VICTORIAN RAILWAYS.

# INSTRUCTIONS

For the Guidance of

## ENGINEMEN

In connexion with the

**Uniform Methods of Dealing with Break-downs, Engine Trouble, &c.**

VICTORIAN RAILWAYS.

# INSTRUCTIONS

FOR THE GUIDANCE OF

# ENGINEMEN

IN CONNEXION WITH THE

## Uniform Methods of Dealing with Break-downs, Engine Trouble, &c.

Melbourne,
March, 1921.

A. E. SMITH,
Chief Mech. Engr.

By Authority:
Albert J. Mullett, Government Printer, Melbourne.

1892.—R.127/21.

# INDEX.

This book is issued with the object of assisting Enginemen to manage their engines efficiently and economically, and to explain how certain breakdowns can be expeditiously dealt with. Whilst not providing for all classes of breakdowns, it should serve as a general guide, and Enginemen will be expected to deal with any other case of failure, giving full attention to the circumstances and conditions prevailing at each particular occurrence, in order to obviate serious delay to the traffic.

In every instance it must always be recognised that, when a train or engine is stopped from any cause, the first and most important duty is the proper protection of the train or engine, as laid down in the Rules and Regulations.

1. *Question:* What are the duties of Enginemen when taking charge of an engine at a depôt?

   *Answer*: After signing on, they must examine the Running Sheet and any notices posted for their guidance. The Repair Report Book must be carefully examined to see that any repairs booked against their engine have been attended to. After getting on the footplate they must—

   (*a*) test the gauge glasses to insure that these are properly registering the level of the water in the boiler;
   (*b*) observe the steam pressure and condition of the fire;
   (*c*) examine the fire-box to see that there are no leakages or bulges;
   (*d*) see that the tubes and brick arch are clean and in good order;
   (*e*) see that the baffleplate is fitted;
   (*f*) see that the firebars are in good order and properly spaced, and that the dump-plate, ash-arrester, and slides are in proper working order and position;

(*g*) examine the smoke-box and see that it and the frameplate on the door are free from ashes;

(*h*) see that the spark-arresters are in good order and thoroughly cleaned, and that the smoke-box door closes tightly;

(*i*) see that there is sufficient fuel, water, and stores, that the sand-boxes are full of dry sand, and that the sand gear is in proper working order;

(*j*) see that the equipment of tools, lamps, &c., is as shown in the "A" list;

(*k*) start the air pump slowly, and afterwards test the hand and air brakes;

(*l*) test both injectors;

(*m*) make a thorough examination of the engine and tender;

(*n*) lubricate all working parts, and carry out all other duties necessary to insure that the engine is in a roadworthy condition.

If any defect is discovered, the Officer in Charge must be notified at once, so that repairs may be executed (or other action taken) in time to avoid having the engine late-out.

2. *Question:* What are the duties of Enginemen who change over or relieve on the road?

*Answer:* (*a*) For the protection of the engine and train, when changing over, either the driver or the fireman must remain on their engine until relieved by one of the other crew.

(*b*) Each engine must, as far as practicable, be left in good running order, coal trimmed, and fuel docket filled in ready to be handed to the relieving driver. The smoke-box and fire must be as clean as circumstances permit.

(*c*) The driver and fireman of each engine must give their relieving crew all particulars regarding the condition of the engine and train

that they are taking over, and also any orders or instructions which they may have received affecting the line over which they are to run.

(*d*) During the dry season, the relieving driver must personally examine the spark and ash-arresters, and see that they and the ash-pan slides are in proper position before leaving the station at which the change-over is effected. This is very important.

(*e*) When relieving in the inner suburban area, these instructions are to be carried out, as far as practicable, without causing detention to traffic. It is, however, imperative that the earliest opportunity should be taken by the driver to examine the fire-prevention appliances and the engine generally. Every endeavour must be made to keep the authorized Roster Running.

3. *Question:* What are the principal duties of Enginemen on the road?

*Answer:* The first and most important consideration of the Enginemen is safety. The train is to be run to time, subject to the strict observance of all Signals, Speed Restrictions, Rules and Regulations, and any special instructions concerning the engine, train, or line. The driver must keep a good look-out at all times, and the fireman also, when not otherwise necessarily engaged.

It is also the duty of Enginemen to use the steam and fuel with economy, and the best results can only be obtained by the co-operation of the driver and firemen, who should adopt the most economical methods of working the engine and firing possible for the class of train and line on which they are running.

4. *Question:* In what condition should the fire and water be when starting with a train?

*Answer:* The fire should be well burnt through before the departure of the train, and this should be accomplished by putting the coal on in ample time. The fire should be thickest under the door and in the back corners, as these are the places where holes are likely to be made by the intense action of the blast when the engine is starting.

