

# NEVADA STATE RAILROAD MUSEUM

CARSON CITY, NEVADA



**FIREMAN HANDBOOK**

**2010**

## **Fireman**

**Description:** The Fireman is a volunteer who will fire the engine in a safe, responsible manner while inside or outside of the yard limits. The Fireman will maintain adequate steam pressure for the operation of the engine. The Fireman shall at all times assure that an adequate amount of water is in the boiler for safe operation and the tender is sufficiently filled with water and fuel. The Fireman will work with the Engineer to ensure the safety of the public at all times during operation of the train. This includes watching crossings for vehicular and foot traffic, and ringing the bell at the appropriate times. Firemen shall familiarize themselves with the use of the engine and train brake controls for their use in emergency situations. They are expected to observe the operations of other members of the train crew in order to prepare for advancement. They are directly responsible to and shall receive directions from the Engineer and Conductor.

### **Firemen's duties include:**

1. Attending the daily pre-operation Safety Briefing.
2. Following the instructions in the NSRM Fireman's Handbook.
2. Being responsible to and taking direction from the Engineer and the Conductor.
4. Passing on signals to the Engineer from the Conductor or other Crew Members.
5. Assisting with proper lubrication of the locomotive.
6. Protecting the locomotive under his charge from damage, carelessness, mishandling and any mechanical or safety failure.
7. Monitoring fuel and water levels.

**Requirements:** Thirty hours as a Conductor, followed by thirty hours as a Fireman Trainee, recommendation by the Crew Chief and successful completion of the Fireman Qualification Test. This will be followed by a 'practical factors' demonstration with certification of competence by the Road Foreman [Chris DeWitt] (or his designee). A Fireman must be at least 21 years old.

**All positions require that the Crew Member have passed the NSRM Rule Book / Safety Test. Attendance at the annual Safety Meeting is required to maintain status as a Crew Member.**

**In addition to the items described in this manual, a candidate for the position of Conductor, Fireman or Engineer must also demonstrate over time that he is always aware of the operating environment of the museum and that he consistently exercises good judgement about the needs of the public, the needs of the train crew, the operation of the train, and the importance of safety. The Road Foreman (or his designee) and the Crew Chief must make this subjective evaluation and both must agree to the promotion of a candidate to any of these positions.**

## 1.0 INTRODUCTION

This Fireman's Handbook is intended to provide the basic information needed to perform the duties of a Fireman. Any update of the safety information will be noted in the text as a revision from the previous issue of the handbook.

Appearance is important. Firemen must be neatly dressed and groomed.

**You should at all times wear your volunteer's name badge.**

It is preferred, but not mandatory, that Firemen be dressed in the typical NSRM uniform: a museum logo shirt, jeans or overalls, a railroader's cap and jackets or coats when required by the weather.

Footwear is an important factor in safety. Wear work boots/shoes with soles and heels firmly attached and heels that are not excessively worn. Suitable footwear around shops, tracks, and moving equipment does NOT include high-heeled boots or shoes, sandals, low quarter slip-on shoes or tennis shoes.

Because of exposure to hot metal it is advisable to wear long sleeved shirts and gloves.

**You should carry your NSRM Rulebook at all times while on duty.**

## 2.0 SUMMARY OF FIREMAN'S DUTIES

The Fireman has responsibility for preparing the locomotive for use and maintaining safe and appropriate conditions for the duration of the day's operation. The Fireman will work in conjunction with and under the direction of the Engineer. He will also direct and monitor the activities of the Hostler Helpers and Hostlers in their duties.

The Fireman **MUST** have a thorough knowledge of the locomotive appliances and the operation of each. This will include the brake system, combustion system, methods of proper lubrication, electrical generation, and proper use of the water delivery and monitoring system including the injector, gauge glass and try cocks.

Before volunteering to serve as Fireman individuals should evaluate their aptitude at handling mechanical devices under critical and rapidly changing conditions. The job of Fireman is a position that cannot be learned or performed by using rote methods. A comprehensive knowledge of the basic skills is necessary in order to be able to safely respond to conditions which may arise. Serious injury or equipment damage could occur if mistakes are made while working in this capacity.

Because of exposure to hot metal it is advisable to wear long sleeved shirts and gloves.

### 2.1 PRIOR TO LIGHTING FIRE IN LOCOMOTIVE

Before moving locomotive from the Annex the following must be done:

1. All doors through which any portion of the train will pass must be fully open to the maximum of their travel and the operating chain secured with a keeper.
2. Inspect locomotive surroundings to make sure that there are no obstructions to be hit when moving the locomotive.
3. Ensure that the Dinky is coupled and the operator is aware of the movement to be done.
4. Release tender hand brake and make sure that reverse lever is positioned in the direction of intended movement and cylinder cocks are open.
5. Remove chain blocking driver and stow on its hook.
6. Position a person in a location to ensure that pedestrians and other workers can be made aware of the movement.
7. When all is clear signal Dinky operator to move locomotive from building.
8. When locomotive is clear of walk signal Dinky operator to stop.
9. Remove chain from hook and place on both sides of driver nearest the engineer's cab window. Set tender hand brake.
10. Notify Dinky operator that movement is complete and Dinky may be shut off or relocated.

## 2.2 LIGHTING FIRE IN LOCOMOTIVE

1. Remove stack cover and if there is no pressure in the boiler insure that atmosphere valve on steam dome is open.
2. Using try cocks, determine the water level in the boiler. Confirm that valves to water glass are open and that water glass shows the same level.
3. Check water and fuel levels in tender.
4. If there is no pressure in the boiler attach shop air line and start shop air compressor.
5. Inspect firebox for leaks or brick damage using a flashlight. Inspection can be made by the light of the burning rag used to start the fire.
6. Open damper on firebox door and main firebox damper.
7. Cut in air line (or steam, if the boiler has pressure from a previous operation) to atomizer and blower and open valves to each in order to clear the line of any condensed water. Close valves after lines are clear.
8. Make sure that oil firing valve is shut and open oil valve beneath apron plate on Fireman's side of cab.
9. The oil tank heater and oil line heater should **NOT** be used when burning light (diesel) oil in the locomotive. The crew will be notified by the Road Foreman if heavy oil is being used.
10. Toss a lighted rag or fusee into the firebox in front of the burner.
11. Replace baffle and close firebox door.
12. Open oil valve on the top of the tender oil tank.
13. Using the blower, atomizer and firing valve, light fire in the firebox and adjust to maintain a spot fire. Log time that fire was lit.
14. When starting with a cold boiler three hours should be allowed before reaching operating pressure. With a warm boiler allow two hours. Building steam at a faster rate causes uneven expansion of the boiler and can cause damage.
15. When starting with a cold boiler allow steam to escape from the atmosphere valve for three minutes before closing valve.
16. When starting with a cold boiler allow steam pressure to reach approximately 20 psi before transitioning to steam atomization and removing house air line.
17. Stop shop air compressor if it was started.
18. Allow steam pressure to build until safety valve lifts. It will be necessary to monitor and adjust firing controls as pressure in boiler builds. Note pressure and time of safety valve lifting in log.

19. The Fireman is responsible for oiling and greasing the locomotive prior to train service and must be familiar with the proper methods and lubricants for all points to be lubricated and for appliances such as the air pump and dynamo.
20. Sand in both the sand dome and sand box should be checked and filled as necessary.
21. Prior to departure for train service the Fireman must insure that all oil cans are filled and tools needed for routine service are available. Oil cans are not to be left in the gangway between the tender leg and the back of the cab where they present a tripping hazard and can be crushed if the locomotive is moved.

### **2.3 FIRING LOCOMOTIVE IN TRAIN SERVICE**

1. The Fireman, in addition to his duties of maintaining safe operating conditions in the locomotive boiler, must be another set of eyes for the Engineer. The Fireman must be able to alert the Engineer of changing conditions, dangers or signals that come to his attention. This is especially important when approaching crossings, arrival and departure from the depot, when there are pedestrians present or during switching movements. The Fireman must, whenever possible, visually inspect switch point orientation to verify that switch is aligned consistent with movement.
2. It is the duty of the Fireman to ring the bell as a warning of impending movement, at grade crossings, approaching the depot or whenever pedestrians are in close proximity to the tracks.
3. Anticipation to actions of the Engineer is important in being able to keep the fire and water properly adjusted to react to changes in throttle and reverse lever settings.
4. Water should be carried in a manner consistent with the anticipated roadbed grade and steam usage in order to prevent a low water condition. Water should always be visible in the water glass to insure a safe operating margin.
  - a. When operating tender-first upgrade the water level in the boiler must be carried high enough to account for water running to the front of the boiler when the grade is encountered.
  - b. When operating boiler-first upgrade the Fireman must anticipate a drop in water level when the locomotive encounters a flat or downhill grade.
5. When using the injector it is preferable to add water in short, frequent amounts rather than long, infrequent amounts. Small amounts of water will cause less thermal shock to the boiler and it will be easier to maintain a steady fire. Also, the injectors will function more dependably if they are kept cool by adding water frequently.
6. **IN THE EVENT OF INJECTOR MALFUNCTION IMMEDIATELY INFORM THE ENGINEER TO START HIS INJECTOR. IF THE WATER LEVEL DROPS BELOW A SAFE OPERATING LEVEL INFORM THE ENGINEER TO STOP UNTIL THE PROBLEM IS RESOLVED. THE FIREMAN SHOULD BE FAMILIAR WITH THE THEORY AND OPERATION OF THE INJECTORS USED ON THE LOCOMOTIVE IN OPERATION INCLUDING MEASURES TO BE TAKEN IN THE EVENT OF MALFUNCTION.**
7. The Fireman is responsible for monitoring the water level in the tender and informing the Engineer and Conductor when water is needed to be taken on.

