

height of the water level when not working the locomotive to full capacity; for example, while drifting, standing in stations or switching, and permitting the level to drop slightly between stations or on hard pulls.

38. It is bad practice to start out, after making a stop, with the injectors working. The cool water introduced into the boiler while the throttle was closed, starts circulating, and reduces the steam pressure. If a start is made under these conditions, the steam pressure will be still further lowered and an excessive amount of firing necessitated. It is, therefore, preferable to start the injector after a train is well under way.

39. The water level must never be high enough to allow water or very moist steam to be carried over the valve chambers and cylinders, because it will destroy the lubrication of these parts and may result in serious damage, due to knocking out cylinder heads, breaking pistons or bending of main rods.

40. The locomotive man can save coal and greatly assist the fireman in his work by handling the throttle and reverse lever in such a manner that the minimum amount of steam will be used. The locomotive should be operated with a full throttle opening (except when starting or drifting) when the cut off is 25% of the stroke or greater; but if 25% cut off with full throttle gives more power or speed than is needed, the reverse should be left at 25% cut off and the throttle partly closed as necessary. With locomotives using superheated steam it is well to use 15% cut off instead of 25%, as mentioned above.

Descending Grades.—41. Be sure that the crown sheet is thoroughly covered with water. When approaching a descending grade, the water supply should be increased and the fire allowed to burn down after the throttle is shut off, in addition, allowing the steam pressure to fall back below the popping point. Prepare the fire, if required, by cleaning same, or otherwise, cover it over to preserve the fire and avoid popping.

Mixed Anthracite and Bituminous Coal. 42. On certain locomotives, as well as in power plants, a mixture of anthracite and bituminous coal used in different proportions is consumed. While anthracite coal should be burned without being disturbed by a hook or fire tool, bituminous coal, however, often requires the use of the hook; this applies particularly where a large grate surface is available and a part of the grate surface is covered with a partially coked fire. This crust should be broken up so that every part of the grate surface will give up an equal amount of heat, thereby reducing the fuel consumption by effecting the highest state of combustion over the entire fire box instead of only a portion of the grate surface.

43. The successful use of mixed coals depends in part on the relative quantities of the two fuels employed; as a general rule, the practices that govern the successful use of bituminous coal are equally applicable in the use of mixed coals.

Firing With Anthracite Coal.—44. The most successful and economical method of firing anthracite depends almost entirely on the preparation of the fire. In cleaning an anthracite fire, all ashes and clinkers must be removed and a new bed of fire replaced over the entire grate surface if one is to ensure a prompt and positive burning, or to ignite the fresh coal that is placed on the cleaned fire. This will give a uniform thickness to the fire which can then be maintained by

careful attention, but if the fire is cleaned in such a manner as to allow ashes or clinkers to remain in the fire after same has been cleaned, such will soon result in the formation of more ashes or dead spots. Anthracite coal, after being placed on the fire, should not be disturbed in any manner by a fire tool, even to remove clinkers or ashes, as it will not again burn level or develop the same rate of combustion over the grates. The imperfect combustion of anthracite coal can be clearly determined by the eye, a clean burning mass with a short flame; if the flame become diminished too much, however, the temperature and steam pressure will drop.

Condition of Fire Reaching Terminal. 45. Locomotives should not be brought into terminals with a dead fire, which is liable to cause flues to leak, nor with too heavy a fire, which will cause a waste of coal when the fire is cleaned.

Cleaning Fires.—46. When banking or cleaning fires, the blower should be used as little as possible, to avoid the rapid cooling down of the fire box and flues, which may cause leaks.

47. When cleaning fires, or with a banked fire, the excessive use of the injectors must be avoided, as this will result in injury to the flues by the rapid reduction of the temperature of the water in the boiler producing contraction, without sufficient fire in the fire box to counteract this effect.

48. After the fire has been cleaned of ash and clinker, the clean fire must be placed at the front end of the grates (where brick arches are not used) and maintained in good condition by applying small quantities of fuel, as may be required, in order to prevent cold air from passing through the front end of grate and injuring the flues. Where brick arches are used, the fire can be banked farther back, as the hot arch brick protects the flues.

