Steam and Hot Water Heating Systems

FOR

PASSENGER TRAINS

AND

INTAKE VENTILATING SYSTEM

INSTRUCTIONS
THE PENNSYLVANIA RAILROAD CO.
Northern Central Railway Company.
West Jersey & Seashore Railroad Company.

No. 103

Steam and Hot Water Heating Systems

—for—

PASSENGER TRAINS

—and—

INTAKE VENTILATING SYSTEM

INSTRUCTIONS

ALTOONA, PA.
1910
GENERAL NOTICE.

Every employee whose duties are in any way connected with the operation and maintenance of the car heating equipment herein described, will be required to have a thorough knowledge of the same, and will be expected to carry out the instructions strictly as in the performance of any duty.

A. W. GIBBS,
Gen’l Sup’t Motive Power.

APPROVED:

W. H. MYERS,
General Manager.

OFFICE GENERAL Supt. Motive Power,
Altoona, Pa., November 1, 1910.
GENERAL DESCRIPTION

1. **The Principle of the System.** The straight steam system of heating passenger trains consists of a single line of train pipe which is supplied with steam from the locomotive. From this line steam is distributed to the radiating pipes of each car and the water of condensation discharged to the ground.

**The Direct System** consists of suitably arranged pipes within the car, through which steam passes, radiating heat directly within the car.

**The Indirect System** consists in passing fresh air over the radiating pipes and thence into the car, as is done with the intake ventilating system now used on certain passenger equipment cars.

**The Hot Water Circulating System** consists of a stove supplied with a coil of pipe within the fire pot, an expansion drum located above the heater and connecting with the upper end of the coil, and a system of pipes, all connecting in a series of bent or straight radiators located under the seats or along the sides of the car. With this arrangement the live steam passes through suitable jackets, which envelop certain sections of the circulating pipes at different points, thus causing a circulation of hot water in the same direction.
as that caused by fire in the heater, the heater pipes radiating heat directly within the car.

The water of condensation from the various arrangements of steam pipes or jackets in each car escapes to the atmosphere through an automatic steam trap used in connection with nearly all steam heat systems, but some special and private cars may be found to be equipped with a drip valve for this purpose. Steam traps are also provided with a blow-off valve to allow for a free escape of air and drainage water, or any sediment that may collect in the pipes.

2. **Essential Parts.**—

**On Locomotives.**

**Main Steam Valve.**—Attached directly to the boiler in cab, and in train service this valve must be opened wide.

**Pressure Reducing Valve.**—Valve through which the required amount of steam pressure to the train pipe is regulated.

**Steam Gauge.**—Located in cab.

**Flexible Metallic Connection.**—Located between engine and tender.

**Steam Train Pipe.**—Located on engine and tender,
End Train Pipe Valve — Located at the rear end of tender.

Steam Hose. — Attached to train pipe end valve.

Straight Port Coupling With Gasket. — Attached to hose.

On Cars:

Steam Train Pipe. — Located under the car from end to end.

End Train Pipe Valve. — One located at each extreme end of the train pipe.

Hose and Couplings. — Attached to end train pipe valve, by which the locomotive and cars are connected together.

Steam Admission or Regulating Valves — To control the passage of steam from the train pipe to the radiating pipes (or jackets) inside the car.

Intake Ventilating System. — Which supplies fresh air and forces the heat units from the heater box into the body of car.

Radiating Pipes. — Located within and along the sides of the car.
Steam Trap.—Connected to the lowest point of the radiating pipes for the purpose of discharging the water of condensation to the atmosphere.

Combined Steam Heat and Drain Valve.—Used only on baggage, express and postal storage cars. Located under the car to cut out and drain steam piping.

TO ENGINE HOUSE FOREMAN, INSPECTORS AND ENGINEMEN.

3. Steam gauges, reducing valves and all other essential parts, including pipe covering, must be carefully inspected and tested, and repaired if necessary not later than September 15th of each year. After this work has been performed, a suitable tin tag must be secured to the steam pipe between the boiler or bridgepipe and steam heat reducing valve, bearing the name of shop or engine house, and date it received this attention.

4. The steam heat apparatus on locomotives must receive daily inspection during the steam heat season, all of its various parts tested, and the same must be known to be in good condition before locomotive is sent out for train service. Extra hose must be carried, as covered by special instructions.

5. Enginemen when taking charge of a loco-
motive must examine carefully the steam heat appliances and know that steam is passing through the train pipe and connections, and on arrival at engine terminals they must report any defects to the steam heating apparatus on the regular form provided for that purpose.