8. In the event that the fire should go out while operating it is imperative that the proper procedure is followed to relight. Combustible gasses can easily accumulate in the firebox causing an explosive condition. If the fire should go out the following methods should be used to relight:
  - a. Reduce atomization of fuel. Over atomization can “blow” the fire out.
  - b. If the fire does not relight immediately close the firing valve and purge combustible gasses from the firebox using the blower.
  - c. When firebox is clear of gasses attempt to relight by using slight atomization and slowly open firing valve.
  - d. If fire will not relight it will be necessary to use a lighted rag or fusee.
  - e. **DO NOT OPEN FIREBOX DOOR OR ATTEMPT TO VIEW FIREBOX THROUGH THE PEEP HOLE UNTIL GASSES HAVE BEEN PURGED FROM THE FIREBOX USING THE BLOWER. SERIOUS INJURY COULD RESULT IF THIS INSTRUCTION IS NOT FOLLOWED.**
  - f. When conditions allow, the fire can be relit using a lighted rag or fusee.
9. In order to prevent boiler water impurity concentrations the locomotive should be blown down regularly. As a general rule this should be done every other run during normal operations.
10. When relieving a crew member in the Fireman position the relieving Fireman must blow down the water column and verify the water level using the try cocks.
11. The Fireman shall maintain an efficient fire with a minimal amount of smoke and should use the blower only when necessary. Generally, a proper fire should emit a slight haze from the stack.
12. When taking water from the tank the Fireman should solicit assistance from an additional person to help position and secure the spout in the tender hatch. If possible the Conductor will assign a Brakeman to help. When first taking water during an operational day the spout should be purged of debris by running a bit of water through it before opening the tender hatch. The water tank valve should be opened slowly to prevent the spout from being disengaged from the feed pipe. The personnel engaged in adding water should be careful to prevent excessive contact with the water due to the presence of boiler treatment chemicals. If contact occurs the affected area should be flushed with fresh water.

## **2.4 PREPARING LOCOMOTIVE FOR THE END OF THE DAY**

1. When putting the train away following the last scheduled run the Fireman should sand the boiler tubes. This should be done with the cooperation of the Engineer when the train is in a location to prevent the soot from negatively impacting the surroundings and must be done when the locomotive is working steam. When possible the Conductor will assign a crewmember to assist in this procedure.
2. While the locomotive is being returned to the annex the Fireman should gradually raise the water level to the top of the gauge glass prior to extinguishing the fire.

3. If the locomotive is to be operated on the following day the Fireman should allow steam pressure to build to just below the point of lifting the safety valve before extinguishing the fire.
4. Extinguish the fire in the locomotive prior to putting the locomotive into any building.
5. Before leaving the locomotive the Fireman must make sure that all appliances and valves that are his responsibility are secured.
  - a. The valves that are specifically the fireman's responsibility are:
    - i. Firing manifold valve and firing valves
    - ii. Fireman's injector
    - iii. Squirt hose
    - iv. Tender water valves
    - v. Tender oil shut off, top and bottom
    - vi. Water glass valves
  - b. The valves that are specifically the engineer's responsibility are:
    - i. Air pump steam valve
    - ii. Air pump drain
    - iii. Drifting valves
    - iv. Cylinder cocks
    - v. Main reservoir drain valve
    - vi. Lubricator steam valve
    - vii. Dynamo valve
    - viii. Engineer's injector
    - ix. Main manifold valve
    - x. Saddle drain
    - xi. Dynamo drain
    - xii. Air pump steam exhaust line drain
6. Check that the Conductor has called Simplex/Grinell (the fire alarm company) to report that a hot locomotive has been put into the building.
7. The stack cover must be put into place after the locomotive is in the building and the engine will not be moved again.
8. The enginemen must keep clutter to a minimum and clean the cab at the end of the day.
9. Enginemen must be certain that an 'Engine Report' has been filled out. You should use the same form to report problems with cars or any other train equipment. Anyone can fill out a report. Enginemen must file a report for each day of operation even if no defects are noted. This assures the shop employees that a report was filed and not forgotten. Make all prudent entries in the logbook.
10. Record your volunteer hours for the museum's records.

## 2.5 BUILDING SECURITY

All buildings on the NSRM property must be secure at the end of each day.

- A) It is the responsibility of Museum Staff to lock the doors on the restrooms as well as to close and lock the doors and activate the alarm at the Interpretive Center.
- B) Before the last run the Conductor will assign one Brakeman to ensure that the wheelchair lift is put away and that all doors and windows at the Wabuska Depot are securely fastened and locked before the train is returned to storage. Generally Museum Staff will be the last to leave the depot and will lock the doors but a member of the Train Crew must check that this has been done.
- C) The Conductor will assure that the Annex Building is secure.
  - 1. The Turntable must be secured and padlocked when switching moves are complete.
  - 2. All overhead doors must be closed and the chain which operates the door secured with a keeper.
  - 3. The gate inside the building that separates the public area from the non-public area is to be closed, and if possible, latched.
  - 4. Check that the doors to the Archive Office area are closed and locked.
- D) **Because they are the last to leave the building, the Enginemen are responsible to ensure that all shop doors and the door behind which the locomotive is stored are closed and locked. In addition they must check that the compressor has been turned off and that the other doors of the building remain secure.**
- E) The last person to leave the Nelson House must ensure that trash has been removed, all of the windows are closed and latched, and the door is locked.

## 2.12 ELECTRONIC DEVICES

The Federal Railroad Administration has issued Emergency Order #26 regarding the use of electronic devices by train operating crews while on duty. Though our operation is not governed under rules of the FRA, adoption of this rule enhances safety of crews and passengers and as such is made part of our operating rules.

- A) These rules are effective when on a moving train, when duty requires any crewmember to be on the ground, when a crewmember is riding rolling equipment during a switching operation and when any other employee of the railroad is assisting with the preparation of the train.
- B) Hearing aids and digital watches are permitted.
- C) Personal electronic/electrical devices must be turned off with any earpiece removed from the ear. This includes, but is not limited to, cell phones, audio players and video players. Any of these devices located in the locomotive cab not only must be turned off but also stored in the engineer's or fireman's seat box.
- D) Exceptions:
  - 1. In the event of an emergency or other problem the Conductor or his designee may use a cell phone to contact Emergency Services or museum staff. This cell phone should remain on but is for duty use only.
  - 2. These devices may be used while on a designated lunch break.
  - 3. As long as it does not interfere with the performance of their other duties crewmembers may take pictures using a digital camera.
  - 4. These devices may be used if all crewmembers have been notified that operations have been suspended.
- E) The Nevada State Railroad Museum does not supply any electronic/electrical devices for use during train operations.
- F) The FRA has provided the attached flow-chart for your information.



# FRA EO 26 – Electronic and Electrical Device Flow Chart

Use of Personal or RR supplied electronic/electrical devices may NOT interfere with RR operating employees performance of safety related duties

Use of RR supplied electronic/electrical devices **PROHIBITED** when:

Personal electronic/electrical devices **MUST BE TURNED OFF** with earpiece removed when: (other than a hearing aid device)

Other RR Operating Employee\*

Locomotive Engineer/ RCO

All RR Operating Employees\*

On a moving train unless:

- Authorized for business purpose
- A safety briefing is held
- Crew agrees it is safe to do so

or  
Authorized business purpose within the body of a passenger train or RR business car

Outside the cab unless:

- Not fouling a track
- No Switching Operation is underway
- No other safety related duties
- All crew members have been briefed that operations are suspended

On a moving train

or  
When a duty requires any crew member to be on the ground

or  
When a crew member is riding rolling equipment during a switching operation

and  
During any period when another employee of the RR is assisting in preparation of the train

On a moving train

or  
When a duty requires any crew member to be on the ground

or  
When a crew member is riding rolling equipment during a switching operation

and  
During any period when another employee of the RR is assisting in preparation of the train

- Exceptions:**
- (1) May use digital storage and display function of personal or RR supplied device to refer to RR rule, SI, TT, other directive, if authorized by RR operating rule or instruction:
  - (2) May use Personal or RR supplied device as necessary to respond to an emergency involving the operation of the RR;
  - (3) Engineer/RCO may use electronic control systems and information displays presented within locomotive cab or on RCO transmitter including functions associated with controlling switches;
  - (4) Under authorized conditions of 49 CFR 220, may use a RR supplied/authorized device in lieu of RR radio, to conduct train or switching operations;
  - (5) May refer to a digital timepiece to ascertain time of day or verify accuracy of speed indicators.

**Note:**  
**WHILE ON DUTY** use of personal electronic/electrical devices for other than voice communication is prohibited except as noted above

\*Means a person performing duties subject to 49 U.S.C. 21103, "limitation on duty hours of train employees."

## 2.6 STANDARD CLOCK

The Standard Clock is in the Restoration Shop. This railroad runs on Pacific Time. The Standard Clock is set automatically via radio signal several times a day. You should adjust your watch to be within one minute of the Standard Clock. Compare your watch with that of the Conductor. Use of a digital watch is permitted.

## 2.7 EXCEPTIONS

All of the above describe the regular activities of an ordinary day's operation. **There is never an ordinary day's operation.** Be prepared for changes in your work necessitated by safety concerns, a different routine (such as Santa Train or night operation), differing equipment or the needs of the museum.

