LOCOMOTIVE BREAKDOWNS:

Note to Students: Refer to Handbook of Instructions, page 30
Also Rules and Regulations, Pages 280-281 under Accidents, Failures, Obstructions etc.

It cannot be too strongly stressed that students should make a close study of the references referred to above, as, an intimate knowledge of the regulations will give the enginedriver the fullest confidence in dealing with any situation that may arise in the course of his daily job of running trains. Many types of locomotive breakdowns, and the method of effecting running repairs, are dealt with in subsequent chapters of the Handbook of Instructions, whilst the Rules and Regulations gives detailed instructions for protecting trains, pilot guard working and for generally clearing the obstructed section of line in the most expeditious manner.

FIRST STEPS: CLOSE EXAMINATION : NATURE OF DEFECTS:

In the event of a locomotive breakdown, the enginedriver, before attempting any remedial action, should make a close examination of his locomotive to ascertain the full extent of the damage sustained and what precise steps he should take to effect repairs. Once he has surveyed the damage and formed an estimate of the likely time to move his train to the nearest siding to clear the main line, he is in a position to give the guard or fireman definite instructions so that positive action can be taken to advise all concerned as to the nature of the damage sustained, the probable duration of the delay, whether assistance is required and whether the train should be protected, according to the rules. The initial time spent in a calm inspection of the locomotive will be well repaid by the knowledge that all his subsequent actions are based on a clear understanding of the steps that are necessary to deal with the position.

POSSIBLE SOURCES OF TROUBLE:

The troubles experienced in every day service on locomotives are those ordinarily due to wear and tear and to bad water and poor quality coal. These may cause the valves and pistons to leak and "blow"; the moving parts of the machinery to "pound" while in motion; the draught to become insufficient to maintain the fire at the proper degree of incandescence to generate a sufficient supply of steam; the injectors to fail to work and the boiler to prime or foam.

The degree of danger to the operation of the locomotive in respect of any of the defects enumerated above will depend upon the extent to which the defect has been allowed to advance.

In the case of a "blowing" valve or piston, there is usually little danger in running, provided that it is due to simple wear and not to a broken part. Where the pounding is light, there may be no immediate danger, but this defect will progressively increase, and if permitted to become excessive, a breakdown may be the result.

Where the water is of such a character as to cause the boiler to foam or prime, there is danger that water may be carried over to the cylinders and cause serious damage there.

A poor draught on the fire, caused by some smokebox defect, may cause delay to the train, but is not usually serious structurally.

It should always be remembered, however, that any defect, no matter how slight, may be the direct cause of greater ones, which result in a serious breakdown, and even disaster.

THE DUTY OF THE ENGINEDRIVER WHEN DEFECTS NOTED:

When any of the incipient defects previously mentioned are noted, the enginedriver should observe them closely, and in case they indicate

a dangerous state of affairs, he should bring his train to a stop immediately. Should there be no apparent danger of an immediate breakdown he should proceed to the terminal and report the defect in the repair journal, and if necessary, make verbal representations to the locomotive foreman or his assistant.

PRIOR KNOWLEDGE OF DEALING WITH DEFECTS ESSENTIAL:

In the first place, the enginedriver should familiarise himself with all the details of locomotive construction, especially of the class of locomotive that he is called upon to run. It will be noted that each class will possess some peculiarity of construction which will necessitate varied remedial action in the case of certain failures. This will be especially true in the case of Walschaert and Baker Valve gear locomotives.

It would be wise then, as a preparation for what may happen, to go over the particular class of locomotive in detail, and see what can and must be done in the case of the failure of any individual part. This will be particularly valuable preparation where it becomes a matter of securing and chocking driving wheels and boxes and related parts, also in following the correct procedure in connection with valve and motion gear failures. In short, it should be borne in mind that the engine-driver who has worked out the problem in advance is the man who is ready to deal with any emergency as it arises.

PROCEDURE IN EVENT OF BREAKDOWNS:

In the event of a breakdown, the most important factor is to clear the track in the shortest possible time. The movement of traffic is so closely co-ordinated, that even a brief closing of the main line means serious delays to opposing and following trains, with loss of revenue and vexatious and sometimes unjustified criticism from passengers on affected trains.