6. When locomotives are not coupled to steam heat trains, the steam hose and couplings must be properly attached to the safety chain, and during the entire steam heat season the end train pipe valve must be adjusted so that a small amount of steam will escape through the steam hose at the rear of tender to avoid the freezing of pipes.

7. When coupled to and heating trains, the main steam valve attached to boiler must be kept wide open, and the required pressure regulated by the adjustment of the pressure reducing valve. It is, therefore, very important that this valve and steam gauge be maintained in good condition.

8. At terminal or division points where locomotives are attached to trains, enginemen must furnish steam immediately at pressure up to 90 pounds, as may be requested by the inspectors or trainmen, to blow out the steam train pipe, and the same continued until advised by the inspectors or trainmen that the steam is passing through the train.
9. The pressure reducing valve must then be adjusted to furnish approximately eight pounds pressure for each car in the train, and this amount must be maintained over the entire division (except when approaching point where engine will be uncoupled from train for any cause).

10. When necessary, upon request of the conductor, the steam pressure must be increased. Enginemen must report all cases to the proper officers for investigation where an unusual amount of steam is asked for.

11. For trains electrically lighted by steam driven generator in the baggage car, the pressure reducing valve on the locomotive must be adjusted to furnish 100 pounds pressure, and the gauge examined after passing the points where the generator will be started, as designated by special instructions, to see that the pressure is maintained.

12. At Division or Engine Terminals the steam pressure must be shut off five minutes before reaching the station or final stopping place, unless otherwise covered by special instructions.

13. In cases of failure of the steam heat apparatus on the locomotive, so that the steam must be shut off, the train conductor must be promptly advised, who will arrange to disconnect all steam hose couplings and protect the steam appliances on the cars from damage by freezing.
14. Steam pressure must never be shut off from the train while on the road, except as in preceding paragraphs and upon request of the conductor or other authorized persons.

TO CAR FOREMAN, INSPECTORS AND TRAINMEN.

15. At Terminal Yards inspectors will make a thorough inspection and the necessary repairs to all parts of the steam heating apparatus on all passenger equipment cars during the month of September in each year, and will be held responsible for the good condition of the equipment for the following steam heat season.

16. At stations where trains are made up they will be held responsible for having the steam heat apparatus on all cars in trains in working order, including the blowing of steam through the train pipe and drip, and the proper adjustment of automatic traps.

17. They must be at the front end of the train when the locomotive is attached to make the steam couplings, open end train pipe valve, and request the engineman to furnish the required amount of steam.

18. When arriving at terminals, or at any point where cars are to be left without steam, all steam heat regulating, blow-off and train pipe valves must be opened wide (except the com-
bined steam heat and drain valve on baggage, express and postal storage cars, which must be closed).

19. When trains are made up and the locomotive attached, great care must be exercised to know that the cars are properly coupled before connecting the steam hose couplings. (If the steam couplings are found frozen, they should be thawed out by blowing steam from one car to another.) Open wide train pipe valves at the ends of all cars. When blowing steam through the train, enginemen will be requested to furnish the required pressure, and the end train pipe valve on rear car must be opened wide and the water of condensation blown out, after which the end train pipe valve on rear car must not be closed entirely, but must remain slightly open over the entire division, so as to allow a very small amount of steam to escape from the steam hose at the rear of train. The inspectors must then report to the conductor and engineman the condition of the steam heat system.

20. To obtain a quick circulation in blowing steam through cold trains, when steam is turned into the train pipe from the locomotive or station plant, the hose couplings about three cars back from the engine should be separated until all water is out and the steam appears and then unifying the couplings at this point, steam is al-
lowed to escape at the couplings two or three cars further back, and so on to the rear of the train. In this way several minutes may be saved in getting steam through the train pipe.

21. When cars are taken on at rear of steam heated trains, unite steam couplings, blow out train pipe and proceed to heat as in making up trains.

22. When placing cars at the forward end of train, steam should be blown through the train pipe before coupling to the remaining portion of train.

23. The steam must not be cut out of passenger equipment cars while in train service, except by closing down the steam regulating valve. This should not be done during cold weather, as the supply pipe to these valves may freeze and burst.

24. Baggage, express and postal storage cars are provided with a combined steam heat and drain valve, located in the branch pipe close to the steam train pipe, generally at the centre of the car. When these cars are placed in trains as dead-head or sealed, the combined steam heat and drain valve must be closed and all other valves in the car opened wide. When it is desired to use steam in one of these cars, the combined steam heat and drain valve must be opened wide in order to cover the drain port. Inspectors or trainmen must be notified before the car is
loaded and sealed, so that all other valves may be tested and properly adjusted.