**BE FLEXIBLE**

**BE SAFE**

**1928**

# ***Southern Pacific***

**Rules and Information**

**on**

**Firing & Handling of Locomotives**

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# DEFINITION OF TERMS

<b>Atomizer:</b>	That portion of burner which delivers steam used for carrying and breaking up oil into small particles to aid combustion.
<b>Black Smoke:</b>	Carbon from partially consumed oil. A sign of imperfect combustion and improper handling of firing device.
<b>Brick Work:</b>	Fire brick used in lining firebox and draft pan to protect mud ring, firebox, fire pan and fire door.
<b>Burner:</b>	A device for atomizing and delivering oil to the firebox.
<b>Carbon:</b>	A grayish black substance forming on the floor or flash wall. Generally formed by some foreign substance, broken brick, tool or waste being left on floor of fire pan, by improper alignment of burner, or by air leaks in fire pan.
<b>Damper:</b>	A metal cover used over the air intake to the fire pan to regulate the amount of air admitted to firebox.
<b>Fire Door:</b>	An opening in back head of boiler through which workmen may enter fire box for inspection and repairs.
<b>Fire Lighter:</b>	Consists of a piece of netting formed in any convenient shape to hold a piece of waste saturated with oil. This netting is attached to a light rod of sufficient length to reach burner.
<b>Firing Valve</b>	A device for regulating the flow of oil to burner.
<b>Flash Wall:</b>	An arrangement of fire-brick in the fire pan toward which fuel oil is delivered and which assists in ignition of the oil and deflects the course of the flame.
<b>Heater:</b>	A pipe controlled by a valve through which steam passes to heat the oil.
<b>Manhole:</b>	The openings in the oil and water tanks in tender.
<b>Measuring Rod:</b>	A steel rod for measuring the amount of fuel oil in tank.
<b>Oil Tank Valve:</b>	A device in oil tank for shutting off flow of oil to burner.
<b>Peep Hole:</b>	A small circular hole in fire door sometimes called sand hole.
<b>Sand Scoop:</b>	A scoop used for delivering sand through peep hole in fire door to remove soot from flues.

**-- Instructions relative to the duties of locomotive firemen --**  
**BEFORE LEAVING INITIAL STATION**

1. Register name on roundhouse register in proper place, showing amount of rest had previous to being called. Examine bulletin board.
2. Upon entering the cab of locomotive for departure of a trip, first ascertain amount of water in the boiler by trying water gauge cocks, also note water level in water glasses. If there is no indication of water, immediately put out the fire, and in no case attempt to put water in the boiler before consulting the engineman. If water shows in the gauges, to determine the true level open water glass cocks, open drain cock to water glasses to clear glasses out, and see if circulation is free; then close drain cock. Then compare with engineman to determine if registering correctly.
3. Examine firebox for any foreign matter, condition of brick work and burner, and note if flues are free from leaks.
4. See that the following supplies are on locomotive: (Habit should be formed of checking them in the same order each trip and the absence of any supplies will then be more quickly noted.) 2 red flags, 2 green flags, 2 white flags; 6 red fusees; at least 12 torpedoes; red and white lantern; **indicator stencils and “dash” stencils** – blank stencils; waste; valve oil can; engine oil can; compound for boiler (if used) and bucket for mixing same; engineman’s tool box, oilers and torches. If supplies or equipment are missing, inform the engineman.
5. If called during the night or shortly before sundown, light both lanterns, and display a red lantern on rear of tank while moving from roundhouse to train.
6. Before starting trip see that water tank is full and that there is sufficient fuel oil in tank. Report amount to engineman. Avoid waste of fuel and water at all times. See that sand box is full of sand and contains scoop. Also, see the steam turret valves, both boiler check valves, and both water tank valves are wide open.
7. In blowing out boilers, blow off cock should be opened five seconds then be closed for a similar period, this to be repeated until satisfied that boiler has been blown sufficiently. For best results, boiler should be blown out when standing or with throttle closed, and injector or water pump must not be working.
8. When locomotive is placed on train and your **identification is positively known**, place numbers in indicators, and if necessary, flags of proper color and at night in addition, lights of the same color and from the ground look at each indicator and determine if numbers are correct. Five minutes after lighting classification lights look at them to see if they are burning.
9. When engineman finishes oiling, fill the oilers, and if in winter, place in a position where they will keep warm.
10. Compare watch with engineman.

## DUTIES ON ROAD

11. **Fireman must report to and receive instructions from his engineman.**
12. **When displaying green or white signal lights and markers as per rules 19, 20, and 21 of the Rules and Regulations of the Transportation Department, notice them at frequent intervals to see if both lights are burning properly; if not, notify your engineman at once and comply with the rules.**
13. After taking on water don't fail to place spout to insure proper clearance for other trains.
14. Read train orders after engineman has read them. Observe block signals and track. Fireman should frequently look back on curves along train for hot boxes, stuck brakes, etc.
15. Be sure to look at indicators and classification lights on caboose as well as markers on passing trains and repeat the identification to engineman.
16. Form the habit of looking at your watch passing train-order signals, and after getting into the clear for other trains.
17. In preparing boiler compound, use ¼ lb. per 1000 gallons water and dissolve thoroughly in a bucket with hot water taken from the squirt hose. When mixing compound with hot water stir well so it will be thoroughly dissolved. Be sure all cold water is drained from squirt hose before mixing with the compound as cold water will not dissolve the compound thoroughly. After compound is thoroughly dissolved, pour contents of bucket into locomotive water tank before taking water.
18. Where locomotives continue on train through terminals, and crew is relieved, firemen will see that long spout engine oil cans are filled before arrival at such terminals.
19. Fireman must keep bell oiled and tell engineman of any work coming to his notice that should be reported.

## ON ARRIVING AT TERMINAL

20. Take down flags, put out classification lights, remove numbers from indicators and replace in box provided. Flags should be neatly rolled up and placed in box provided.
21. On arriving at terminal, if at night, hang a red lantern on rear of tank before locomotive is cut off **and remove same when locomotive is placed on roundhouse lead.** When locomotive stops on roundhouse lead see that boiler has a full glass of water. Report to the engineman amount of fuel oil in tank.
22. Examine firebox to determine condition of brick work and flues and report to engineman.
23. On arrival at roundhouse register information required and be sure caller knows where to locate you.

## STARTING THE FIRE

24. Start the fire in a locomotive as follows:

See that the locomotive is securely blocked.

Have two gauges of water in the boiler, determining the water level by use of the gauge cocks. Note condition of water glasses.

Remove carbon, fire brick or other obstructions that would interfere with the flame from the burner to opposite end of firebox.

Open the damper.

Insure flow of oil to burner by heating oil in tank to proper temperature and by mild circulation of steam through engine oil heater.

Open the blower valve enough to create a light draft through the firebox.

Blow out any condensation that may be in the steam pipe or steam passage of burner by opening the atomizer valve for a few seconds.

Open the oil tank valve.

Apply the fire lighter in the firebox and stand to the left of the fire door.

Open atomizer valve enough so that when the oil begins to flow the steam current will be sufficient to carry the oil to the fire. Open firing valve carefully to avoid a heavy explosion when the oil ignites using only enough oil to generate steam without making black smoke. It is imperative that the atomizer be opened first, then open the firing valve gradually.

**Observation may be made through fire door, but guard against the out-flash of flame that may follow the ignition.**

**In firing up a locomotive the fire may, from some cause, go out; watch it closely until the boiler is hot. If fire goes out, it must be re-lighted by applying the fire lighter.**

**Lighting it from heated bricks causes an explosion which may result in personal injury and damage the brickwork.**

**When starting fire, in a locomotive having steam in the boiler, that has been extinguished from any cause, see that the blower is on enough to draw the gases from the fire box and flues, as neglect of this precaution may cause an explosion.**

When firing up a locomotive not under steam, the engine house steam line should be connected and used to supply steam for both the blower and the atomizer of the locomotive.

After the boiler has accumulated forty pounds pressure of steam the engine house steam line should be disconnected and steam supplied from the locomotive boiler.

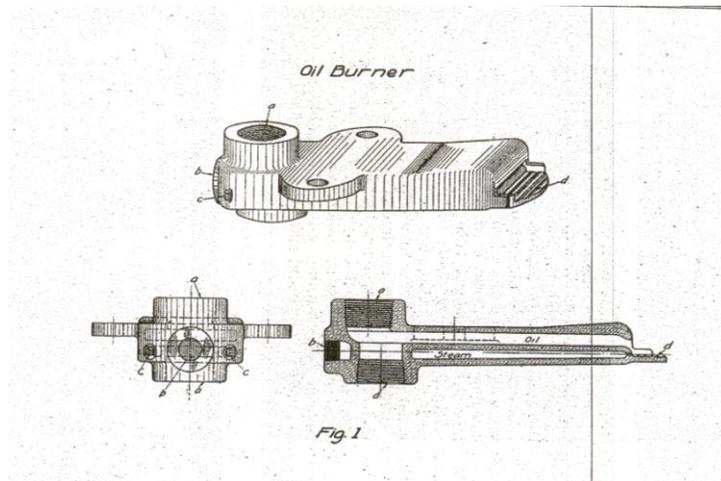
Wood should be used in starting the fire when steam pressure is not available to work the atomizer and blower. Be careful when putting the wood in the firebox not to damage the brick work or burner.

Carefully adjust the atomizer and the firing valve so that the oil will be atomized and consumed as it passes from the burner. Careless adjustment may cause part of the flow of oil to drip down from the burner and be wasted, or by dropping into the pit may cause damage by fire or explosion.

Before starting the locomotive, all wood must be completely burned or removed from the firebox to avoid danger of setting fire to adjacent buildings or inflammable material. Sparks from burning wood will readily go through the flues and stack when locomotive is working.