Therefore, it is essential in the event of a breakdown or failure, that the train crew exert every effort to get the train clear of the main line, even if it is only as far as the next siding. Good judgment must be used, of course, and if there is a possibility that damage will occur either to the track or locomotive and cause a total failure, the locomotive should not be moved. However, even with quite a serious breakdown, the locomotive, if moved slowly, can often be run to a siding with comparative safety

Breakdowns can be minimised by inspections at intermediate stops. Particular attention should be paid to rods and brasses, especially the connecting rod "little end" brasses, because they are comparatively small, and therefore liable to "slack back" or even break. The keyway in the piston rod at the crosshead, the tyres, and in fact all moving parts, should be inspected as far as time will permit. This inspection is especially important in view of the high speed at which our modern locomotives are run.

All locomotives are supplied and equipped with a fairly wide range of tools suitable for dealing with most classes of breakdowns. (see list of tools and equipment attached to Lesson No. 3). In consequence, if the breakdown is not too serious, the enginedriver can immediately set about effecting sufficient repairs to get his train to the next station or siding, or even complete its run to the terminal.

In the case of heavy breakdowns or derailments, which involve such breakdowns as broken driving axles, leading or trailing bogie axles, broken tyres or failures involving heavy work, it may be necessary for the enginedriver to send for assistance. In this case, the enginedriver must use the most expeditious means of contacting the nearest locomotive depot or Train Control Officer, giving full, but concise details of the nature of the failure and the class of assistance required.

The fact that assistance has been sent for in such cases does not relieve the enginedriver of the responsibility of using all the means

at his disposal to prepare his locomotive for removal from the section.

The regulations for protecting trains have been adequately dealt with in previous lessons.

WALSCHAERT:- What should be done in case of accident.

It would, of course, be impossible to lay down rules to cover every case that might arise. It is possible, however, to consider some of the more usual or more possible types of failures; and to determine the best and quickest courses to follow in such cases.

METHOD OF REMOVING SIDE RODS:

The term side rod as here used refers to the combined sections on one side. This distinction is made because in some places, one section alone is referred to as a side rod.

On some locomotives, notably the "G" class, the outer portion of the crank pin is turned down to a smaller diameter than the part on which the side rod brass wears. This portion of the crank pin is threaded and the side rod is held on the pin by a nut, a washer and a split pin.

On the "J" and "K" classes, the side rods are held on the crank pins by a bolt, which runs right through the pin, with the outer end countersunk in a washer and with a nut on the inner end. The sections of the side rod are connected by knuckle pins, that are held in the rods by nuts, washers and split pins. The side rod brasses are solid, and are pressed on to the rods, so that cotters are not used as when the brasses are made in two pieces. Therefore, to remove a section of a side rod, all that is necessary is to take out the split pin, and remove the nut and washer from the end of the crank pin and knuckle pin; then drive the pin out and work the rod outwards until it comes off the crank pin.

The majority of our locomotives, however, are fitted with split brasses on the connecting rod, centre coupling and side rods. These are held in position by straps fitted with bolts and cotters which pass through the rod.

The large end of the connecting rod is forged in a rectangular section to form a seat for the jaws of the big-end strap, which is bolted to the rod by two accurately ground taper bolts provided with lock-nuts and split pins for additional safety. The two brasses are fitted to the inside of the strap and are retained by flanges machined on them at the back and sides.

EFFECTS OF REMOVING THE SIDE RODS:

The side rods, in addition to distributing the thrust of the piston equally to all crank pins, also performs the important function of keeping the crank pins in their proper relation to one another when either side is passing dead centre.

To explain the foregoing, the attached sketch shows an arrangement of the side rods of an eight wheel coupled locomotive of the "K" and "J" class.