Special notice must be taken of the level of the water in the boiler, and, whenever practicable, a margin should be allowed for supplying a small quantity of water to the boiler whilst standing on the train, to prevent the engine blowing off, and to avoid the necessity for dropping the damper.

5. *Question:* What are the best methods of obtaining the highest percentage of heat out of the coal and preventing smoke?

*Answer:* By firing lightly and as often as required for the work the engine is doing, and by using the damper and firehole door to admit the proper quantity of air. Too much air cools the fire-box and reduces the rate of steaming, besides helping to cause leaky tubes. Too little air prevents complete combustion, and, instead of all the available carbon in the coal forming carbonic acid gas, some of it passes out of the chimney as carbon monoxide, and in the latter case less than half the available heat is obtained from the coal. In other words, coal is being wasted. Smoke can be prevented by the proper regulation of the firedoor opening after firing. When the coal, which should not be larger than 4-in. pieces, is put on the fire, gases are given off, and, unless sufficient air is admitted above the fire, they will pass through the tubes and chimney to the atmosphere unburnt, and appear as black smoke. By observation, the Enginemen can easily ascertain whether the proper quantity of air is being admitted.

Another means of economizing in fuel is the co-operation of the driver and fireman in the working of the engine. For instance, the driver, whenever practicable, should keep the fireman informed as to how he is likely to work his engine at points in advance, so that the fire can be arranged accordingly.

It is also advantageous (more especially on lines with varying grades) to have a fire put on before altering the valve travel; due consideration, however, being given to the locality, that is, the proximity of a stopping station or the shutting off of steam to allow the engine to drift. When drifting, the fire should be clear and burning brightly, with the jet slightly on.

A fire put on just before the alteration of the valve travel will prove its full value when put into practice, but intelligent forethought must also be exercised to avoid waste of fuel by firing unnecessarily.

6. *Question:* What are the duties of Enginemen when stabling an engine at the end of a trip?

*Answer:* Consideration must be given to the amount of shunting or other work to be done, so that only sufficient coal will be used. When the engine goes over the pit, the fire should be well burned down, and the boiler well filled with water. The fire should be raked with a pricker, to insure that no unburned coal is left in the firebox.

The fire-grate, ash-pan, and smoke-box must be properly cleaned, and the engine supplied with the required quantity of fuel and water. On arrival in the shed, the engine and tender must be thoroughly examined, all tail trimmings drawn, and any work necessary must be entered in the Repair Report Book.

Should the Enginemen who have run the engine be relieved on the pit, they must book

any repairs required which have come under their notice; or, if the engine be left by them without examination, this must be recorded in the Repair Report Book. The relieving driver or hostler must after thoroughly examining the engine, also book in the Repair Report Book any defects which may be discovered when stabling the engine.

It must be distinctly understood that it is the duty of the employees responsible for stabling the engines to take all precautions to insure that engines are thoroughly roadworthy, or so that they will be ready to leave the shed when required without delay.

7. *Question:* What are the principal causes of an engine steaming badly?

*Answer:* Unskilful driving or firing; blast pipe out of alignment or partly choked; blast-pipe joint defective; spark-arresters dirty or defective; steam pipes leaking; Westinghouse exhaust pipe or jet pipe defective; smoke-box drawing air; leaky or dirty tubes; defective brick arch or baffleplate; firebars not properly spaced; accumulation of scale on water side of boiler tubes; valves or pistons blowing; unequal travel of valves; and steam pipe to by-pass valve defective.

8. *Question:* If an engine breaks down from any cause, between stations, what should a driver do?

*Answer:* After stopping and ascertaining the cause, he must see that his train or engine is properly protected, and then proceed to get the engine in working order, so as to clear the section with the least possible delay. If the breakdown is likely to cause a serious delay, and time could be saved by obtaining assistance, advice must be sent to the station or signal box where

assistance is most likely to be obtained. In wiring to his Depôt Foreman or to the nearest Depôt Foreman for assistance, the driver should bear in mind that the officer with whom he is communicating knows nothing of his trouble, and he should, therefore, be explicit and give full details. A clearly worded telegram is of the greatest value to the Rolling Stock Officer who has to provide the assistance required, and who would, if he knew just what was required, be able to deal with the emergency in the best and most expeditious manner. This also applies to the derailment of an engine or vehicle.

9. *Question:* When an engine or tender has been rerailed after derailment, what should a driver be specially careful about?

   *Answer:* He must, in all cases, gauge the wheels to see that they are in good running order, irrespective of whether the derailment has been an easy one or otherwise. He must also see that the springs, pins, and hangers are all in order, and that no pieces of iron packing, &c., have been left about the axle boxes.