## ADJUSTMENT OF BURNER

Figure No. 1



25. The burner must be adjusted so that the atomized oil will strike the flash wall. The burning oil must pass across the firebox parallel with the side sheets and the floor of the firebox. It should strike the center of the flash wall. Should it strike toward one side, that side of the firebox only will be filled with flame, thereby adversely affecting the steaming of the locomotive. If the oil should strike some obstruction before reaching the flash wall, it may result in poor steaming of locomotive and cause black smoke and carbon. The oil and steam ports at mouth of burner must be kept open, and the openings should be uniform throughout their length. If open at one side more than the other, a larger quantity of steam or oil will be drawn from that side. The upper and lower lips of the atomizer port must be even. If there is a slight extension of one beyond the other, it will direct flame upward or downward. Sand holes in the partition wall between cavities of burner will cause irregular flow of oil. Burner should be tested for these defects before being applied. Burner should be carefully inspected and adjusted before the locomotive leaves the roundhouse in order to insure a free steaming locomotive and an economical combustion of fuel. If for any cause the burner should get out of order or out of position while on the road, the engineman should adjust, and report it upon arrival at the terminal.

### INSUFFICIENT FLOW OF OIL TO THE BURNER

26. If the flow of oil to burner is not sufficient for operation desired, it may be due to:
- Low temperature of the oil.
  - Low oil supply in tender tank.
  - The burner or piping being clogged.

## HOW TO “BLOW OUT” BURNER AND OIL PIPES

27. To blow out the burner:

Close the tank oil valve (on tender).

Open blower to create draft through firebox. Open the firing valve gradually until full open. Stand to left side of fire door then slightly open the blow-back valve.

The steam will then pass through the blow-back valve into and through the oil feed pipe and oil opening of the burner, slowly blowing out any oil that remains in the feed pipe. When this is accomplished open wide the blow-back valve for a short time to allow the full steam pressure to blow through the oil passage of the burner. Then close the blow-back and the firing valve.

To blow back the oil feed pipe passage into the oil tank:

Close firing valve,

Open oil tank valve (on tender),

Open blow-back valve.

Allow steam to blow back through blowback valve into the oil tank, driving with it any obstruction that may be in the feed pipe or on the seat of the oil valve.

Then: Close the engine oil heater valve,

Close oil tank valve,

Close blow-back valve.

Except when “blowing out” the oil pipes or the burner, the **blow-back valve must be kept closed.**

If the blow-back valve is left open or if it is leaking, steam will pass into the oil pipe with the oil causing an intermittent flow of oil to the burner, accompanied with black smoke and possible explosions.

## TEMPERATURE OF OIL IN TANK

28. It is important that the oil in the tank be at proper temperature. If oil is too cold, it will not flow freely to the burner, will not atomize properly and the exhaust will have a greater effect on the fire than it should. Overheating the oil makes it difficult to regulate the fire at the burner.

The oil gases make the flow to the burner irregular.

This results in the fire fluctuating and wastes fuel, because a good portion of the gas from the burner escapes unburned. This condition makes it difficult to carry a light fire when drifting or standing. The remedy is to shut off the tank heater and engine oil heater and to take cold oil in the tank at the first opportunity. A bad effect of overheating the oil is that asphaltum separates from the lighter oils and settles at the bottom and the lighter oil is driven off as vapor.

The temperature to which the oil should be heated depends on its viscosity. Ordinary oils used should not be heated over 140 degrees F. Heavy oils must be heated higher. Good practice for judging the temperature of the oil is to place the back of the hand on the outside of the tank near the oil outlet. If oil is too hot it will be uncomfortable to back of hand.

When possible the oil in the tank should be heated when the locomotive is standing. When heating is done by direct use of steam the heater valve should be opened wide and left on

until the oil is at the proper temperature. It should then be entirely shut off and not used again until necessary. It is bad practice to crack heater valve and leave on continuously. Heat the oil and then shut it off. Apply heater at different intervals to keep the asphaltum body well mixed with the lighter oils. At times it will be noticed that the oil in the pipes between the tender oil tank and the burner becomes so cold that it flows too slowly through the burner. This condition may be overcome by early and proper use of the engine oil heater. The oil in the tank may also be heated by opening the blow-back valve and closing oil feed cock.

## **WATER IN OIL**

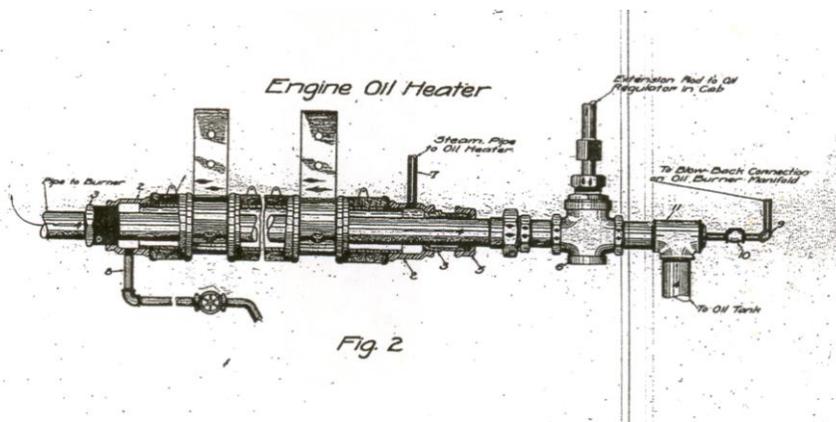
29. Water may accumulate in the oil by improper handling of the **heater valve**. When the locomotive is standing or drifting, this water settles toward the outlet, gets into the oil pipe, passes to the burner and puts out the fire. Water in the oil also produces intermittent flashes or kicking of the fire and at times the fire will die down entirely and then flash up as the water disappears and oil reaches the burner. Water in the oil produces a very dangerous condition.
- It is very important that water shall not be allowed to accumulate in the oil tank, as the spasmodic fire which results will not only cause steam pressure to drop, but there is great danger of making the flues leak.

## **EXPANSION OF FUEL OIL**

30. Heating the oil increases the volume and decreases the specific gravity and weight per gallon through expansion of the oil. Decreasing the temperature decreases the volume and increases the gravity and weight per gallon. The oil changes about one percent in volume for each 25 degrees change in temperature. In other words, 1000 gallons of oil at 60 degrees F. will increase ten gallons, or to 1010 gallons if raised to 85 degrees F. and to 120 gallons if raised to 110 degrees F.; that is to say, 1000 gallons of oil will change 10 gallons in volume for each 25 degrees change in temperature.

# THE ENGINE OIL HEATER

Figure No. 2



31. The engine oil heater is described as follows:

The heater casting or chest (1) constructed of tubing of proper strength to sustain boiler pressure, having ends closed by heads which are in the forms of reducer sockets (2-2). In the outer ends, through bushings (3-3) is fitted an oil supply pipe (4), forming a portion of the conduit through which oil is fed from the supply tank to burner. All steam and oil joints are made tight and piping securely fastened by screwing up cap (5) so that it abuts against the outer end of bushing (3). The heater is placed between the oil feed cock (6) and burner. The front end of the casing (1) is provided with a drain (8) the purpose of which is to drain the condensation and permit circulation of the steam in the heater casing. Connection (7) is made for the steam supply pipe, through which steam is admitted to the heater casing. The blowback pipe (9) is connected with check valve (10) directly into the outer end of T-fitting (11) on oil supply pipe between the oil feed cock and the oil tank supply pipe connection. The check valve (10) allows steam to enter through oil pipe but prevents oil passing back into the blow-back pipe. A direct blast through oil supply pipe can be obtained by opening valve (4), Figures 6 and 7, which will clean out all obstructions.

In the operation of all of engine oil heater, steam is admitted by opening valve (7), Figures 6 and 7. Steam passes into engine heater casing (1), Figure 2, through connection (7) and around the oil supply pipe (4), heating the oil and escaping through drain (8). The valve controlling the flow of steam to heater is called the engine oil heater valve. This valve should be opened sufficiently to allow a light flow of steam through the heater casing, as the opening of the heater valve to its full capacity accumulates high pressure steam in the heater casing and results in gasifying the oil, causing intermittent flow to burner.

When necessary the blow-back valve (4), Figures 6 and 7, may be used to heat the inside of the oil supply pipe (4), Figure 2, by closing the oil tank valve and opening the firing valve and allowing steam to pass through blow-back valve in cab gradually. The firing valve and blow-back valve should always be closed before opening the oil tank valve.

## **THE ATOMIZER**

32. The atomizer is used to spray the oil into small particles by the use of a jet of steam so that it may be more easily vaporized and ignited, also to carry the oil against the flash wall with force sufficient to diverge particles in all directions to effect a condition that will completely fill the firebox with flame.

When the atomized oil strikes the flash wall, the continued driving force assists in further separating it, which, from the effect of the heat present, quickly evolves into inflammable vapors that are thrown off in all directions to burn as they mix with the air being admitted. After closing throttle and cutting down firing valve, cut down the atomizer correspondingly. A slight change in the adjustment of atomizer sometimes produces good results when the locomotive is not steaming well; that must be left to the judgment of enginemen.

Bear in mind that the proper adjustment of the atomizer valve is to use the least amount of steam required to fill the firebox with flame. If this effect cannot be produced, determine if the burner is partially stopped up, or out of alignment, or if there is some obstruction in the direct line of the oil flow, or if the flash wall is intact.

If too much atomizer is used with a little fire, it will create a disagreeable gas and will cause the fire to burn with a series of light explosions.

## **THE BLOWER**

33. It is usually advisable to open the blower when the throttle has been cut off, but when the blower is used, it should be worked as lightly as requirements will permit. When the locomotive is standing, if a greater fire is desired, the blower may be partly opened to give a better draft. The use of the blower increases the draft through the firebox, the additional air bringing in a greater supply of oxygen. Bring the firebox temperature up as gradually as conditions will permit.