If the side rods are all in place, and those on one side are on dead centre, the others on the opposite side will be on either the upper or lower quarter. The rods on the dead centre are practically idle at this instant and exert no power, nor do they assist to turn the wheels; the side rods on the quarter are doing all the work. As they move off the centre, however, both sides are at work until the other side reaches the dead centre, when the conditions outlined above, are reversed. Consequently, if the rods which happen to be on the dead centre are removed, the others opposite will force the wheels around until they reach the centre, and if the locomotive is barely moving, (or has no momentum) here, they will stop. With the pressure

against the piston,&the side rods in the position shown in Fig. 2, there would be nothing to force the wheels in any particular direction, but they could turn one way just as easily as the other. If they all turned in the same direction, no risk would be incurred, but sometimes they move as shown in Fig. 3. It is seen from a study of the sketch what disastrous results would follow. Crank pins could be sheared off, and the side rods could bend and break and seriously accentuate the difficulties already being experienced in uncoupling the locomotive.

The object lesson which should be firmly fixed in the mindof the student is that in every instance where it is necessary to remove a side rod, the corresponding rod on the other side must also be removed.

If one connecting rod breaks and no damage is sustained to any other rods, nothing need be taken down except the broken rod, as in this case the wheels will be forced to turn in the same direction because all the side rods are in place.

If a leading or trailing side rod breaks on an eight wheel coupled locomotive, it is only necessary to take down the broken rod and its opposite number, as these rods, by the location of the knuckle pins, are independent of each other.

With the arrangement shown in the sketch, the central side rod is solid between the crank pins of wheels Nos.2 and 3, while the other rods are dependent on the middle being coupled to it and to the crank pins at the other end.

Consequently, a break in the intermediate side rod would mean that all the side rods on both sides would require to be removed, as there would be nothing to drive either back or front, and it would therefore be unsafe to leave any rods on the undamaged side for the reason previously explained.

When uncoupling a locomotive, remember to keep the following two points firmly fixed in your mind:-

(1) Connecting rod can be run one sided with safety.
(2) Corresponding side-rods on both sides must come down.

The speed of the locomotive must be reduced if towed without side rods as otherwise the unbalanced driving wheels may cause damage to the rails.

Following is a copy of the Chief Mechanical Engineer's instructions dealing with the method of uncoupling the connecting and side-rods of the "Ja" class locomotives which are fitted with Roller Bearing crank pins.

LOCOMOTIVES CLASS JA-WITH ROLLER BEARING CRANK PINS . 1ST ENGINE JA 1240.
INSTRUCTIONS FOR REMOVAL OF THE CONNECTING AND DRIVING COUPLING RODS

In the case of any defect developing while on the road and necessitating the removal of the connecting rods or connecting and coupling rods the following procedure should be followed:-

(1) Remove the return crank arm complete with spherical roller bearing and eccentric rod. Do not dismantel this bearing.

(2) Remove the set bolts and locking plate from the big end locking ring. The locking ring can then be unscrewed from the crank pin and removed.

(3) Removal of the big end locking ring will expose the threaded end of the bearing withdrawal sleeve. The special spanner should then be screwed on to this sleeve and tightening up the spanner against the bearing will draw the sleeve loose.

Support the connecting rod end and withdraw the sleeve completely.

The connecting rod complete with bearing and end labyrinth covers can then be withdrawn from the crank pin.

(4) If the coupling rods do not require to be removed the special retaining sleeve carried as part of the breakdown equipment must be slipped over the crank pin to engage with the spacer ring, which normally separates the connecting and coupling rods and which must be retained in place.

The big end locking ring should then be replaced and screwed up firmly against the retaining sleeve. Do not on any account overtighten this locking ring otherwise the coupling rod bearing withdrawal sleeve will be driven further inwards and the coupling rod bearing may be broken. Finally replace the locking plate on the big end locking ring.

(5) If the coupling rods also require to be removed proceed as follows:-

After taking off the connecting rod as described, remove the spacer ring which normally lies between the connecting rod and the coupling rod.

Removal of this spacer ring will expose the threaded end of the coupling rod bearing withdrawal sleeve.

This sleeve should be withdrawn exactly as described for the connecting rod big end bearing sleeve, and by using the same spanner.

When the sleeve has been completely withdrawn, the coupling rod complete with bearings and labyrinth covers, can be removed from the crank pin.

IMPORTANT: Apart from the usual instructions that when being refitted at Workshops or depots every possible care must be taken to ensure that the bearings and labyrinth covers are kept scrupulously clean the following important point must be noted.