10. *Question:* What is a safety plug, and what are its functions?

    *Answer:* A brass plug screwed into the crown plate of the fire-box, having a hole drilled right through it, which is filled with lead. Should the crown plate be uncovered by reason of low water and the plug be exposed to the fire, the lead will melt, and the steam will pass into the fire-box, warning the driver of the defect and damping the fire.

11. *Question:* What should be done if the tubes are leaking where expanded into the tube plate?

    *Answer:* A good bright fire should be maintained, and cold air kept from the tubes; the steam should also be kept, as far as possible, at the

maximum authorized pressure. If bran can be obtained, shut the feed-water cock on the tender, disconnect the hose bag, and place the bran in it. After coupling up the hose bag again and re-opening the feed-water cock on the tender, the injector should be opened smartly, and the bran will then be carried into the boiler. In any such case, bran must not be placed in the tender tank, as it will only result in the strainer becoming choked up.

The blower must be used as little as possible.

12. *Question:* If a tube bursts, what should be done?

*Answer:* Put on both injectors at once to overcome the loss of water and reduce the boiler pressure. If possible, get under the protection of the fixed signals before stopping. If possible, the tube should then be plugged. If no iron plugs are available, a wooden plug may be made from any timber which may be handy, such as a sapling. This should be left long enough to reach across to the tube plate, and should have a place sawn or otherwise cut round, where it will be required to break off. The fire-box end must be plugged first, and, if the fracture is not very bad, it may not be necessary to plug the smoke-box end.

The water will generally damp the fire sufficiently, but, if the fracture is near the smoke-box, the bulk of the water will go that way, and the driver must, therefore, be prepared to protect the boiler by dropping the fire, if necessary.

13. *Question:* What should be done if a regulator gland stud breaks?

*Answer:* If the break takes place outside the nut that locks the stud to the stuffing-box, slacken back the nut so that the broken stud can be screwed into it, but if there is not sufficient of

the stud remaining to secure the gland in this manner, take off the regulator handle and fill the space between the gland and the handle with washers or other suitable packing taking care to see that the regulator handle is not jambed but works freely. A tight-fitting nut may be resorted to in effecting a repair to a broken stud or bolt.

14. *Question:* What should you do if the regulator valve become choked or will not shut tightly?

*Answer:* Apply the brakes and open the regulator wide, then close it quickly; this will often remove scale or foreign matter which has lodged on the valve.

15. *Question:* If the regulator becomes uncoupled so that steam cannot be shut off, is it necessary to stop and leave the train?

*Answer:* No; the engine can be worked with the reversing gear by putting it in mid gear, or partly into back gear when about to stop, but under such conditions the boiler pressure must be reduced, and the driver should wire for immediate assistance.

16. *Question:* How many types of injectors are there?

*Answer:* There are two types of injectors—lifting and non-lifting. A lifting injector is one which is placed on the boiler above the water line in the tank, and raises its supply by suction. A non-lifting injector is one that contains no lifting tube, and is placed on the engine below the level of the tank bottom.

17. *Question:* What are the principal causes of injector failure, and how can they be remedied?

*Answer:* (*a*) Injector becoming hot through neglect to close the steam valve tightly. Care should always be taken to close the steam valve properly, otherwise the injector may fail

through overheating, and, moreover, the steam gradually injures the cones and increases the risk of failure. When an injector is overheated, pour cold water on it to get it to start again.

(*b*) Check Valve blowing back. To remedy this, pour cold water over the injector to cool it, and tap the injector gently with a piece of wood; there must not, however, be any disfigurement of, or injury to, the injector.

(*c*) Admission of air at any of the connexions. Drawing air prevents a partial vacuum being formed when the steam valve is opened; the water will, therefore, not lift into the injector. Any unions which may be slack must be tightened. If the defect be the supply pipe leaking, it must be tightly lapped with a piece of canvas or other suitable material.

(*d*) Strainers becoming choked with foreign matter. To remedy this, close the overflow valve and blow steam through the strainer into the tank; if this does not effect a clearance, take down the strainer and thoroughly clean it, also uncouple the hose bag and flush it out.

18. *Question:* If the check valve of an injector fails to seat itself, what should be done?

*Answer:* The stop-plug should be closed; the cap of the injector should then be taken off, and the valve taken out, cleaned, greased, and replaced. The cap should then be replaced and the stop-plug re-opened.

19. *Question:* If the thread of a steam valve spindle of an injector becomes stripped, what should be done?

*Answer:* If this occurred, the valve would remain open. A piece of rope (tarred rope, if available) should be placed around the body of the injector and through the wheel of the steam valve

spindle. By twitching the rope, the valve may be forced back on to its seat and secured. In a case of emergency, such as the other injector working badly, it is possible to work the injector having the defective spindle by carefully slacking and adjusting the twitch, thus allowing the proper amount of steam to take up the feed water.