25. If for any reason cars equipped with the hot water system cannot be heated by steam, fires must be kindled in the heater, and the defect reported at the next inspection point.

26. If the steam couplers of foreign cars will not couple satisfactorily with the standard, same including hose should be removed, placed in car to which they belong, and new hose and standard couplings applied, charging to the car owner, unless otherwise provided for.

27. Railway Mail Clerks will regulate the heating and ventilation of their cars.

28. Express Messengers will regulate the heating and ventilation of their cars.

29. Dining Car Conductors will regulate the heating and ventilation of their cars.

30. Pullman employes in charge of sleeping or parlor cars will regulate the heating and ventilation of their cars.

31. In private or other cars in train having a system of steam heat which differs from those described in this Instruction Book, a diagram with full instructions regarding the handling of the system will be found posted in each car, and the attendants in charge of such cars will regulate the heating and ventilation of their cars. Postal and Express Cars will be provided with special Instruction Cards for the information
and guidance of Railway Mail Clerks and Express Messengers.

32. Any failure of steam heat in cars in charge of above attendants must be reported immediately to the train conductor. Trainmen will regulate the heating and ventilation of all other cars while on the road, including cars with hot water systems but not having regular attendant and will assist conductor as he may order.

33. Train conductors will be held responsible for the proper heating of the entire train, and shall see that all Railway Mail Clerks, Express Messengers, Pullman Employes and Dining Car Conductors carry out the special instructions posted in their cars for the heating and ventilation thereof, and where this is not done, they must instruct the attendants how to correct the difficulty.

34. Train conductors should notify engine-men before leaving the station, of the pressure of steam that will be required to heat the train. This should be approximately eight pounds for each car in the train, and must be maintained by the engineman over the entire Division, unless otherwise directed. This pressure can be increased at the request of the conductor, but the necessity for so doing must be reported by him to the proper official on arrival at the terminal. Steam pressure at 100 pounds should be request-ed for trains using the electric generator in the baggage car.
35. The conductor should notify the attendant in charge of the electric generator to adjust the pressure reducing valve in the baggage car to furnish steam for heating the train at approximately eight pounds pressure for each car. The steam pressure carried on the generator should not be less than eighty pounds and may be higher without detriment to its working.

36. At those points where it is necessary to blow out the steam train pipe, such as when changing locomotives, the shut-off valve under the baggage car, having the electric generator, must be opened by the attendant in charge. After this has been done, this valve must be closed and the steam to heat the train furnished through the pressure reducing valve located within the car.

37. Trainmen will arrange immediately before entering a terminal where the train is to be broken up, to open full all steam regulating valves and blow-off valves on automatic traps. This should not be done until enginemen have shut off steam, which will be five minutes before arriving at terminal, unless otherwise covered by special instructions. On cars not accessible to trainmen, the attendants in charge must be directed how to adjust these valves. This rule must be carefully followed in order to deliver trains in proper condition.
38. On "Through" trains arriving at stations where locomotives are changed, trainmen must arrange to close the steam regulating valves (except as in paragraph No. 18) and must report on form M. P. 217 to the Foreman of Car Inspectors immediately upon arrival any defects in the steam heat system, and cars that do not heat properly. Trainmen taking charge of trains at Division Terminals must examine as soon as possible all regulating valves, blow-off valves attached to automatic traps and end train pipe valves, to know that they are properly adjusted.

39. In cold weather the trainmen should frequently examine the end train pipe valve on rear car to know that a small amount of steam escapes. When steam does not appear, the valve should be opened at first opportunity to clear the train pipe of the water of condensation. When this cannot be done, practically the same results can be obtained by opening the blow-off valve attached to the automatic traps on rear car. This will insure a good circulation of steam throughout the train pipe.

40. The regulating valves in the car will control the amount of steam to the radiating pipes or steam jackets, and must not be closed tight in freezing weather.

41. The automatic traps are designed to free
the steam system of each car of condensation with blow-off valves closed. If they are not properly adjusted, or if for any other reason the radiating pipes or steam pipes leading to regulating valves are not sufficiently warmed, the blow-off valves should be opened, but must not remain open longer than three minutes at a time, and must then be closed. In severe weather this operation should be repeated three or four times over the division.

42. Never try to regulate the temperature of a car by the train pipe valve or by steam valve on the locomotive. All cars are provided with deck ventilators of the swinging type, or exhaust ventilators on cars having the Intake Ventilating System, and the temperature should be regulated by them in connection with the regulating valves. When serious defects occur in the radiating pipes on one side of cars fitted with the Intake Ventilating System, the cold air damper should be closed on that side when the car is so equipped.