## **THE DAMPERS**

34. The dampers must be regulated to suit the conditions under which the locomotive is working. When the locomotive is standing or drifting, fire pan damper must be regulated to prevent excessive cold air being drawn into the firebox, to avoid possible damage to the firebox, sheets and flues. When the locomotive is working, the dampers should be regulated to give proper admission of air to the fire for proper combustion.

## **SMOKE ABATEMENT**

35. Improper adjustment of the firing apparatus is usually indicated by the appearance of black smoke at the stack. Black smoke emitted denotes that part of the carbon has not burned. It would have burned while in the firebox had it come in contact with oxygen. Slightly closing the firing valve will reduce the flow of oil through the burner. Slight use of blower will bring additional oxygen to firebox, burn the free carbon gas, and black smoke will then disappear. If the locomotive will not steam with a slight color at the stack, a further supply

of oil will be a detriment, as soot will accumulate in the flues and cause a greater reduction in steam pressure. Black smoke may be caused by faulty brickwork, or improper handling of the firing apparatus. An accurate combination of oil and steam in the atomizer, with proper admission of air, is necessary to produce thorough combustion. The accumulation of carbon in firebox and soot in flues is due to improper combustion. In passing through the flues, the particles of soot come in contact with and adhere to the inside surface of the flues. Soot is a non-conductor of heat. A sufficient quantity deposited on the flues will make a locomotive fail in steaming qualities. Black smoke should be avoided at all times. A clear stack is not a sign of proper combustion for it may mean an excessive amount of air is being taken into the firebox. The best combustion is indicated by a slight light gray haze at the stack.

## **SANDING FLUES**

36. The locomotive should be well sanded when starting on a trip, selecting a suitable point with view of avoiding smoke nuisance. During this process, engineman will watch the stack, note the change in color and instruct the firemen as the black smoke diminishes. Keep on sanding as long as black smoke follows each application. Use small scoop provided for that purpose. The amount of sand necessary to clean the flues varies with the amount of soot present and also with the manner in which it adheres to the flues.

Sanding should never be done when engineman is not on the lookout ahead, within city limits, or while passing any sidetrack, or over switches. Sanding must not be done near bridges, cotton platforms or buildings or when it is likely to cause any annoyance to the public. After a reasonable application of sand, it will be noted that the amount of escaping black smoke is considerably less. During the first two or three miles the occasional repetition of this sanding process will loosen up considerable more soot, which was present but did not come off with the first sanding. The sanding must be repeated until, by the absence of smoke at the stack, the flues are known to be reasonably clean. In the process of sanding, the locomotive must be worked hard enough to draw the sand through the flues. Firemen will use no more sand than is necessary to clean the flues. The sanding should also be done just prior to entering points where locomotive is to be put in roundhouse or otherwise detained, in order to have the flues clean when firing up again. Atomizer should be slightly reduced and firing valve slightly closed when sanding; also dampers partly closed, that all gases may be carried through flues and out of stack.

## **DRUMMING**

37. The drumming of a locomotive may be due to faulty condition of the brickwork, careless handling of the firing valve, the atomizer or improper damper opening. The disturbance may be taken as a warning that too much oil or steam is being allowed to pass from the burner. The usual cause for drumming is the misuse of the atomizer, or a locomotive not properly drafted.

## **PUTTING OUT FIRE**

38. In putting out the fire, first shut off the oil valve on tender. After the oil in pipes between this valve and the burner has been allowed to flow out and burn:

Close the firing valve.

Close the atomizer.

Close the air pump throttle.

Close front and back dampers.

Engine men leaving the locomotive at point where no hostler or watchmen is located, will put out the fire as outlined above.

## **FILLING TENDER OIL TANK**

39. It should always be borne in mind that fuel oil gives off gas that is highly explosive when mixed with the proper amount of air; it must also be remembered that the rate of giving off gas increases with temperature of oil. In escaping, this gas fills the surrounding air with explosive mixture, which will explode and flash back into the tank. For that reason a lighted torch or lantern should never be brought nearer than ten feet to vent pipe, or oil tank manhole or measuring rod opening.

To avoid overflowing oil tank never fill above marker bar located in manhole strainer. This will allow sufficient room for expansion when heater is applied.

When taking oil and after valve to the spout has been closed, allow the spout to drain before moving from the manhole, to prevent oil from being spilled on top of tank which is hazardous to enginemen and trainmen while walking over top of tank. The top of oil tank should be free from oil at all times. The manhole should be clamped down tightly and under no condition should it be left open, except when tank is being filled with oil.

## **MEASURING OIL**

40. Attention should be given to accurate measurements, and instructions relative thereto should be fully complied with.

To measure the oil, pull up the measuring rod, and wipe oil off at the top. When wiping rod see that threads of waste do not adhere to it as they will finally reach the valves, clog them, and interfere with oil distribution. Do not allow waste to collect on top of oil tank as it may be blown into the oil.

## FIRING LOCOMOTIVES

41. The firing of an oil burning locomotive differs very materially from the firing of a coal burning locomotive and more careful attention is necessary in burning oil than coal to render economical combustion. While the firing of an oil burner does not require any great physical exertion, it demands that close attention be given it at all times to produce satisfactory results. To this end the engineman and fireman must work together. The fireman should observe the movements of the engineman, maintaining as closely as possible the maximum steam pressure; also, an even water level. For the fireman to accomplish this, he must not wait until notified by the engineman to operate the oil valve but every time the engineman changes the throttle or reverse lever, the fireman should regulate the fire. The atomizer must be adjusted as the oil feed increases. Under no circumstances admit more oil than the air supply will burn. Whenever black smoke forms, oil is being wasted. In regulating the air supply that is needed for complete combustion admit enough air to consume all of the smoke but do not go to the other extreme admitting more air than is needed to consume the smoke. The best method of adjusting the draft is by increasing the air supply gradually until the color of the fire in the firebox becomes clear.

It is advisable at first to have a very moderate draft; then, by close observation, build up the fire by gradually increasing the oil feed, atomizer opening and air supply, until the desired fire is produced.

A smoky flame denotes insufficient air and imperfect combustion. An excess of air results in cooling the hot gases, which is wasteful, because the heat is being carried off by the excess air.

42. Principle on which injectors work: ----

The action of the injector is due first to the difference between “kinetic” or moving energy and its “static” or standing energy; second, to the fact that steam at a pressure travels at a very high velocity and when placed in contact with a stream of water it is condensed into water, and at the same time it imparts enough velocity to the water to give it sufficient momentum to overcome a pressure even greater than the original pressure of the steam. By imparting this velocity to the water it gives it sufficient energy to throw open the check valves and enter the boiler against high pressure.

An injector consists of a body supplied with a steam valve, a steam nozzle, a primer, a combining tube, a delivery tube, a line check valve, an overflow valve, a water valve; a lifting injector has a lifting tube.

Difference between lifting and non-lifting injector:--

A lifting injector will create sufficient vacuum to raise the water from the level of the tank.

The steam tubes in a non-lifting injector are different and will not raise the water, but merely force it into the boiler. A non-lifting injector must be placed below the level of the water in the tank so that the water will flow to it by gravity.

A lifting injector will not work with a bad leak between the injector and the tank -- it will not prime because the air admitted through the leak destroys the vacuum necessary to raise the water to the injector level. A non-lifting injector will work, as the water will escape from the pipe instead of air being drawn into it as with a lifting injector.

If an injector primes well, but breaks when the steam is turned on full, the trouble is due to

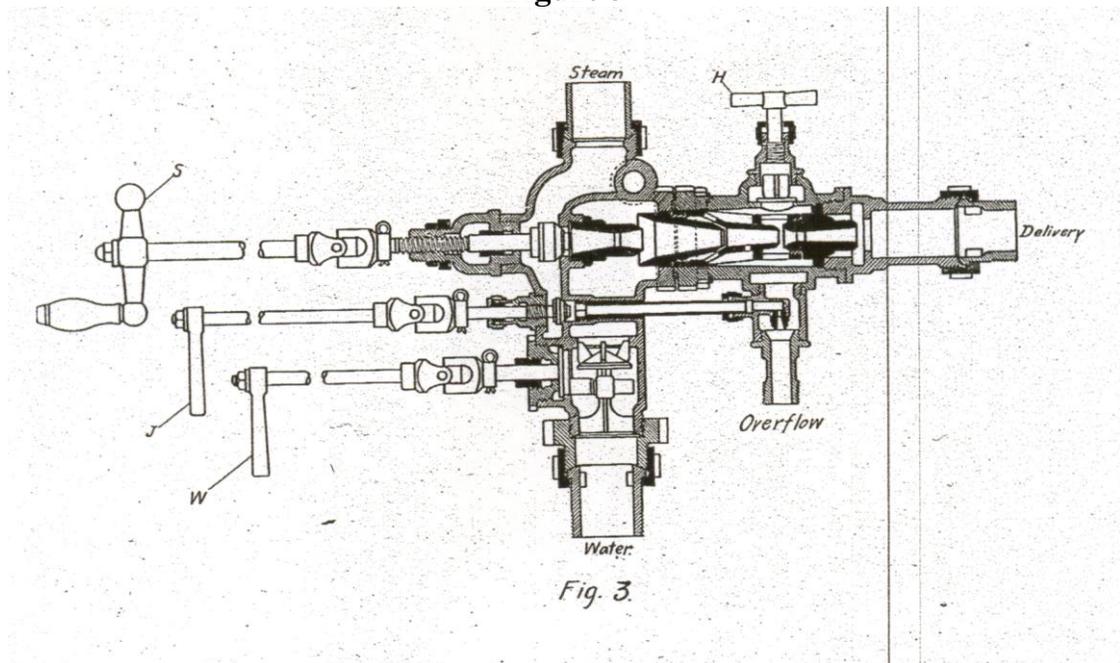
insufficient water supply, tank valve partly closed, strainer stopped up or tank hose kinked, injector tubes out of line, limed up, delivery tube cut-out or wet steam from the throttle. If an injector will not prime, trouble is due to insufficient water supply, priming tube out of order, or with the lifting injector the trouble might be caused by leak between the injector and tank.