20. *Question:* What would be the effect if the feed water were too high in temperature to condense the steam in the injector?

*Answer:* It would prevent the injector working, as it would be impossible without proper condensation to overcome the boiler pressure and force the water into the boiler.

21. *Question:* If both injectors become so defective that neither of them could be worked, what should be done?

*Answer:* Precautions should at once be taken to protect the crown of the fire-box by dropping the damper; and, if there be only a limited amount of water in the boiler, the fire should be damped by covering it with earth or slack coal, preferably the latter. When the boiler is thus protected, the cause should be located and remedied, if possible, as indicated in the preceding answers. With the Gresham injectors, this emergency should be a rare occurrence.

22. *Question:* What are the causes of a front cylinder cover being knocked out?

*Answer:* (*a*) Failure to open release cocks before starting, thus allowing water to accumulate in the cylinders and steam chests.

(*b*) The nut on the end of the piston rod being slack.

(*c*) The cotter on the crosshead being slack.

(*d*) The little or big end knocking.

(*e*) A broken axle-box.
(*f*) Slack axle-box wedges.
(*g*) Big or little end out of line.
(*h*) Roll in axle-boxes through wear, &c.

23. *Question:* If the front cylinder cover were knocked out or blown out, would it be necessary to disconnect any part of the engine?

*Answer:* This will depend on the extent of the damage. If the damage done to the cylinder cover be slight, and the opening a small one, it will, in many cases, be possible to run the engine under its own steam without disconnecting anything, and with only a slight escape of steam the engine will prove to be more powerful than if one cylinder only is working. A test should be made to see if the engine would haul the train out of the section. If the damage to the cylinder is serious, and the disabled engine is unable to haul the train owing to the loss of steam through the broken cover, and if no further damage is likely to occur, the piston may be allowed to run, but the valve must be centred and secured in that position. The engine could then be worked with one cylinder. See Questions Nos. 45 and 46.

24. *Question:* What are the objects of by-pass valves?

*Answer:* (*a*) The by-pass valves on the steam cylinders of engines fitted with the Schmidt superheater are provided in conjunction with a steam circulating system for protecting the superheater elements from overheating. The object of these valves is to allow the circulating steam to escape when the engine is standing, and to enable the engine to roll freely. When the regulator is shut, steam from the blower and circulating valve passes to the underside of the pistons on the by-pass valves and opens communication between the ends of the cylinders.

When the regulator is open, steam passes from the steam collector to the top of the pistons of the by-pass valves, and, driving them down, closes communication between the ends of the cylinders.

(*b*) The by-pass valves on the steam cylinders of superheater engines fitted with other than the Schmidt are of the V.R. type, and are provided for the same object, but they are operated by steam from the steam chest. When the regulator is open, steam passes from the steam chest to the underside of the by-pass valves, causing them to seat, and closes communication between the ends of the cylinders. When the regulator is shut, the pressure on the underside of these valves is released, and the compression in the cylinder unseats them and opens communication between the ends of the cylinders.

25. *Question:* If a by-pass valve sticks or breaks, what should be done?

*Answer:* Indications of this trouble resemble those of a broken piston valve, and care should be taken to properly locate the defect. If the defect be on an engine fitted with a Schmidt superheater, the by-pass pipes should be disconnected at the valve body, and blank washers inserted in the joints, and the pipes connected up again. In the case of an engine fitted with V.R. by-pass valves, the by-pass pipe should be disconnected at the end next to the defective valve, insert a blank joint, and connect the pipe up again.

26. *Question:* What means are there to prevent damage to the superheater elements of an engine when it is drifting?

*Answer:* (*a*) A steam circulating system, which operates in conjunction with the blower and allows a small amount of steam to circulate through the elements.

(*b*) By draught retarders, which consist of jets of steam discharging into the flue tube to prevent the passage of hot gases from the fire-box, and so protect the elements. These also operate in conjunction with the blower.

27. *Question:* Describe how to re-pack a gland?

*Answer:* Set the engine so that the gland can be drawn clear of the stuffing-box, remove the nuts, and draw back the gland; then, if necessary, clean out all the old packing, using a tool for this purpose. Insert the packing in single rings, taking care that the joints are broken. Replace the gland, and screw up and lock the nuts.

28. *Question:* What are the two most important things to attend to in screwing up a gland?

*Answer:* To see that the gland stands square with the rod, and to have the nuts well locked.

29. *Question:* Can a driver tell, when running, which piston is blowing?