43. The temperature of cars when properly ventilated should be about 70 degrees, except sleeping cars at night when the temperature should be about 60 degrees.

44. The Inside Temperature of Cars when placed in Passenger Stations for service should be as follows:

When outside temperature is more than ten degrees above zero.

When
Coaches in through service equipped with the intake system of ventilation ........... 60 to 65 degrees
Coaches in through service not equipped with the intake system of ventilation ........... 65 to 70 degrees
Coaches in suburban service equipped with the intake system of ventilation ........... 55 to 60 degrees
Coaches in suburban service not equipped with the intake system of ventilation ........... 60 to 65 degrees
Pullman sleeping cars between the hours of 10.00 P. M. and 6.00 A. M. ................. about 60 degrees
Pullman sleeping and parlor cars in daytime ........................................... 65 to 70 degrees

45. When outside temperature is less than ten degrees above zero.

Coaches in through service, regardless of ventilating system. 65 to 70 degrees
Coaches in suburban service, regardless of ventilating system ...................... 60 to 65 degrees
Pullman sleeping cars, between the hours of 10.00 P. M. and 6.00 A. M. .............. about 60 degrees
Pullman sleeping and parlor cars in daytime .............................. 65 to 70 degrees
46. Temperatures should be kept below rather than above the highest figures given. Responsibility for regulating temperatures in all cars, except Pullman cars, while in the yard and until delivered to the train crew, will rest with the Foreman in charge of the men assigned to this duty. While in a general way, the same instructions apply to Pullman cars, yet it is to be understood that the Pullman employes will look after and be held responsible for maintaining the desired temperature in their cars.

47. Train conductors when taking charge of trains placed in stations must observe the temperature in each car, and if the temperature is not within the requirements of these instructions a report shall be made promptly.

48. Temperature of Cars while on the Road should be maintained as follows:

- Coaches in through service..... 65 to 70 degrees
- Coaches in suburban service..... 60 to 65 degrees
- Pullman sleeping cars between the hours of 10.00 P. M. and 6.00 A. M. ...............about 60 degrees
- Pullman sleeping and parlor cars in daytime .................. 65 to 70 degrees

49. If thermometer in any steel coach registers the maximum temperature as provided for in instructions governing coach equipment, and in the judgment of the conductor is not comfort-
ably heated, the maximum temperature may be increased five (5) degrees and report made by the conductor.

THE STANDARD STEAM COUPLER.

50. The standard steam coupler is known as type S-4 and is made in two pieces. The shank or nipple end of coupler to which the hose is secured can be removed from the coupler head. The inside diameter of passage through the coupler casting and composition gasket is 1½". Contours of engaging lugs are accurately machined to insure perfect alignment and uniform compression of the gasket.

VAPOR SYSTEM OF STEAM HEAT.

51. We now have in service a number of postal, passenger and Pullman cars equipped with this system of heating, the operation of which is as follows:

Steam passes from the train pipe into a Vapor Regulator, where it is automatically controlled or regulated so that only sufficient steam is allowed to pass from the regulator into the heating pipes to just fill them with steam all the way to the outlet at the bottom of the regulator underneath the car, and without creating any actual pressure
in these heating pipes, regardless of what pressure may be in the train pipe.

When the admission valves are open, the heating pipes contain steam at atmospheric pressure only, or steam at just 212 degrees in temperature.

When the admission valve is closed, steam at atmospheric pressure passes from the Vapor Regulator underneath the car to the admission valves, where it crosses over or "short-circuits" through the valve and passes directly back to the outlet of the Vapor Regulator instead of first passing through the heating pipes.

With this arrangement, the Vapor Regulator is operating and is hot at all times when steam is in the train pipe, regardless of whether the atmospheric pressure steam is allowed to pass through the radiating pipes when the admission valve is in the open position or whether it is "short-circuited" and cut out from going into the heating pipes when the valve is in a closed position.

No blow-off valves are used with this system. The pipes are open to the atmosphere at the outlet, and all water or condensation will pass out as soon as it reaches the lowest point, and as the heating pipes never contain steam under any pressure whatever, no blowing out would be possible.
52. Directions for operating this system are as follows:

Steam can be turned on or off any heating coil by opening or closing the Cut-Out Valve located on the floor near centre of car in a coach, and near the end of coil in baggage or mail cars.

Open the Cut-Out Valves by moving lever to the RIGHT.

Close the Cut-Out Valves by moving lever to the LEFT.

Open or close the Cut-Out Valve as far as it will go in the direction desired.