The coupling rod bearing having been correctly mounted, and its withdrawal sleeve driven in to the correct position, it is extremely important that the spacer ring between connecting and coupling rod bearings should have metal to metal contact.

To ensure this, it is essential to mount these bearings in the DRY condition only and to fill with grease only after final assembly.

The first few revolutions of a newly mounted bearing will probably "throw" a considerable amount of grease. This is of no moment as the labyrinth depth of chord has been designed to retain enough grease for efficient lubrication.

TAKING DOWN CONNECTING ROD:

In the event of a failure that requires the connecting rod to be taken down, proceed as follows:-

Place the locomotive on the disabled side in a position so that when removing the little end pin it does not come in contact with the spoke of a wheel; also see that the main crank-pin on the other side is in a position that will permit the locomotive to be started after the rod has been taken down. This crank pin, if the locomotive is to be moved forward, should be somewhere between the front of dead centre and the bottom quarter or between the back of dead centre and the top quarter.

Next remove the split pin and the nut or nuts from the little end pin, (depending on the type of assembly) remove the union link, and drive the pin out, then pry the crosshead forward away from the rod. The front portion of the rod on some classes of locomotives, which are fitted with what is known as the "alligator" type of crosshead, such as the "AB", may now be rested on the bottom guide bar.

After the front end is disconnected, remove the eccentric-rod from the bottom of the expansion link and the eccentric crank from the main crank-pin.

The back end of the connecting rod can then be pried off the crank-pin, provided the front end is also pried outwards at the same time, thereby preventing the rod from binding on the pin.

When removing the eccentric crank arm from the crank pin, remove the bolt which passes through the crank pin first. If the drawbolt is removed first, the other bolt will bind and difficulty will be experienced in removal.

On locomotives having crank pins not fitted with collars between the connecting rod and the centre-coupling brasses, the connecting rod brasses must be clipped on to the crank pin when the connecting rod is removed and the coupling rods are left in position.

Locomotives fitted with solid brasses must have the special retaining sleeve, which is carried in the breakdown equipment, slipped over the crank pin, and finally the whole assembly secured by the placing in position of the connecting rod cap. This cap is held in position by two bolts similar to the bolts in the eccentric crank arm.

PHOTOGRAPHS AND INSTRUCTIONS RELATING TO SPECIFIED FAILURES ON "J" "Ja" CLASS LOCOMOTIVES.

Key to names of parts.

1. Connecting-rod
2. Eccentric Crank
3. Eccentric-rod
4. Gear Connecting-rod
5. Radius Bars
6. Reverse Yoke
7. Gear Reach rod
8. Reversing-shaft Arm
9. Bell Crank
10. Gear Frame
11. Valve-rod
12. Lap and lead rod
13. Union Link
14. Crosshead
15. Valve-stem crosshead
16. Valve
17. Piston
18. Slide-bars
19. Bell-crank Clamp
20. Reverse-yoke Retaining Link
21. Retaining-link Bracket
22. Valve-crosshead locking screw
23. Valve centring screw.

The photographs illustrated in this lesson are a replica of the Baker Valve gear model which are available for inspection and study in the North and South Island Instruction Cars. Every opportunity should be taken of inspecting these and the other models which the Brake Inspector will be pleased to demonstrate.

Fig. No. 1 of the group of photographs shows the complete arrangement of the Baker Valve gear in its fully assembled state in order that students may quickly identify the names and location of the various parts.

Fig. No. 6 is included in order to give students a close up view of the arrangement of the Gear Connecting-rod (4), Radius Bars (5), Reverse-yokes (6), Gear-reach rod (7), Horizontal Arm of Bell Crank, (9), Gear Frame (10), Lap and Lead Rod (12), Union link (13), Crosshead (14), Valve stem Crosshead (15), and slide-bars (18).

Part of the Gear Frame (10), has been cut away to show the valve-rod, (11), (in the other photographs) in its relation to the vertical arm of the Bell Crank.

Figure No. 2 shows the amount of uncoupling necessary in the event of (a) the Eccentric Crank (2), (b) Eccentric Rod (3), (c) Gear Connecting-Rod (4), (d) Radius Bars (5), (e) Reverse-Yoke (6), (f) Horizontal Arm of the Bell Crank (9).