*Answer:* Yes, from the sound of the exhaust when travelling slowly. Looking at the left-hand driving crank-pin, the exhausts that take place just before it reaches the front and back centres will be from the left-hand cylinder, and those that occur just before it reaches the bottom and top quarters will be from the right-hand cylinder, so that an intermediate blow coming between the front centre and the bottom quarter, or between the back centre and the top quarter, will probably be from a defect of the left-hand piston.

In any case of doubt, the driver should properly test the valves and pistons as described in Question No. 41, so that the defect can be properly located and booked in the Drivers' Repair Report Book.

30. *Question:* How would you locate a knock?

*Answer:* First carefully examine the engine for loose or broken parts, then place the engine on the top or bottom centre, set the tender brakes hard on, and instruct the fireman to give the engine a little steam, and also to move the reversing lever forwards and backwards a few times. Whilst this is being done, carefully note all lost motion of each connecting rod, brasses, crosshead, the condition of the wedges, &c.

By testing both sides in this manner the driver can readily discover all knocks, and either remedy them, or put an intelligent report in the Repair Report Book.

31. *Question:* If a little end be knocking badly, what should you do?

*Answer:* First tighten up the cotter or wedge; and, if this be not effective, keep the regulator slightly open, in order to cushion the piston at each end of the stroke, and thus minimize the risk of damage. If both these expedients fail, the defective side of the engine must be disconnected, otherwise there is a liability or risk of breaking one of the cylinder covers.

32. *Question:* What should you do if one of the main crank pins breaks on an engine with outside cylinders?

*Answer:* Clear away all the broken parts, take down the side rods from both sides of the engine, then take down the eccentric straps and rods on the disabled side, centre the valve and properly secure it, and block the piston at the back end of the cylinder. The engine may then be run with one cylinder. See Questions Nos. 45 and 46.

33. *Question:* What would you do if the head of the big end wedge bolt breaks off (standard types of engines)?

*Answer:* If the brasses are knocking, and in case of emergency, lift up the cotter bolt and secure it by binding wire around it and the connecting rod, or, if possible, take out the cotter bolt and insert it in the top of rod, screw it well into the wedge, then adjust the wedge by using the nut and some washers on the bolt. If at an out-station, and time permits, disconnect the big end by taking out the bolt at the rear end, then pinch the connecting rod away from the brasses until the wedge is exposed, put up the cotter bolt and wedge. Then place some packing under the wedge, taking care not to make the brasses too tight, connect up big end by replacing the bolt, and screw up the nuts.

34. *Question:* What would you do if a big end cotter was lost on an engine fitted with inside cylinders or a V or W class engine?

*Answer:* Replace the cotter by a suitable spanner or a wedge made from hard wood to prevent the brasses from knocking. If at an out-station and time permits, take out the two bolts connecting the strap to rod, then pinch butt of rod up to big end brass; see the amount of overlap, as the holes in the butt and the strap would not be in line; then pinch butt away from the big end brass, and insert a liner between the butt and the brass equal to the distance the holes were out of line; replace the strap bolts, and screw up the nuts.

35. *Question:* What should you do in the case of a broken big end strap or a defective connecting rod big end?

*Answer:* Disconnect the broken parts on the defective side, take down the eccentric rod and straps on that side, centre the valve and properly secure it, and proceed with one side, taking care to see that the good side of the engine is

not stopped at, or near, the centre. The best position to stop is with the crank pin on the good side, about an eighth of a revolution past the centre, which position will enable the engine on starting to acquire a maximum of momentum before the crank reaches the next centre. If the engine should stop at or near the dead centre, and will not start, the only remedy will be to use a pinch bar or screwjack to move the engine until the crank on the good side is in the position previously described. See Questions Nos. 45 and 46.

36. *Question:* What is likely to cause a bent or broken side rod, and what should be done in any such case?

*Answer:* Excessive slipping of the wheels, together with defective sanding, is generally the cause of a bent or broken side rod. Of course, a bad flaw may also be the cause. In the case of a four-wheeled coupled engine, both rods will have to be taken down; with a six-wheeled coupled engine, should the short end be defective, the short end on the opposite side must also be taken down; with a V-class eight-wheeled coupled engine, the eccentric strap and rods are connected to the second pair of coupled wheels, and if the side rod connecting these wheels to main driving cranks be defective, the engine will have to be disconnected, and a relief engine obtained to haul the engine to the depôt; but should any short end only be defective, it would then be sufficient to disconnect the corresponding one on the opposite side.

If it is necessary to take down the connecting rod, place the bush ring on the crank pin and replace the collar and split pin; this will prevent the side rods from coming off. Then draw piston to the back end of the cylinder and secure

it there between the crosshead and the rear end of the cylinder by means of the plate provided.

In the event of a bent side rod binding on the crank pins, the best method is to disconnect the rod on the opposite side of the engine first, then, with a pinch bar, move the engine a little to ease the defective rod, which should then be easily removed.