When the steam is not on the car no attention need be given the apparatus inside the car to prevent its freezing.

The Cut-Out Valves may be left open or closed when car is not under steam.

Train pipe valves outside under the end of the car should be left open when car is without steam.

This arrangement of Vapor System in sleeping cars is divided into several distinct coils or heating units, each having its own cut-out valve.

Instructions covering the operation will be found in the Porter's locker.
HOT WATER HEATING SYSTEM.

53. Principle of the System.—The principle of the hot water heating system is the circulation of heated water through the pipes in the car. The whole system of piping, including the generating coil, the pipes rising to and descending from the expansion drum, and the expansion drum to half its height, is filled with salt water. Upon fire being built in the stove, the water in the generating coil becomes heated and the circulation is established by the hot water rising into the expansion drum and descending again from the latter to the radiating pipes distributed around the car, returning through the remainder of the circulating system. Therefore to establish and maintain a circulation it is absolutely necessary to have the water level above the connection of the riser and down-flow pipes. If it is not, there is danger of burning out the coil.

54. Essential Parts.—

The Heater.

Generating Coil, located in the heater.

Expansion Drum, located at the highest point of the system, and connected by a pipe to the upper end of the generating coil.

Combination Cock, located at the end of the expansion drum.
Pressure Safety Valve, located at the top of the expansion drum.

Filling or Drain Cocks, located at the lowest point of the circulating pipes under the car.

Circulating Pipes, which form a continuous loop in the car, one end of which is connected to the expansion drum, and the other end to the lower end of the generating coil.

Steam Jackets, distributed at two or more points on circulating pipes.

Steam Traps, which automatically discharge the water from the steam jackets.

55. Use of Steam Instead of Fire.—To provide for the use of steam where fire is prohibited, a section of the circulating pipe at different points in the car is surrounded with a large pipe (or jacket) into which steam is admitted in sufficient quantity to heat the water and thereby establish and maintain the circulation.

The jackets have the same functions as the generating coils in the heater, and when in use there should be no fire in the heater.
INSTRUCTIONS TO FOREMAN AND REPAIR-MEN.

56. **Washing Out**—After the car has been equipped with the apparatus, and before the safety valve has been applied, the pipes must be thoroughly washed out with hydrant or pump pressure. To do this, connect the hose to one of the drain cocks at the lowest point of the system, and force the water through the pipes until it escapes at the hole for the safety valve, a pipe having been screwed into this hole to lead the water away from the car. This operation must be continued until the waste water shows that no dirt remains in the pipes. The hose should then be disconnected and all the fresh water in the system allowed to drain out where pumped in. If the heater contains two generating coils and there are two circulating systems, this operation must be repeated with the second system also.

57. **Preparation of Salt Water**—The brine or salt water used for filling the pipes must always be a saturated solution, that is to say, it must contain as much salt as the water will hold in solution when cold. It must be prepared at least twelve hours before it is to be used. The vessel containing the brine should always have a surplus of salt in the bottom. The water should be stirred up occasionally and sufficient salt added to insure the solution being of proper
strength. Clear salt water should be drawn from near the surface of the vessel through a screen and pumped into the pipes. It should never be used immediately after being stirred, because undissolved particles may be pumped into the pipes and may in time obstruct them. No deposit or obstruction of salt can occur unless undissolved particles are pumped in. The salt used must always be perfectly clean; crushed rock salt is preferable. Packing house salt, being more or less greasy, must not be used.

58. Testing the Circulating System—After all the fresh water in the circulating system has run out, connect a pressure pump to one of the drain cocks and to a vessel containing the salt water. An overflow pipe, having a shut-off valve and a special pressure gauge between it and the expansion drum, should be carried to the same vessel. The salt water must then be pumped into and through the system. This pumping must continue until the water discharged from the pipe at the top of the expansion drum escapes in a solid stream, entirely free from air bubbles. The waste pipe must then be closed and the pumping continued until the gauge indicates a pressure of 300 pounds per square inch in the circulating system. This pressure must be retained for at least one hour, during which time a thorough examination must be
made for leaks throughout the entire system. If the heater contains two generating coils, and two circulating systems, the above operation must be repeated with the second system also.

59. Inspection and Test of Pressure Safety Valves—Before the pressure safety valve is attached, it must be carefully inspected, tested, and set to relieve the pressure at 125 pounds. When annual inspection takes place, these valves must be removed, inspected and tested as above.

