

# PENNSYLVANIA RAILROAD

LINES EAST OF PITTSBURGH

## Locomotive Maintenance Instructions No. L-24

ISSUED ALTOONA, PA.

JANUARY 26, 1916.

### Instructions to Enginemen and Firemen for the Economical Use of Coal (SUPERSEDING CIRCULAR No. 81-A, DATED MARCH 17, 1910.)

#### GENERAL.

1. Enginemen and firemen must work together at all times in order to save coal and reduce smoke. In order to use coal economically, it is not only important that the locomotive should be fired properly, but it is also important that the injector, throttle and reverse lever be handled properly.

2. **Coal and Combustion:** The burning of coal in the locomotive fire box requires air, which must be admitted through the grates and fire door. Soft (bituminous) coals are made up of about six parts carbon, three parts gaseous matter, and one part earthy matter. When coal is burned, the carbon forms coke which burns slowly and without smoke, the gaseous matter burns as flame and the earthy matter forms as ash or clinker. When the coal is first heated by being thrown on the fire, the gaseous matter is expelled in the form of a gas, and if the fuel bed is hot enough and plenty of air present, this gas will be burned before it escapes out of the stack. More air is needed just after firing and while the gas is being burned, than later, and this additional supply of air should be admitted and regulated by the fireman, by the amount of the opening at the fire door. If the gas is unburned, it will produce smoke. Smoke, therefore, means waste of coal and must be avoided.

#### PREPARATION OF LOCOMOTIVE FOR SERVICE.

3. **Inspection:** Enginemen and firemen when taking charge of a locomotive must see that the fire grates and ash pan are in good condition, free from ash and clinker, and the ash pan properly closed and secured, to prevent hot coals from dropping along the road, as they are liable to start fires. The arch pipes, flues and crown sheet should also be examined, to see that they are in good condition.

4. **Preparation of Fire:** The grate bars, after being shaken, must be left level, so as to prevent the burning off of the fingers or edges of the bars. In order to prevent smoke, the coal should be applied in small quantities at intervals, the fire door kept on or against the latch, and the blower used as lightly as time will permit, the entire available time being used to gradually build up the fire.

5. **Starting the Lubricator:** The lubricator should be started slowly before leaving the storage track or engine house, to see that all the feeds are working properly and should be set to feed the proper amount 15 minutes before departure with train, to insure the valves and cylinders being lubricated when starting.

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**6. Water Level:** The height of the water level in the boiler when leaving the storage track or engine house should be such that there is an opportunity for working the injector to prevent loss of steam due to the safety valves popping. A scant three gauges of water is the correct amount.

#### OPERATION OF LOCOMOTIVE.

**7. Size of Coal:** Large lumps of coal do not make a satisfactory fire and they should be broken into pieces not larger than three inches.

**8. Condition of Fire:** A bright level fire over the entire grate must be carried whenever possible. When a sloping fire is used, no more coal should be banked at the fire door than is necessary.

**9. Frequency of Firing:** Small quantities of coal placed in the fire box at regular intervals keep the fire bright, reduce smoke, and keep up steam pressure without waste of coal; large quantities of coal placed in the fire box at one time cool down the fire, cause smoke and a waste of coal, as the supply of air is not great enough to meet the sudden demand and, consequently, there is not complete combustion.

**10. Handling Fire Door:** To prevent smoke and save coal, the fire door should be placed on or against the latch after each shovelful of coal is fired, also after using the hook, scraper or slash bar, and when standing on sidings, in yards and at terminals.

**11. Handling Grates:** The grates must be shaken as often as necessary to clean the fire of ash and clinkers, in order to admit sufficient air for proper combustion. They should not be shaken hard enough to cause the loss of good fire, which means waste of coal. Care should be taken to place the grates level after each operation, to prevent the fingers or edges of the bars being burned off. The grates shall not be shaken while the locomotive is working in or around stations and industrial plants, nor while over trestles, bridges or track troughs. The best time to shake grates is when the steam is shut off, that is, when the draft is lightest.

**12. Dead Spots in Fire:** Dead spots in the fire must be avoided at all times, as they frequently result in leaking tubes, due to the cool air which passes through them, causing the tube sheet to contract.

**13. Firing:** Drawings on page 3 illustrate the condition of the fire with good and bad firing.

Figs. 1 and 2 illustrate the condition of the fire, when the practice of level and regular firing is followed. It is good practice to maintain a slightly heavier fire along the sides than in the center of the fire box, as it prevents the tendency for an excess of air to pass in next to the side sheets, which would cause thin spots to form, allowing cold air to pass into the fire box.

Fig. 3 illustrates the thinning action of the drafts along the side sheets.