An injector will not prime if the injector throttle leaks badly or if the boiler check leaks badly or is stuck up.

If steam or water shows at the overflow pipe when the injector is not working you can determine whether it is the boiler check or injector throttle by closing the main steam valve at the boiler; this will stop the leak if it comes from the injector throttle. An injector will prime if primer valve leaks, but may waste some water from the overflow.

To prevent injector feed pipes or tank hose from freezing in winter when not in use, steam valve should be slightly opened to permit a slight circulation of steam through the feed and branch pipes. The heater cock should be closed and the drip cock under the boiler check or on the branch pipe should be opened to insure a circulation of steam through the branch pipe.

**Figure 3**

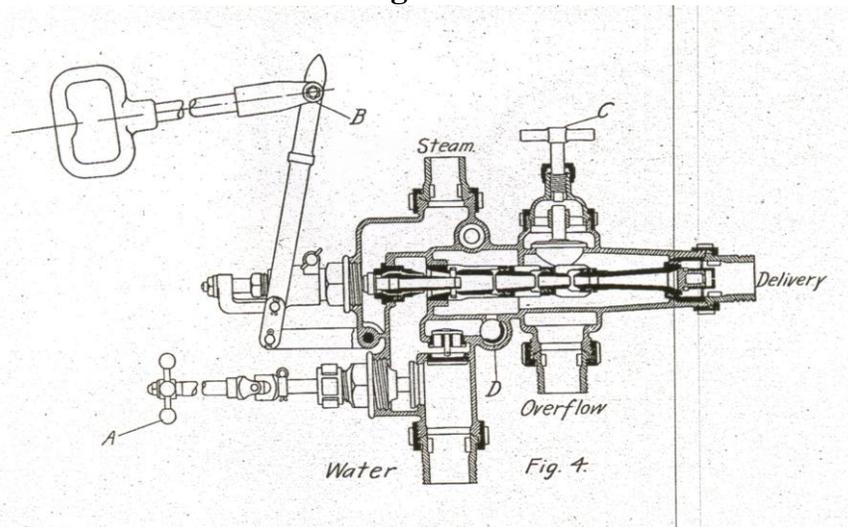


43. Method of operating locomotive monitor lifting injector as shown in figure 3:  
To start: open valve W; then the open valve J. When water appears at the overflow, open valve S until overflow ceases, and then close valve J. Do not increase steam supply after overflow has ceased.

To stop: Close valves S and W.

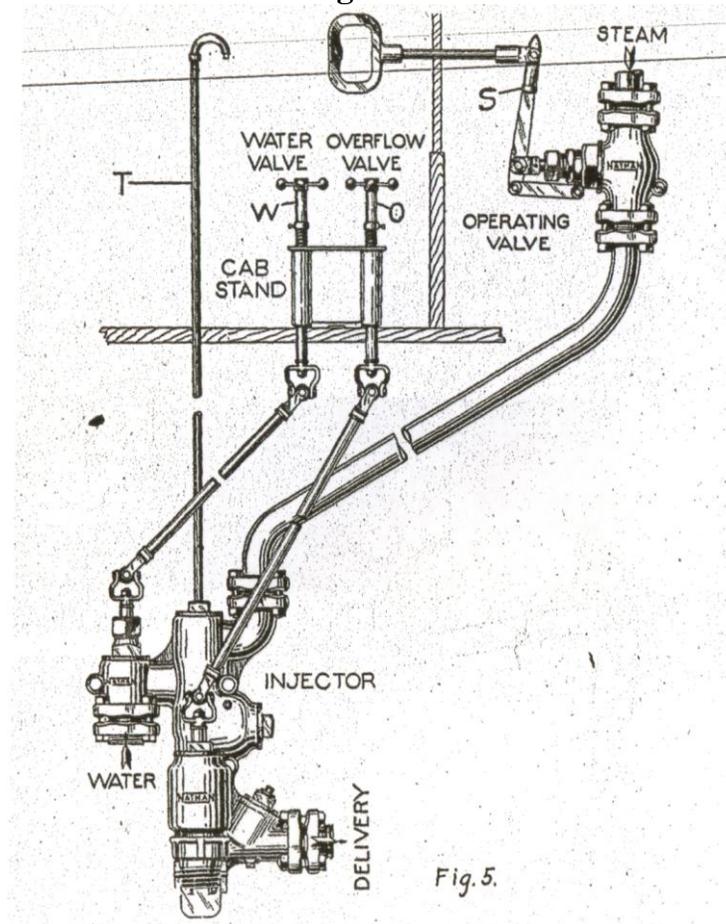
To blow-back injector or to apply heater, close valve H and open valve S.; but the valve H should never be closed except when the injector is to be used as a heater. Regulate quantity of water needed by valve W. To cut down the injector, throttle water by valve W. If this is not sufficient, reduce the quantity of steam supplied.

**Figure 4.**



44. Method of operating locomotive lifting injector's Simplex Type, shown in figure 4:  
To start: open water valve A; then pull out lever B. Regulate quantity of water needed by valve A. To use as heater from the feed water, close cock C and pull out lever B.  
To stop: push in lever B. In operating lever B it should be handled gently, never pull or close same with a bang. When injector is in operation should water continue to flow out the overflow it is generally caused by the water inlet valve leaking and prevents the prompt lifting of the feed water; it will only be necessary to turn around key D., so that the letter "S" on the Square spindle end will be up. This will permit the continued use of the instrument, until inlet valve can be repaired. Upon arrival at roundhouse this should be reported.
45. Method of operating 1918 Special "A" and "B" non-lifting injectors as shown in Figure 5:  
To start: Open water valve W; then open overflow valve O. When water appears at overflow, pull out operating valve lever S to its full extent. To stop: push in lever S and close either the overflow valve O or the water valve W. In shutting off injector while on the road, it is preferable to close overflow valve, thus avoiding disturbing adjustment of water valve controlling water supply. Quantity of water needed is regulated by water valve W. To blow back injector or to apply heater, close overflow valve O, open water valve W, and slightly pull out operating valve lever S. If the feed water is warmer than the injector will take up without spill at the overflow, overflow valve O must be closed after the injector has been started. When injector breaks, steam will blow through tell-tale nozzle T in cab. If injector does not start again automatically, push in lever S and start over.

**Figure 5.**



*Fig. 5.*

## **FEED WATER HEATERS**

45. The purpose of the feed water heater is to reclaim the heat in a portion of the exhaust steam that otherwise would be wasted at the stack and return it to the boiler in the feed water, thus reclaiming a large amount of waste heat and reducing the amount of heat required in the furnace to raise the temperature of the water in the boiler to that of the steam at the prevailing boiler pressure.

The proper use of feed water heaters ensures a fuel savings off from 10 to 20 percent, depending on operating conditions. This saving is due to the fact that less fuel is required to convert hot water into steam and in part to the increase in efficiency of the boiler because it has less work to do when part of the heating of the water is accomplished in the heater. Due to the fact that the waste steam is condensed and used again in the boiler feed water, the heater also has the effect of increasing the effective water tank capacity from 12 to 15 percent.

## **FEEDING WATER TO BOILERS**

47. In supplying water to boiler, a small quantity at a time (not over 1 inch in glass) should be fed when locomotive is not working, as circulation is not active and as the water delivered to the boiler is comparatively low in temperature, it settles to the bottom, causing contraction resulting in boiler leaking.

The best results will be obtained while engine is working by feeding the boiler to maintain an even water level at all times; it is also important to maintain an even steam pressure.

Irregularity in supplying water to boiler, also allowing steam pressure to vary, causes contraction and expansion of flues and sheets which result in leaky boiler. The steam pressure should not be allowed to vary more than 5 pounds from the maximum.

Great care must be taken on approaching the top of a hill or station, where it is expected the locomotive will be shut off, to gradually slow down so that the water in the boiler may be increased to a point where the injector can be immediately shut off when the throttle is closed. Starting out of a station with the injector working will materially reduce the steam pressure.

On locomotives equipped with feed water heaters the pump should not be used to supply the boilers when engine is not working steam as there is no available exhaust steam flowing to heater to heat the water. The pump should be started immediately with the opening of the locomotive throttle and regulated to maintain an even water level in boiler at all times and to have sufficient water in boiler approaching stations and on approaching top of hills where it is expected that locomotive throttle will be closed. In event more water is wanted the injector should be used to maintain the water level.

## **LOCATION OF OIL BURNING EQUIPMENT**

48. The various cab valves, tank fittings, and other oil burning equipment shown in Figures 6 and 7 are as follows:

- No. 1 – Blower Valve
- No. 2 – Atomizer Valve
- No. 3 – Tank Oil Heater Valve
- No. 4 – Blow-back Valve
- No. 5 – Oil Regulator
- No. 6 – Oil Feed Cock
- No. 7 – Engine Oil Heater Valve
- No. 8 – Oil Heater Drain
- No. 9 – Check Valve
- No. 10 – Oil Heater Pipe.

Figure 6.