60. Service Filling—After the pipes and fittings are found to be perfectly tight, the pressure should be relieved at the drain or filling cock under the car, so that the pressure safety valve can be attached in its proper place. The combination cock should then be opened and the salt water pumped up again until it shows at the bottom of the funnel of the combination cock, which should then be closed and the funnel turned downward. A fire must then be built in the heater or steam admitted to the jackets and continue until complete circulation is established. After the circulation has been established the fire or steam should be removed, and when the pipes have cooled, water should be added, if necessary, to the expansion drum, through the combination cock, until it appears in the funnel, as in the test a slight shrinkage of water may occur owing to
the trapping of air at points in the pipes when filling them.

61. Another Method of Filling—Open all draw-off or pump cocks on the circulating pipes, remove safety valve (keep combination cock closed) and connect from topmost expansion drum tapping a ½ inch pipe, as shown in sketch. This piping must be made up so as to be absolutely tight. Extend the ½ inch pipe downward towards the ground, outside the car, and connect to the upper end of a coil of pipe in a barrel or tank, the latter being located as close to the car as convenient.

The coil is made of ½ inch pipe, and should be made up about 2 inches smaller in diameter than the inside of the barrel and coiled as closely as possible, so as to get in a large amount of heating surface. Near the lower end a tee is inserted and an angle valve connected to the tee as shown. In order to prevent the salt or other solid matter getting in the pipes, a metal strainer is attached to the angle valve. A cheap and convenient form of strainer is illustrated herewith, but any form will do, provided it has at least twenty-five ⅛ inch holes in it. The lower end of the coil is extended through the side of the barrel or tank, lock nuts being used inside and outside, and a ½ inch globe valve is placed on the end of the pipe. The ½ inch angle valve is pro-
vided with an extension handle, reaching above the top of the barrel.

Fill the tank with the brine with which it is desired to fill the pipes. The water in the barrel must, of course, be sufficient to fill the pipes without drawing the level in the barrel down too near the strainer. At no time should the water level be less than 4 inches above the strainer. One hundred feet of 1 1/4 inch pipe contain about seven and one-half gallons of water, so, if the number of feet of circulation piping is known, the water necessary is easily calculated. An excess of at least one-third should be allowed for, as a measure of safety. A barrel full of water will suffice for all ordinary cars, or for each half of the double circulation car, but it is well to have an extra amount on hand, to use in case the water level in the barrel is lowered too near the end of the strainer.

Close the angle valve in the barrel and open the globe valve on the end of the coil. Connect a steam hose to the draw-off cock furthest from the expansion drum and blow about twenty-five or thirty pounds of steam into the pipes. As fast as it issues freely and in full volume from each open draw-off cock, close that cock. In a very few minutes every foot of the heater pipes will be full of live steam (as will be indicated by the temperature of the pipes), and this steam will
force its way up into the expansion drum and out through the coil and the globe valve on the end of the latter. It carries with it the air that has collected in the pipes, which is discharged from the globe valve, together with the water of condensation. If live steam escapes with the water, close the valve a little, or until water and air only escape.

After the air is expelled the steam heats the water in the barrel to the boiling point. By boiling, the air, which is always in suspension in any body of water not boiled, is expelled, and the water in the barrel, after being made salt enough to float a potato while boiling, is suitable for use in the circulation pipes.

Close the globe valve outside the barrel, and the draw-off cock, through which the steam enters the pipes, and disconnect the steam hose. Then open the angle valve inside the barrel. The steam issuing from the pipes is now directed into the brine in the barrel, and continues to escape into it until the pressure reduces. The steam remaining in the pipes condenses and forms a vacuum, into which the hot brine from the barrel is forced by the atmospheric pressure, and, if the work has been carefully done, in a very few minutes the pipes will be completely filled. This will be indicated by the level of the water in the barrel becoming stationary.
62. **Firing**—The quickest circulation is obtained by regular and moderate firing. Too rapid generation of heat is undesirable, and must not be permitted, because thereby water may boil over and waste through the safety vent on the expansion drum before proper circulation has been established.

63. **Replenishing the Water**—When the water in the expansion drum is found to be below the level of the combination cock, which may be caused either by blowing off from the pressure safety valve, or from leaks in the pipes and fittings, a sufficient quantity of fresh water may be added through the combination cock to restore it to the original level. Fresh water, however, should only be used in an emergency; warm salt water should be used whenever possible. Should it be necessary to replenish when the circulating water is hot, the combination cock should be opened very slowly to relieve the pressure and prevent any undue discharge of water.

