawl casing cover. Fill oil boxes on right and left elevator casings, and re-fill them every two or three hours. Slide support bearing and universal joints are oiled from cups under door in cab floor. Set lubricator to feed about three drops per minute to stoker cylinder.

304. Q—How is the coal delivered from the tender to the fire box with a Duplex stoker? With a Standard stoker?

A—When the first of the slide plates is pulled forward the coal falls to the conveyor trough beneath, and is then carried by the conveyor screw through the crusher to the transfer hopper beneath the cab deck where a rib divides the proper amount to the right and left elevators, and is then raised to the distributor elbows and through openings in the back head, through distributor tubes, where low pressure steam jets in connection with the distributors distribute the coal over the grate surface.

After the Standard stoker is started in the forward position, open the first tender slide, coal will then fall into the tender conveyor trough, and is carried forward by the conveyor screw through the crusher to the end of the conveyor screw and is then forced through an elbow and upright conduit in sufficient quantities to meet engine requirements by speed of driving engine. It is then distributed over the fire space by proper adjustments of the distributor jets.

305. Q—If the trailer spring or spring hanger should break, what precaution should be taken?

A—Engine should not be run in backward motion, as there is a liability of being derailed.
Q—Why is it necessary to run Headlight Generator with Starting Valve wide open?
A—Any restriction in the steam supply to the Headlight Generator, or drop in boiler pressure of forty pounds or more from rated working pressure, will reduce the speed of the headlight generator so that the proper voltage will not be maintained.

Q—What inspection should be made at the end of trip?
A—The engine should be inspected for hot parts and other defects.

Q—What other duty has the engineer to perform?
A—He must make an intelligent report of the condition of the engine on the form provided for that purpose, and when a special explanation is necessary, should take the matter up personally with the foreman in charge.
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- Partial failure.
- Total failure.

Remarks:.........................................................................................
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