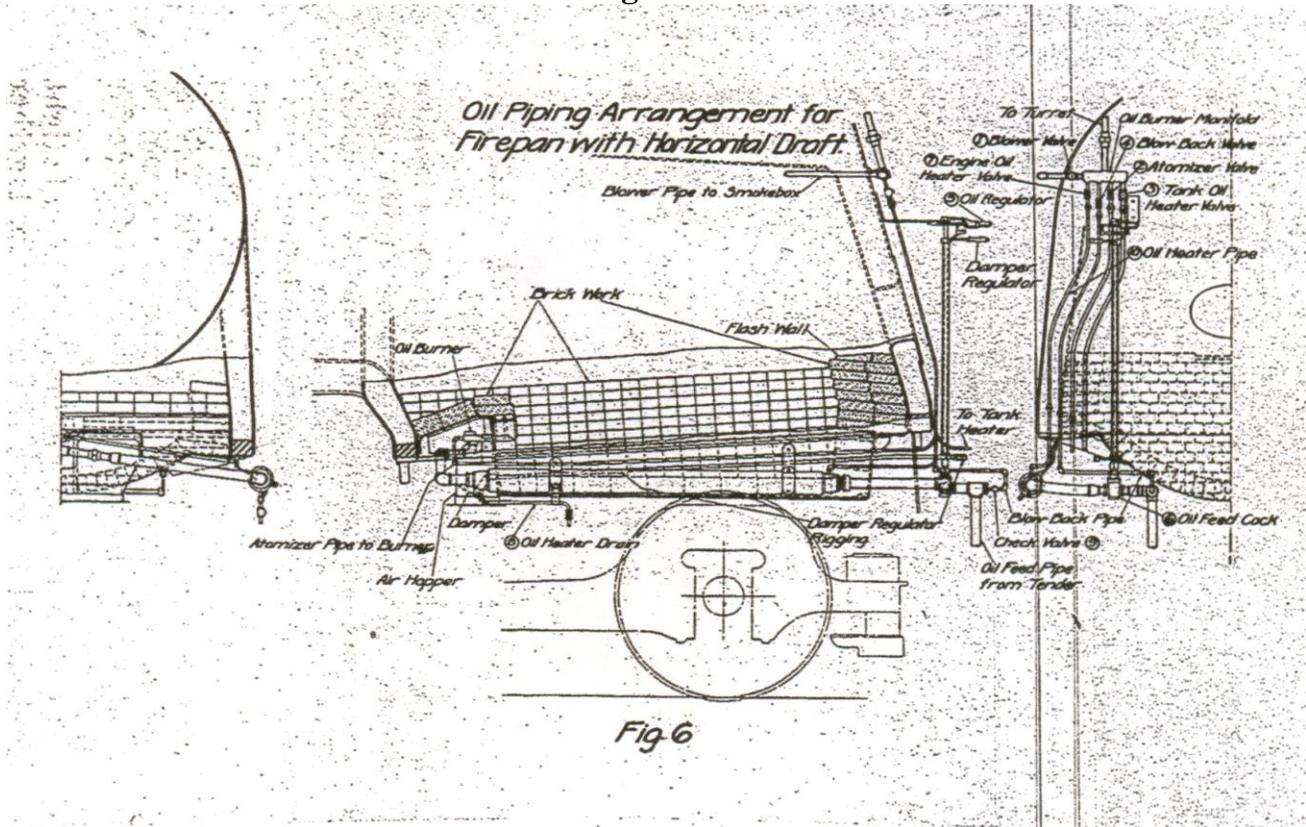
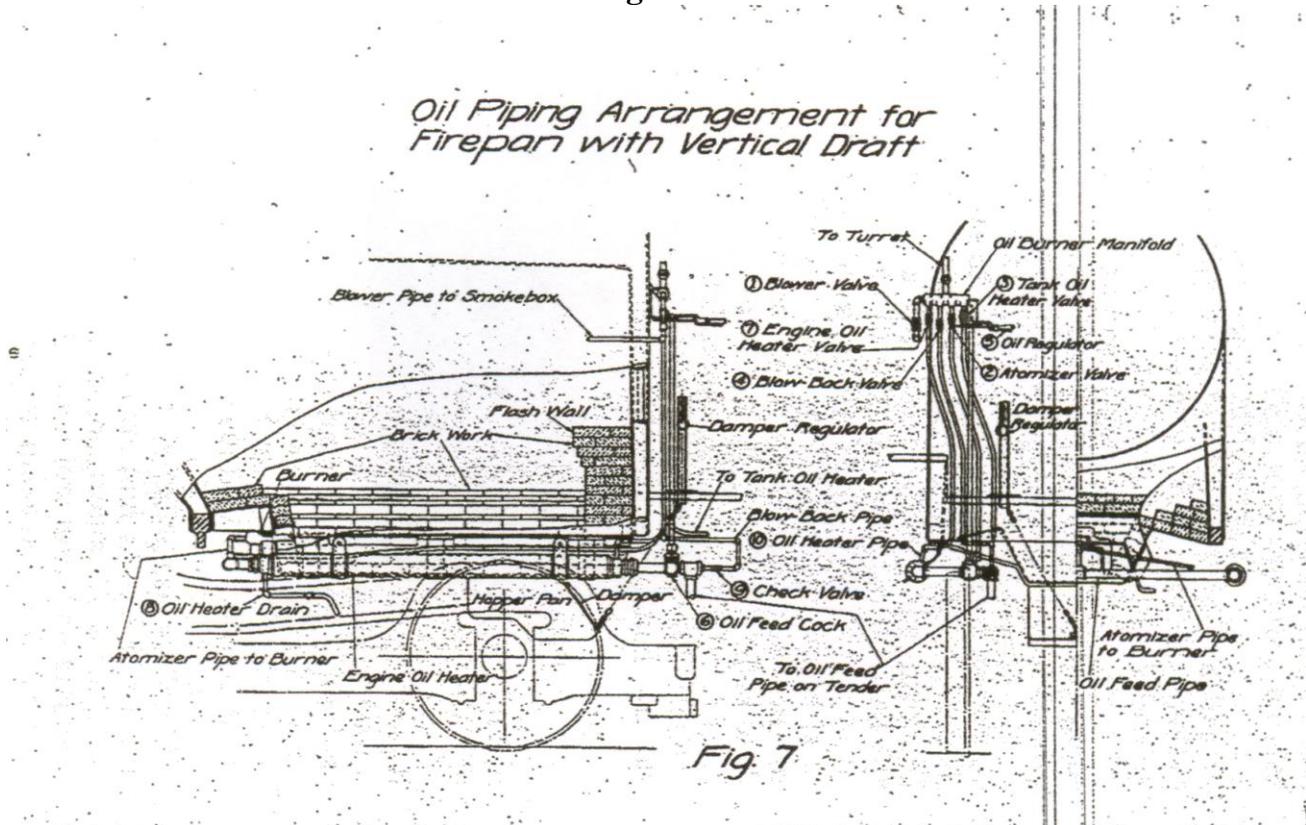


Figure 7



## ROUNDHOUSE INSPECTION OF LOCOMOTIVES

49. On arrival of locomotives at engine house, thorough inspection of firebox, fire pan, and firing apparatus, should be made. The fire pan must be free from any obstruction of brick or carbon accumulation.
- See that joints between the fire pan and the firebox are absolutely airtight. Air leaks at these points produce bad results. The oil and steam channels of oil burner should be thoroughly cleaned out, using a saw blade for this purpose.
- Smoke boxes should be absolutely airtight and should be examined each trip together with front end steam pipes and petticoat pipes. Baffles to be in good condition and properly adjusted.
- Flame from burner should strike flash wall in center, and not strike floor of fire pan before striking flash wall. Draft openings in bottom of fire pans should be cleaned out thoroughly each trip. No lost motion should be allowed in firing device. Sand for standing flues should be fine in size, and thoroughly screened, dry and free from foreign materials.
- After each round trip, or if necessary after each trip, flues must be tested with a torch to see that they are opened from end to end by holding torch to the flue. If open, the draft will deflect flame into flue. Flues must be maintained in clean condition and not allowed to go out to stop up. When flues are stopped up they should be bored out with augers and then blown out thoroughly with air or steam.

## PUTTING LOCOMOTIVE IN ROUNDHOUSE

50. Hostlers will be held strictly responsible for condition of all locomotives at the time they leave them at the roundhouse or designated track. They must be left with throttle closed tightly, reverse lever in center position, cylinder cocks open, blocks under wheels, dampers and fire door closed tightly. Firing valve, oil tank valve, blower, atomizer, heaters, compressors, dynamo, lubricator, steam valves and injectors closed, unless engine is left under steam in charge of engine watchmen.

## WHEN PLACING ENGINE ON YARD TRACK

51. It must be left in position to give the required clearance to adjacent tracks.  
**Foremen in the course of their duties** must keep these points closely under their observation.

## APPLYING BRICKWORK

52. In applying brickwork for aligning firebox and fire pans use fire clay or molding sand, stirred with water to the consistency of a thin paste. The brick should be placed as closely together as possible. Large quantities of lining mixture should not be used at any one point or depended upon entirely as a fire resisting service. After the brick setting has been completed, all exposed surfaces are coated with a solution of soda ash and water, mixed until it will flow freely. This makes a very satisfactory glaze and a fire resisting surface. Under no circumstances should brick work be cooled by pouring water over it.
- Other lining and glazing materials approved by Superintendent Motive Power, may also be used.

## METHOD OF CLEANING OIL TANKS OF TENDERS PREPARATORY TO MAKING REPAIRS

53. The tank should first be drained, manhole cover removed, and sufficient time allowed for tank to thoroughly drain and ventilate. If the oil is thick, or repairs are being made in cold weather, steam should be admitted to heat the tank and oil so that the draining of the tank may be facilitated. While tank is being steamed out some old sacking may be thrown over manhole opening so as to confine the steam; at the same time there will be no danger of pressure being created in tank sufficient to cause any damage. After tank has been thoroughly drained, inside should be gone over with waste soaked in kerosene (this being considered better than turpentine, benzene, or gasoline as there is less liability of gas forming). While cleaning inside of tank, manhole should remain uncovered and outlets at bottom of tank opened, to make ventilation as thorough as possible.
- There should always be a man stationed outside at the manhole with a rope convenient to use, watching, so that in case of accident through men being overcome with gas, they can be quickly removed. As it is **exceedingly dangerous, under no consideration** shall an **open light** or **fire** of any kind be used inside or about oil tanks while repairs are being made, nor shall hot rivets be driven until tank is thoroughly cleaned and ventilated.