37 *Question:* What should you do if a piston rod breaks?

*Answer:* Remove all the broken parts, then take off the connecting rod and draw the crosshead out or secure it right back, place the ring provided on the crank pin to keep the side rods on, take off the eccentric rods and straps on the defective side, centre the valve and properly secure it. The engine may then proceed on one cylinder. See Questions Nos. 45 and 46.

38. *Question:* If the leading or trailing side rod of "C" class (consolidation) engine breaks, what should be done?

*Answer:* The leading and trailing side rods, being knuckle jointed, it is only necessary to remove the broken pieces of the rod and the corresponding rod on the opposite side of the engine.

39. *Question:* If the centre side rod of "C" class (consolidation) engine breaks, what should you do?

*Answer:* Take off all the side rods on both sides of the engine, and then replace the connecting rods and the eccentric arms, and the engine can then run on its own power, taking as much loading as possible, according to the grade, conditions, &c.

40. *Question:* What is meant by lost motion?

*Answer:* This term is used to designate the loss of piston or valve travel due to the wear of some

parts of the engine. Thus, if the bearings of the main connecting rods are worn, the pistons must move a distance equal to the wear at each end of the stroke before it moves the crank pin. Taking up the lost motion means making the parts which were loose fit properly, and thus obtain the maximum power from the engine at the minimum cost.

41. *Question:* Explain how you would test the valves and pistons of an engine?

*Answer:* Place the engine with the right-hand crank down at a right angle to the centre line of the piston rod and the cylinder; in this position, the right piston head will be very near the centre of the cylinder, and with the reversing lever in full forward gear, the right front port will be about full open to admit steam to the front of the piston; if the reversing lever be placed in full back gear, the right back port will be about full open to admit steam to the back of the piston, and if the reversing lever is placed in mid gear, the right valve will be about the centre of its travel or stroke, and, therefore, overlapping both ports.

Then put the brakes hard on, open the cylinder cocks, place the reversing lever in mid gear, and give the engine steam. If steam does not escape from the right-hand cylinder cocks, the valve on that side may be considered tight. Place the reversing lever in full forward gear, and again give the engine steam, and if steam does not escape from the back cylinder cock, the piston on that side is tight. By placing the reversing lever in full back gear, then applying steam as before, and, observing whether steam escapes from the front cylinder cock, the piston will be tested from the back, but this is not absolutely necessary.

Then move the engine until the left crank is down in the same position as that described above for the right crank, and proceed to test the valve and piston on the left side.

When the reversing lever is in mid gear, the left valve will be tested; in full forward gear the left piston will be tested from the front, and in full back gear from the back.

42. *Question:* If a link hanger or a lifting arm should break, what should be done?

*Answer:* The valve gear on that side of the engine may be used by placing a piece of packing ($\frac{3}{4}$-in. piston packing) in the link slot above the link block, so as to support the link in that position, the valve on the other side being placed in forward gear in a similar position to the defective side. No attempt must be made to alter the valve travel, so that the engine can be run only in one direction, and should be run with the utmost caution. If, however, it should be necessary to back the train or engine into a siding, this can be done by taking out the packing, lifting the link, and substituting a long wooden block, so that the link will be supported in a position near that at which it works the valve full stroke backwards, and the other valve must then be placed in back gear, in a similar position to the defective side. The wooden block must be securely fastened, either by rope, wire, or strong twine, so that it will be held in position when the engine is in motion.

43. *Question:* If a hanging link should break, what should be done on an A2, AA, A, D, DD, DDE, E, RY, and Y class of engine?

*Answer:* (*a*) If only one link is broken and there is no relief engine available and no great distance to go, proceed cautiously, as all the above classes of engines are fitted with two hanging links to each quadrant link.

(*b*) If both hanging links are broken, the link must be lifted and packed as described in Question No. 42.

44. *Question:* What should be done if the reversing lever or reach rod breaks?

*Answer:* (*a*) If on an engine with the weigh-bar shaft brackets in two pieces, the top of the bracket should be slackened back, the links placed in such a position that there would be sufficient travel of the valve to take the load over the steepest grade. Then insert a liner in the bracket, and screw up same to hold the links in position.

(*b*) If on an engine with the weigh-bar shaft brackets in one piece, and running engine first, place a piece of packing ($\frac{3}{4}$-in. piston packing) on top of the quadrant blocks; but, if running tender first, the weigh-bar shaft must be tied securely, so as to hold the links in the correct position.

(*c*) In each case, the broken parts of the reversing lever must either be taken down or properly secured.

45. *Question:* When it is necessary to centre a valve of an engine after being disconnected, what should be done?