64. **Failure of Circulation**—Should it be found that the circulation cannot be obtained, and that the elbow which connects the pipe in the car to the generating coil is hot, and that water shows in the combination cock, it is evidence that the pipes have become clogged. The water should then be drained off, pipes washed out and refilled, as provided for in paragraphs 56 and 58.
65. **RETESTING CIRCULATION**—The circulation test must be repeated at least once a year, or when cars are in shop for repairs, and a metal tag must be securely attached to the heater, in a conspicuous place, giving the date and place of test.

66. **MATERIAL AND WORKMANSHIP**—In all new work and repairs, extra heavy wrought iron pipe and cast iron fittings must be used. Special care must be taken to avoid straining of pipes or fittings in order to get them into place, and they must be securely held in position by clamps or otherwise to prevent subsequent straining.

67. **EXPANSION DRUM**—When double coils and double circulating systems are used, two expansion drums or one large drum with a SOLID partition forming two separate compartments must be used.

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**INSTRUCTIONS TO FOREMAN, INSPECTORS AND ATTENDANTS.**

68. **INSPECTION AND TEST OF SYSTEM**—Inspection and test of hot water heating system must be made once a year, as provided for in paragraphs Nos. 56 to 60 inclusive, and a metal tag securely attached to the heater in a conspicuous place, giving the date and place of test.
69. **Heater and Room**—An inspection of the heater, grate, pipes, casing of the heater room and roof guard, should be frequently and carefully made, to insure their being in good condition. The floor under and around the heater must be kept clean and free from lumps of coal, bunches of waste, or any combustible matter.

70. **Examination for Water Level**—At all principal terminals, at the end of each trip, or when there are indications of the pressure safety valve discharging, or of improper circulation, the combination cock should be opened slowly and the height of the water ascertained. If water does not appear in the funnel of the combination cock, salt water should be added (warm if available) until it does appear. When this inspection is made and it is found necessary to replenish the water, it should be done with as low temperature of circulating water as possible.

71. **Starting the Fire**—In starting a fire in the heater, short wood or charcoal should be used, the coal supplied gradually until the chamber is about two-thirds full. The generating coils should at no time be entirely covered. The damper door should be regulated so as to prevent a sudden sharp fire.

72. **Cleaning Heater**—The grate should always be kept free from ashes, and the ash pan clean, as an accumulation of ashes will not only
obstruct the draft, but will also cause the grate to burn out.

73. **Cleaning Double Generating Coils**—In heaters equipped with double generating coils, an accumulation of ashes will frequently be found around the coils, which will cause poor circulation. In cases of this kind the fire should be reduced sufficiently to permit the removal of the ashes.

74. **Regulating Draft**—The condition of the fire is maintained by the draft. To increase the draft, close the upper door or open the damper slide in ash pit door; to decrease the draft, open the upper door or close the damper slide, according to type of heater. At all times, even when using steam, the safety plate at the top of the heater, and ash pit door at the bottom of the heater, must be kept closed. The series of holes in this door will admit sufficient air to create the necessary draft. *In no case should a car be left with full draft on the heater.*

75. **Temperature**—The car should be kept at an even temperature at all times, and the fire should not be allowed to burn out.

76. While on the road, should the pressure safety valve blow off, discharging sufficient water to stop the circulation, a moderate fire may be continued until the water can be replenished and
further repairs made, which must be done at the first opportunity.

77. IMPAIRED CIRCULATION—While on the road, should it be found that a car cannot be heated, and that the elbow connecting the pipes in the car to the generating coil is hot, and that water shows in the combination cock, it is evidence that the pipes have become clogged. The combination cock on the top of the car should be kept open unless it is found that the pressure safety valve is relieving the pressure. A moderate fire may be continued as provided for in paragraph 76.

78. REPORT OF FAILURE—In all cases of failure, a report by wire should be immediately made.

79. Kindling wood and coal should be carried at all times for emergency.

INSTRUCTIONS FOR OPERATING THE HOT WATER HEATING SYSTEM.

(To be Placed in Heater Room.)

80. In starting the fire in a hot water heater, short wood or charcoal should be used, and coal supplied gradually until the fire chamber is about two-thirds full. The generating coils should at no time be entirely covered. The upper door should be regulated so as to prevent a sudden sharp fire.
81. The grate should always be kept free from ashes and the ash pan clean, as an accumulation of ashes will not only obstruct the draft, but will cause the grate to burn out.

82. The heater room floor under and around the heater must be kept clean and free from lumps of coal, bunches of waste, or any combustible matter.

83. In heaters equipped with the double generating coils, an accumulation of ashes will frequently be found around the coils, which will cause poor circulation. In cases of this kind the fire must be reduced and the ashes removed.