### PRECAUTIONS AGAINST FIRES

54. All concerned should exercise the utmost vigilance and caring for oil stored. See to it that any leaks that may develop in pipe lines and connections are promptly repaired. Special care should be given in the matter of drippings from locomotives, more particularly when in roundhouse to remove, as far as possible, the danger from fires.
- Enginemen observing live sparks escaping from smokestack will report it at once to Superintendent and Master Mechanic by wire; also on work report on arrival at roundhouse. Carbonaceous matter is formed on side sheets when burner is out of alignment, pan leaking air between brickwork and boiler sheets and obstructions between burner and wall of firebox. This may be later carried through the stack and cause fire.
- Avoid throwing pieces of waste or other inflammable material on deck of locomotive where it will be carried into the firebox through the fire door.
- Enginemen and firemen must report condition of sand if found to contain any inflammable matter.
- In case of oil fire **use sand -- never use water** to extinguish fire. All roundhouses in which locomotives are handled must be provided with barrels for storing sand to be used for extinguishing oil fires. This sand is not to be used for any other purpose. One barrel is to be located between every alternate pair of pits. These barrels should be kept filled with dry sand and inspected periodically. An old scoop is to be kept in top of barrel. Roundhouse pit sumps should be cleaned out at least once a week.

## GENERAL INSTRUCTIONS

55. Start the locomotive carefully to avoid slipping and prevent cold air being drawn through the flues.

Increase speed gradually and allow enough time for boiler to expand to normal working conditions before injecting water. The firemen must be at the firing valve when the locomotive is started and gradually increase the flow of oil as required and avoid black smoke.

When the exhaust is increased sufficiently close the boiler valve, and adjust the firing apparatus to suit conditions. A strong exhaust may snuff out a low fire. The stronger the draft the greater must be the oil supply.

Exercise care against suddenly opening the firing valve. Excessive flow of oil will cause gas explosions and black smoke. When the locomotive is working hard and slow, the light use of blower will assist in eliminating black smoke.

Carbon forming on the flues, flu sheet and side sheets, due to unconsumed oil, is evidence of imperfect combustion, also extravagant use of oil.

Fire door should be kept closed and tightly clamped while locomotive is on the road or under fire. When making observations through fire door guard against the out flash of flame that may follow ignition in case fire should go out, by having blower on strong enough to create a draft that will remove all gases from the furnace.

When the baffler fire door is used note if proper bafflers are used. This can be observed by noting the location of the top tip of baffler; it should be approximately in line with center of door opening. It is necessary to have proper baffler plates with the vertical and sloping boiler heads to insure proper deflection of the air to the furnace.

Regulate the firing apparatus to suit the position of the reverse lever and throttle.

Leaky steam pipes, side seams, flues and improper combustion from any cause will produce a red flame in the firebox. Forcing the fire will fill flues with soot, overheat sheets, burn off rivet heads, and cause leaking.

In all cases of fire or derailment unlatch oil tank valve.

In leaving the locomotive in charge of hostler, enginemen and firemen will see that the boiler has a full glass of water, using the blower and additional fuel oil, if necessary, to avoid use of injector by hostler.

A locomotive should not be moved unless the fire is burning. The cold drafts of air damage the sheets and flues.

Excessive feeding of fuel oil when the locomotive is working slowly on a grade or about yards must be avoided.

The front end arrangement requires constant attention, as any front end defect, such as steam pipes or super heater units leaking, draft pipes out of adjustment, leaks around nozzle, stand or tip, or air leaks into the front end, will reduce the draft and bring insufficient air supply through the firebox, impairing the steaming of the locomotive.

A good fireman anticipates the movements of the reverse lever and throttle, acts accordingly, eliminates the smoke nuisance and saves fuel oil. An even temperature should be maintained in the firebox. It should not be increased too rapidly by forcing the fire, or reduced suddenly by permitting cold air to pass through the firebox and flues. It is of utmost importance that an even temperature be maintained to preserve the life of the firebox and flues, and to prevent

failure by leaking. In view of the ease with which fuel can be wasted, it is necessary that every effort be exerted to properly handle the locomotive, the burner and its accessories, to obtain economical combustion and to guard against injury to boiler or firebox. The greatest economy should be practiced at all times in the use of fuel, exercising good judgment and harmonious co-operation with the engineman, showing a willingness to learn and practicing the best methods.

The engineman is responsible for the conduct of the fireman while on duty. The fireman is under the direction of the engineman and his duties are to be performed in accordance with the engineman's instructions.

The pressure indicated by the steam gauge is the pressure inside the boiler per square inch -- atmospheric pressure is the pressure represented by the density of the atmosphere in pounds per square inch, which is 14.7 lbs. at sea level.

Safety valves are used on boilers to limit the maximum steam pressure; more than one safety valve is used as additional protection against excessive pressure -- one is set at maximum pressure, and the others are set at two or three pounds above the maximum pressure. These safety valves are adjusted by roundhouse forces only. Firemen should exercise the greatest care in preventing these valves from blowing unnecessarily, as there is a waste of fuel of approximately 2 gallons per minute while pops are blowing.

Steam heat equipment on a locomotive is comprised of a globe valve throttle at the boiler, a reducing valve, a steam gauge connected to the steam heat pipe and the proper piping and hose connections. The pressure carried in the steam heat pipe is 40 pounds for eight cars or under and 5 pounds additional for each car over eight unless electric head end lighted; then it should be between 90 and 100 pounds and is controlled by the regulating valve.

Steam is admitted to the steam heat pipe in which it passes at a reduced pressure into the steam heat or train pipe under the entire length of train. The reducing valve is located in cab, close to steam heat throttle.

In case reducing valve will not admit sufficient steam to the train pipe, it may be taken apart and steam valve blocked open. If pressure runs too high in the steam heat pipe, it can be controlled with the steam throttle at the boiler head.

The steam heat reducing valve controls the pressure by the inlet valve for live steam opening and closing by the movement of a metallic diaphragm in the valve, which is opened by a spring pressure on one side and closed by steam pressure in the steam heat pipe on the other side. To regulate this pressure, stiff in the spring to carry more, weaken it to carry less, by turning the handle connected to this spring either up or down.

If steam heat gauge shows the required pressure and cars are not properly heated, first note where the hand on the steam heat gauge stands when the steam is shut off. If it does not drop back to zero, see how much it lacks of this and note the raise of steam pressure shown by the gauge when steam is turned on. This is to test the gauge. If gauge is not correct send back steam enough to heat the train. The firemen should always shut steam off in time to relieve pressure in steam heat pipe when he knows train is to be parted, or nearing the end of the run.

## **INSTRUCTIONS RESPECTING HANDLING OF LOCOMOTIVES EQUIPPED FOR BURNING HEAVY FUEL OIL**

56. Before starting fire obtain the temperature of the oil by placing the hand near the bottom of the oil tank. If tank has a mixture of heavy and light oils have the temperature such as to properly atomize the oil at the same time to ensure the required feed of oil to maintain a maximum steam pressure. If tank is filled entirely with heavy oil the temperature should be about 150° F.

The blow-back device is located on the oil burner manifold on boiler head, along with the atomizer, engine oil heater and oil tank heater valve. After the temperature of the oil is ascertained the blow-back device should be opened and steam allowed to enter the oil supply pipe and blow back into oil tank for a few seconds. The oil tank valve should be closed. The firing valve should then be opened and steam allowed to blow through oil burner. The blow-back device should then be shut off tight, firing valve shut off, engine oil heater valve cracked and oil tank valve opened. The fire should then be started in the usual manner, as per rule 24. The oil tanks are equipped with coil and direct heaters. When using the coil heater the drain valve from same should be opened sufficiently to relieve pipes from condensation. The direct heater should only be used when it is impossible to obtain the required feed of oil by use of the coil heater. When using the direct heater open the valve full for only a few seconds then close tightly. The fireman should endeavor to keep the temperature of the oil at 150° F. in the oil tank when using heavy oil only, using the engine oil heater to maintain the temperature throughout oil supply pipe to burner. This can be accomplished by opening the valve to engine oil heater from 1/8 to 1/4 of a turn, but do not open engine oil heater valve to its fullest capacity, as this results in accumulation of high pressure steam in heater which boils the oil, causing intermittent flow of oil to the burner. This oil will be delivered to the locomotive at a temperature of 150° F. as the circulating device of the oil plant is designed especially to handle this oil at this temperature. The viscosity of this heavy oil is such that it flows freely and atomizes best at about 150° F.

In extinguishing the fire, the oil tank valve should be shut off first and oil burned out of pipes. After fire goes out the firing valve should be shut off and blow-back device applied and oil blown out of pipes into oil tank. The firing valve should then be opened and oil blown out through oil burner. During winter months, if this is not done, this heavy oil will freeze in pipe and it will be necessary to thaw them out before oil will feed to the burner.

When locomotives are not under fire in roundhouse, the roundhouse steam connection at blowers should be made and temperature of oil kept up with heater so locomotive can be fired up on short notice. During winter months engine oil heater should be kept on slightly while locomotives are standing in roundhouse with fire extinguished. This will keep the oil supply connection warm, and save delay in firing up.

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**This appendix is strictly informational and does not necessarily pertain to operations at NSRM.**

<u>Date:</u>	<b>Description</b>	
8/28/2009	Original release	
9/10/2009	Revised release	Electronic Device
1-31-2010	Revised Release	Standard Clock

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