*Answer:* The side that is not defective should be placed in the position for testing valves, viz., the big end on the top or bottom quarter and the reversing lever in mid gear; then move the disconnected valve so that the distance from the stuffing-box to the cotter hole is the same as on the side not disconnected. The valve should then be properly secured, as described in Question No. 46.

46. *Question:* In any case where it is necessary to centre the valve, how would you secure it?

*Answer:* (*a*) On an engine having glands, the gland must be canted.

(*b*) On an engine fitted with a superheater, the clips provided must be used, as described in Question No. 51 (*a*).

47. *Question:* How would you ascertain if a valve spindle were broken inside of the steam chest, and what should be done?

*Answer:* First test the valves by placing the crank on bottom centre, reversing lever in forward gear, brake on, release cocks open, then instruct the fireman to reverse the reversing lever, and watch the front end of the valve spindle. If it does not move, the spindle is broken. Then take down the eccentric rods and straps. If the engine has piston valves with glands at the front and back, centre the valve, taking care to see that both broken parts of the spindle are together, and lock it at both ends with the glands. Attend to the lubrication of the cylinder, take out testing plugs, and allow the piston to run. If the engine has slide valves, the defective valve should be pushed right forward, the connecting rod and big end be taken down, and the piston blocked forward and secured in that position.

48. *Question:* If a valve spindle gets bent or doubled up so that the valve cannot be shifted, what should be done?

*Answer:* Uncouple the valve gear on the defective side of the engine, as previously described, and notice which steam port is open. If the front port is open, after taking down the connecting rod, draw the piston to the back end of the cylinder, and secure it there with the blocks provided. If the back port is open, the piston should be pushed right forward, and secured there. The engine may then be run with one cylinder.

49. *Question:* What should be done in the event of a slide valve breaking?

*Answer:* (*a*) If the breakage of the valve is such that all the steam and exhaust ports can be covered by the broken valve, the defective valve should be disconnected and the ports closed by the valve, which must be properly secured in that position. The connecting rod and the eccentric rods and straps on the defective side must be taken down, and the piston must be pulled to the back end of the cylinder and properly secured. The engine may then be run with one side.

(*b*) If a flange is broken off completely, or nearly so, and all the steam and exhaust ports cannot be covered, the defective valve should be disconnected and placed nearly central so as to cover one steam port and the exhaust port; thus, if the front flange be broken off, place the valve half an inch back from its central position and pull the piston to the back end of the cylinder, and properly secure it and the valve in those positions. If the back flange be broken off, place the valve half an inch in front of its central position, and push the piston to the front end of the cylinder, and properly secure it and the valve in those positions. The connecting rod and the eccentric rods and straps on the defective side must be taken down. The engine may then be run with one side.

(*c*) If the valve breaks right across so that the exhaust port cannot be covered, the engine will be completely disabled, and assistance must be sent for.

50. *Question:* What should you do in case of a broken eccentric strap or rod?

*Answer:* Take down the eccentric straps and rods on the defective side, and centre the valve and

properly secure it. Take out the testing plugs or relief valves on the defective side, attend to the lubrication of the cylinder and piston rod, and allow the piston to run, taking great care to prevent the engine that is working from stopping at or near the dead centre.

In the case of an engine not fitted with testing plugs or relief valves, the cylinder may be lubricated through the release cocks. See Questions Nos. 35, 45, and 46.

51. *Question:* In the case of a breakdown or failure of the motion of an engine fitted with the Walschaert valve gear, what action should be taken?

*Answer:* (*a*) When it is necessary to centre the valve, first disconnect the combination link from the crosshead arm. Then, to centre the valve, place the clip marked F on the front end of the spindle up against the lubricating ring or the valve spindle bush of an engine fitted with a dummy gland cover, then move the valve so that the end of the spindle is flush with the edge of the clip. Secure the clip in this position, and put the other clip on the back end of the spindle up against the lubricating ring, and secure it.

(*b*) When a valve spindle is broken, centre the valve and secure it as described in Clause (*a*). Then disconnect the front end of the radius rod, and securely tie it to the motion plate. Then take down the combination lever from the valve spindle, and remove the eccentric rod. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(*c*) (i) When a radius rod is broken near the link, centre the valve and secure it as described in Clause (*a*). If necessary, disconnect the front portion of the radius rod from the