84. The condition of the fire is maintained by the draft. To increase the draft, close the upper door or open the damper slide in ash pit door; to decrease the draft, open the upper door, or close the damper slide according to type of heater. At all times the safety plate at the top of the heater, and the ash pit door at the bottom of the heater, must be kept closed. The series of holes in this door will admit sufficient air to create the necessary draft. *In no case should a car be left with full draft on the heater.*

85. The car should be kept at an even temperature at all times, and the fire should not be allowed to burn out.
86. While on the road, should the safety valve blow off, discharging sufficient water to stop the circulation, a moderate fire may be continued until the water can be replenished and further repairs made, which must be done at the first opportunity.

87. Should it be found that the car cannot be heated, and that the elbow connecting the pipes in the car to the generating coil is hot, and that water shows in the combination cock, there is evidence that the pipes have become clogged. The combination cock should be kept open unless it is found that the safety valve is relieving the pressure. A moderate fire may then be continued as provided for in paragraph No. 86.

88. When necessary to refill the pipes while the circulating water is hot, the combination cock should be opened very slowly to relieve the pressure and prevent any undue discharge of water.

89. In all cases of failure, a report by wire should be immediately made.

90. Kindling wood and coal should be carried at all times for emergency.
DESCRIPTION OF THE INTAKE VENTILATING SYSTEM.

This system consists of taking air in from the outside through two hoods at diagonally opposite corners of the car roof, on wooden cars, and on all four corners of the car roof on steel cars, thence through down-takes underneath the hoods to the spaces, one on each side underneath the car floor, enclosed by the floor, the false bottom, the outside sill, and nearest intermediate sill. From these spaces, which extend the full length of the car, the air passes up through the floor by means of proper apertures, thence over the heating pipes and out into the car through casings located under each seat (in dining cars through brass grills in the heater boxes located between the tables), and finally escapes from the car through ventilators located on the centre line of the upper deck.

Each hood, which has wire gauze covered openings front and back, is provided with a flap valve, which must always be open towards the direction in which the car is moving.

According to the instructions posted in the cars, the operating lever at the front end of the car should be turned so that it points away from the aisle, and at the rear end of the car towards the aisle; or, in other words, the lever should in each case point towards the right-hand side of car when facing the locomotive, in wooden cars.
In steel cars, this valve is operated automatically by the air pressure, except in some few cars which are manually operated by means of a rod, which, according to instructions posted in the toilets, should be pushed up in forward end of car and pulled down in rear end of car. Trainmen must see that these levers are properly adjusted before or immediately after train starts. In the down-take, below the flap valve lever, is a butterfly valve, the normal position of which is "open." This valve controls the admission of air to the car, and must only be closed when it is necessary to exclude all foul or cold air, as when going through tunnels, or when heat is shut off from car. Also when standing at stations it is desirable to close this valve in order to reduce the circulation while the locomotive is detached. The control of the ventilating system, by which the amount of air taken into the car is increased or diminished, should be by the exhaust ventilators in the upper deck. The combined area of the openings of the register valves in these ventilators is a little less than the area of the two intake boxes. If the cars do not heat properly, these ventilators should be partially closed by turning the handle, which should stand lengthwise of the car when open, and crosswise when closed, and not by closing the inlet valve in the down-take boxes. The injecting action of the hoods should always be in excess of the exhaust-
ing action of the ventilators, so as to allow the warm air in the heater boxes to pass out into the car body and not draw cold air in at the cracks around the doors and windows. The smoke bell and the tube over the lamp are never closed by turning the ventilator valve. This only closes the space surrounding the smoke bell, and leaves a constant opening about one-fourth the area of the ventilators over the lamps. The deck sash in cars fitted with this system are purposely made tight and immovable, with no detriment to the ventilation, provided the valves are operated according to instructions.

When a car has been standing closed for some time during cold weather, and is then put in a train and steam admitted to the heating system, there is sometimes difficulty in getting the air currents in the heater boxes started in the right direction, but the difficulty may be overcome by opening the car doors for a few minutes, and also by adjusting the flap valves according to the directions of the air outside of the car, so that the air may pass in and through the down-take box.

In-take valves and exhaust ventilator valves should work freely and the air duct between floors should be occasionally cleaned of cinders.
Pressure Steam Heating.
RADIATING PIPE

TRAIN PIPE

Standard Hot Water
Heating System.
Standard Pipe Arrangement at Ends of Cars.
Combined Steam Heat and Drain Valve.
(Baggage, Express and Postal-Storage Cars.)
Stove or Heater With Two Generating Coils.
(Cars Having the Hot Water Heating System.)
Method of Filling Circulating System.
Intake Ventilating System.
(Cross Section of Car.)