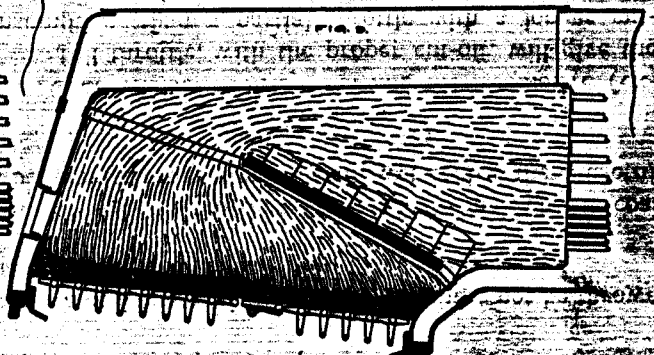
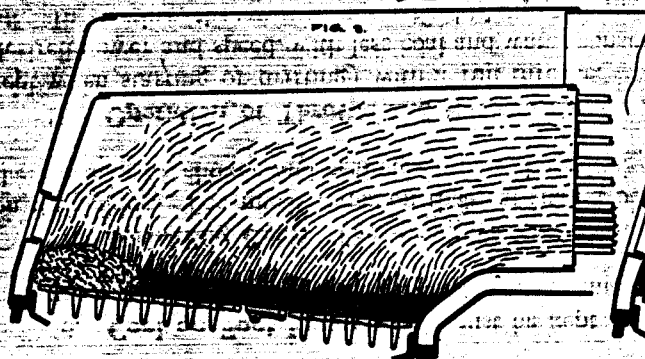
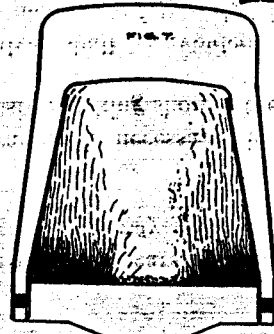
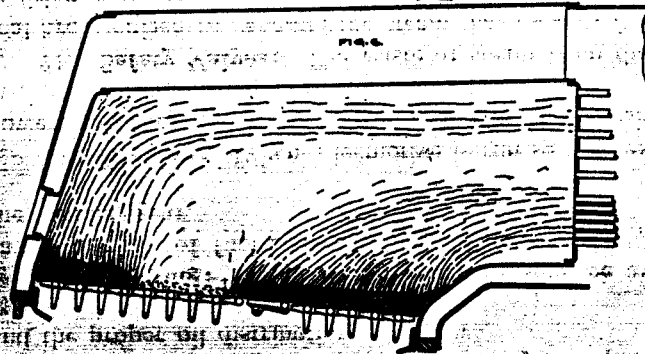
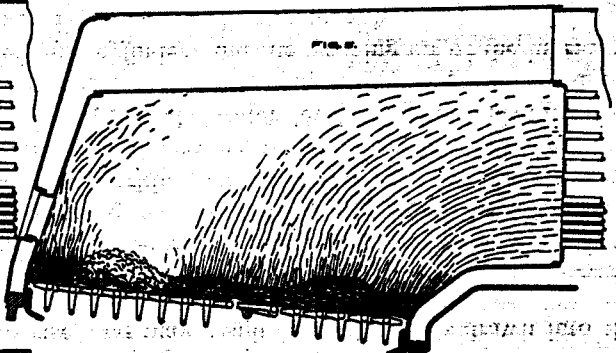
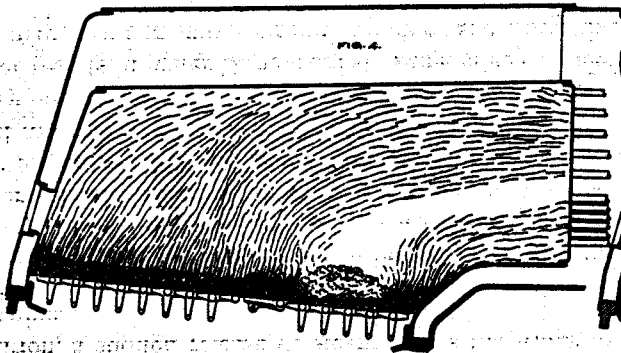
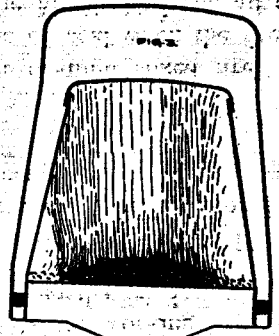
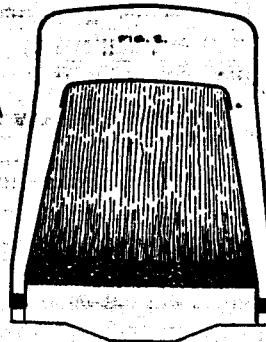
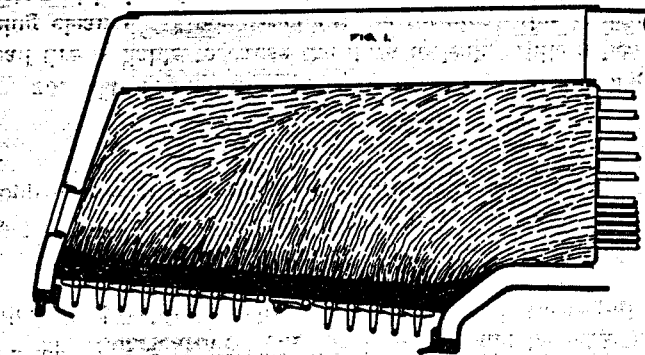
Fig. 4 illustrates the temporary reduction in fire box temperature, due to the introduction of a shovelful of coal.