combination lever, then take down the combination lever from the valve spindle, and remove the eccentric rod. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(ii) When a radius rod is broken behind the link, centre the valve and secure it as described in Clause (*a*). Disconnect the radius rod from the combination lever and securely tie it to the motion plate. Then take down the combination lever from the valve spindle, and remove the eccentric rod. If necessary, remove the broken parts. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(iii) When the radius rod is broken near the combination lever, centre the valve, and secure it as described in Clause (*a*). Then securely tie up the radius rod to the motion plate. Take down the combination lever from the valve spindle, and remove the eccentric rod. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(*d*) (i) When the lower reversing arm, or pin, or radius-rod block, or radius-rod hanger is broken, remove the broken parts where necessary. Then place a piece of packing ($\frac{3}{4}$-in. piston packing) under the link block, and also a block on top of it, to prevent it from slipping, and securely tie them in that position. The reversing gear must then be placed in forward gear so that the radius rod on the other side is in a similar position to that of the defective side. If the engine has to be run tender first, place the $\frac{3}{4}$-in. piston packing on top of the link block, lift the link block up to the top of the link, and place a block under the link block, and securely tie them in position; then place

the reversing gear in back gear, so that the radius rod on the other side is in a similar position to that of the defective side. In either case, the position of the reversing gear must not be altered after the positions of the radius rods have been matched.

(ii) When the top reversing arm or the reversing rod is broken, slacken back the reversing shaft brackets and insert a liner inside each of the brackets, and set the radius rods to the "Cut off" required, tighten up the reversing shaft brackets to hold the radius rods and reversing arms in the fixed position. Remove or secure the broken parts. If the engine has to be run tender first, the reversing shaft brackets must be slackened back, and, after the radius rods have been set to the "Cut off" required in back gear, the reversing shaft brackets must be again tightened up to hold the radius rods and the reversing arms in the fixed position.

(*e*) When a crosshead arm, combination link, or the combination lever is broken, centre the valve and secure it as described in Clause (*a*). Then disconnect the front end of the radius rod and securely tie it to the motion plate. Take down the combination lever from the valve spindle, and remove the eccentric rod. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(*f*) When an eccentric rod, pin, arm, or link foot is broken, centre the valve and secure it as described in Clause (*a*). Then disconnect the front end of the radius rod, and securely tie it to the motion plate. Take down the combination lever from the valve spindle, and remove the eccentric rod. The eccentric arm must not be removed from the crank pin, as it is required

to keep the connecting rod in position. Disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

(*g*) When a connecting rod, piston rod, or a crosshead is broken, centre the valve and secure it as described in Clause (*a*). Then disconnect the front end of the radius rod, and securely tie it to the motion plate. Take down the combination lever from the valve spindle and remove the eccentric rod. Take down the connecting rod. If the piston rod is not broken, pull the crosshead to the back end and block it there; but, if it is broken, the broken parts must be removed and the crosshead properly secured. The eccentric arm must not be taken off, but left in position, in order to keep the clamps, which must be put on to take the place of the connecting rod big end, on the crank pin. If necessary, disconnect and plug up the steam pipes to the by-pass valves. The engine may then be run with one side.

52 *Question:* When an engine is working with only one side what load will it take and at what speed should it be run?

*Answer:* (*a*) As there is only one cylinder working the power of the engine will be reduced by at least one-half; therefore the load should also be reduced by at least that amount provided that the grades on the section of the line to be passed over are not all favorable to a heavier load.

(*b*) The maximum speed of the engine in any such case must not exceed 25 miles per hour.

53. *Question:* What is the difference between a plug trimming and a tail trimming?

*Answer:* (*a*) A plug trimming is one that only feeds when the engine is running and is used for those parts that have sufficient motion to shake the

oil over the top of the syphon pipe, such as big ends, outside rods, eccentric, &c.

It is made by wrapping worsted over a piece of twisted wire in the usual way, and, when in use, the top of it should be a little below the top of the syphon pipe, care being taken that the lower end of the trimming is clear of the journal.

(*b*) A tail trimming is one that is always feeding, so long as there is oil in the cup, and is used for those parts of the engine which are steady, such as slide bar oil cups, &c. It is made by taking several strands of worsted and passing them through a loop at the end of a piece of wire, then dropping the wire and worsted down the syphon pipe, allowing the ends of the worsted to hang over the top of the pipe to the bottom of the oil-box. The wire ends should be spread at the top to prevent the trimming going down too far, and the worsted covering should be of sufficient thickness in the pipe to avoid waste of oil. All tail trimmings should be drawn after the day's work, and so stop waste of oil.

(*c*) All trimmings require to be removed and examined occasionally, as they are in time apt to become clogged by impurities in the oil.

54. *Question:* If an engine spring, top leaf of a spring, a spring buckle, or a spring hanger broke, what should be done?

*Answer:* If the top leaf is broken, the clip and wooden wedge provided for the purpose may be used. If the buckle or hanger is broken, the engine must be lifted and the packing must be placed between the framing and the top of the axle-box, the amount necessary being gauged from the opposite side before the engine is lifted. Before placing the packing on top of the