49. The same general principles, in so far as upkeep, handling, inspection, etc., that apply to the coal burner, apply to the oil burner, with this difference, however, that while it is hard to get enough air into the ash pan of the coal burner it is quite easy to get too much air into the oil burner, and this applies especially to air leaks around the fire box, brickwork and mud ring. Frequent inspection should be made, by turning on the blower and holding a lighted torch to these points. If leaks are found they should be corrected each trip, as air thus admitted takes a short circuit, goes directly into the lower flues, causes them to leak and to coat over with soot, arresting combustion at this point. Next to the proper alignment of the burner, the avoidance of air leaks is the greatest factor to be considered from a fuel saving standpoint.

50. The burner should not be set so high as to cause the jet to strike the fire door, nor so low as to allow the flame to drag on the bottom. Any obstructions in the shape of fallen brick, etc., in front of the burner should be removed at once.

Handling Oil.—51. Different grades of oil require different methods of handling. However, all oil should be heated sufficiently to cause it to flow freely to the burner. While with many grades of oil the proper temperatures can be maintained with the closed heater, yet when using the heavy Mexican oils the open heater should be turned on strong at first so as to stir up the oil, thereafter shut it off and maintain the proper temperature with the closed heater. No oil of whatever grade should, however, be heated to above a point where the back of

the hand cannot be pressed firmly against the tank without discomfort, for when oil is heated too hot many valuable heat units escape in the form of gas.

Final Inspection and Work Reports.—52. Great care should be exercised on the part of the locomotive man, on reaching the terminal, to make a thorough examination of the locomotive and prepare an intelligent written report for the information of the locomotive house foreman and those who make repairs.

53. Leaky piston and valve stem packing, cylinder packing or valves which cause blowing, all tend to draw on the coal pile unnecessarily, as it takes coal to generate wasted steam. This also applies to locomotives' steam heat appliances, cylinder cocks, safety valves which blow down too much steam pressure before closing, or, in other words, to all steam wasted.

54. The fireman should be consulted in regard to any defects that have come to his notice, especially with the grates, grate rigging, brick arches, ash pan, firing tools, scoop rigging and dampers (where provided). Particular attention should be given to the condition of the brick arch, because this device, properly maintained, is a considerable factor in the saving of fuel and the reduction of smoke.

55. It is important that the locomotive man, as well as the locomotive inspectors, report all defects in a locomotive on arrival at a terminal which require attention before the locomotive is again placed in service, especially as some defects can be detected to the best advantage while the locomotive is in service.

Oil Firing.—56. In firing with oil, the locomotive man and fireman must work together. Every time the locomotive man changes the throttle or reverse lever the fireman must regulate his firing valve to suit the changed requirement. From this it follows that the locomotive man should never start the locomotive until the fireman is at the firing valve, and should be careful not to slip the locomotive, as such is liable to put out the fire, and the fireman should be equally careful not to use too much steam at the atomizer. Steam will not burn, and a bright fire with just a tinge of blue smoke at the stack indicates good combustion. Black smoke and a red fire indicate waste. Locomotive men should bear this one fact in mind, regardless of whether they are handling oil or coal burners. Any excess fuel used, either on account of a defective locomotive, or from poor handling on the part of the crew, is a charge against them and not against the locomotive house. Therefore, exercise care while out on the road and report all fuel wasting defects on arrival, and so keep your record clear.

Operation of Superheater Locomotives. 57. The general operation of superheater locomotives is the same as the ordinary saturated steam locomotive. Attention is directed to a few items in connection with superheater locomotives which need careful consideration.

58. Cylinder cocks should be kept open when standing, and, as far as possible, when starting, until dry steam appears.

59. A hydrostatic lubricator should be started at least 15 minutes before leaving time, in order that the valves and cylinders may be thoroughly lubricated when starting on the trip. The oil supply to the cylinders should be constant, as there is no water in the steam to assist in the lubrication and, on this account, the superheater locomotive requires more careful lubrication for valves