Fig. 5 illustrates the restoration of temperature before a succeeding shovelful of coal is placed at another part of the fire box, as in the system of light and level firing.

Fig. 6 and Fig. 7 illustrate the effect of thin spots or holes in the fire.

Fig. 8 illustrates the effect of heavy firing at the fire door. Such firing lowers the temperature at the back end of the fire box, as a sufficient supply of air cannot pass through to support proper combustion, and practically eliminates this portion of the fire box for steam generating purposes.

Fig. 9 illustrates the application of a brick arch and shows the path of the products of combustion. The effects of good and bad firing, illustrated in the previous drawings, would apply also to a fire box with a brick arch.



14. **Filling Tank:** Overflowing the tank at the standpipe or when scooping water from the track tanks, must be avoided.

15. **Taking Coal:** Do not overload tenders at coaling stations. The fireman shall do the necessary trimming of the coal pile on the tender, to prevent coal from falling off. This will avoid loss of coal as well as danger to passing trains, trackmen and others.

16. **Coal on Foot Plate:** Coal must be kept in the coal space of the tender, and must not be thrown out on to the tracks, nor allowed to collect and remain on the foot plate.

17. **Sprinkling Coal:** The sprinkling hose shall be used to keep down dust and to moisten the coal on the tender. Too much water on the coal should be avoided, as to some extent, wet coal is the cause of the forming of clinker and sealing over of the tubes.

18. **Operation of Throttle and Reverse Lever:** Coal will be saved by working the locomotive (except when starting or drifting) with a full throttle. A full throttle, with the proper cut-off, will give the desired power and speed, with less coal and water consumption, than a partial throttle with a longer cut-off. In starting, the reverse lever should be put in full gear, to insure the rapid heating of the cylinders and the proper oil distribution.

19. **Slipping:** Slipping of the drivers shall be avoided. It not only tears and upsets the fire and causes a waste of fuel in re-building, but it wears out tires and rails and may result in serious damage to the running gear.

20. **Braking:** When a locomotive is run so that excessive braking is necessary, it indicates waste of power and, consequently, a waste of coal. The necessity of excessive braking should, therefore, be avoided.

21. **Safety Valves:** The waste of steam from the safety valves shall be avoided. Thirty pounds of coal are required to generate the steam that escapes from a large modern safety valve in one minute. In addition, a sudden release of steam causes the water to rise, and may result in water being drawn into the dry pipe.

22. **Water Level:** Coal can be saved by maintaining, by use of the injector, a uniform water level and by using the injector to prevent loss of steam, due to safety valves releasing. A scant three gauges of water should be carried in the boiler when the locomotive is working, except as may be required preparatory to passing down a heavy descending grade. On hard runs it may be of advantage to allow the water level to drop slightly between stations or on hard pulls and regain the water level by taking advantage of every opportunity to raise the level when not working the locomotive to full capacity. High water in the boiler results in water being carried to the valve chambers and cylinders and the washing off of the lubricant, and may result in knocking out cylinder heads, breaking pistons, or bending main rods.

23. **Lubricator:** The lubricator should be watched to see that all the feeds are working properly. Adequate lubrication results in reduced coal consumption and wear, due to decreasing the friction.

24. **Fire Doors:** Before the throttle is closed, the fire door shall be placed on the latch and the blower used just enough to prevent smoke and flames from coming out through the fire door. Firing should be stopped long enough before the throttle is closed to prevent smoke and waste of coal.

#### LOCOMOTIVE ARRIVING AT TERMINALS.

25. **At Terminals:** Locomotives should be brought into terminals with a medium coked fire. A dead fire is liable to cause the flues to leak, while a heavy fire will cause a waste of coal when the fire is being cleaned. Upon reaching the terminal, the engineman shall report upon the M.-P.-62 form, all defects and leaks of steam or water in any part of the locomotive, consulting the fireman concerning any defects which he may have noticed about the grates, grate rigging, brick arch, ash pan, firing tools, and scoop rigging.



26. **Inspection:** There are many defects which cause waste of coal that can best be located when the locomotive is in operation and the engineman will be held responsible for the reporting of all such defects. These defects include the following:

Leaking piston rod and valve stem packing.

Blowing valves and piston rings.

Leaking steam heat appliances and cylinder cocks.

Safety valves which release too soon, allowing too great a reduction in the boiler pressure before closing, or which flutter.

Leaking throttle valve, blower valve and other miscellaneous steam leaks.

27. **Cleaning Fires:** See that plenty of water is in the boiler before cleaning the fire, so as to avoid the use of the injector during the operation, as this may result in injury to flues by the rapid reduction of the temperature of the water in the boiler, producing contraction. When cleaning or banking the fires, use the blower as lightly as consistent with the prevention of black smoke, in order to avoid the rapid cooling of the fire box and tubes, which causes leaks. After the fire has been cleaned, the clean fire should be placed at the front end of the grates, where gas coals are used, and distributed evenly over the grates, where low volatile coals are used.

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