The Eccentric Rod (3), and Gear Reach Rod (7), have been removed and the Bell Crank (9), has been placed in its mid-gear position by attaching the Bell Crank Clamp (19) to the Guide-Bar (18) in the position provided. The Bell Crank Clamp (19), has been secured in position by the Clamp Set Screws.

The Valve (16), will now have free movement equal to twice the lap plus the lead.

For any of the above named breakdowns, there now remains only the Reverse Yoke (6) to secure to allow the locomotive to proceed. By the use of the Retaining Link (20), and the Retaining Link Bracket (21) as shown in Fig. No. 2, the Reverse Yoke may be adequately secured in this manner, when time permits and no undue delay to following or opposing trains would result. A second method which could be adopted to save time is to secure the Reverse Yoke (6), to the Gear Frame (10) as shown in Fig.4. This is down by lashing the Reverse Yoke to the Gear Frame by a strong piece of cord or wire, to prevent any movement of the Reverse Yoke. There is also a third method which could be safely used and that is to disconnect the Gear Reach Rod (7), from the Reverse Shaft Arm and secure it to the Running Board of the locomotive by using the bolt holes provided for securing the Retaining Links and Brackets. In addition lash to Gear Frame (10) as shown in Fig. 4.

Fig. No. 3 illustrates the procedure to be adopted if the Gear Reach-rod (7) Reversing Shaft Arm (8) or the connection of the Gear Reach Rod Arm to the Reversing Shaft Arm fails.

The assumed broken parts have been removed and the Reverse-yoke (6), on the disabled side has been clamped at the desired cut-off with the Retaining Link (20) and Retaining Link Bracket (21). This equipment is included in the breakdown equipment in the tool box of all "J" and "Ja" class locomotives.

The locomotive is now ready to proceed. It should be noted that with this equipment, that the Reverse-yoke may be secured at approximately full cut-off, or mid-gear with two intermediate positions.

If it is necessary to reverse the locomotive whilst the Retaining Link and Retaining Link Bracket is in use, the Reverse-yoke on the disabled side should first be secured in mid-gear position.

The other side may then be placed in backward gear and the locomotive moved.

If the Main Reach-rod (not shown in the photograph) Reversing Shaft (8), or Reversing Arm to which the Main Reach-rod is connected fails, it will become necessary to adopt the same procedure on both sides of the locomotive, i.e., remove both Gear reach rods (7), and then clamp both Reverse-yokes (6) forward or backwards and at the desired cut-off as may be required.

In this case the speed of the train or locomotive must be controlled by the judicious use of the regulator.

Fig. No. 4 illustrates the type of failure which would necessitate the covering of the steam ports by centring the valve (16), and securing with the Valve Centring Screw (23), and the Valve-stem Locking Screw (22).

These failures comprise any of the following:-

(a) The Connecting-rod (1), (b) Crosshead (14), (c) Guide-bar (18), (d) Piston (17), (e) or rear Cylinder Cover (not numbered).

The photograph shows the Connecting-rod (1) and Eccentric-rod (3), removed. The eccentric-rod has been removed in order that the Valve-rod (11), may be left in position. It will be noted that the

Valve (16) has been placed in its central position over the steam ports and the Valve-centring Screw, (23), inserted in the front of the valve chest cover and then secured by the Valve-stem Lock Nut Screw (22). On the model, the Valve-crosshead Locking Screw is shown as being on top of the Valve-stem Crosshead (15), but in actual practice it is located under the Valve-stem Crosshead on the locomotive. The Crosshead (14) has been blocked at the front end of the Guide Bars (18), by the Piston Chock as illustrated. The Piston Chock is held firmly in position by the Guide Bar Clips which are also provided in the breakdown equipment.

The photograph does not show these clips, but they are the ordinary U type bolts fitted with two nuts to secure the Piston Chock firmly to the Guide Bar after it has been placed in position.

If the Gudgeon pin (Little End Pin), fails and the Lap and Lead rod is damaged in addition to the above mentioned failures, dismantle the damaged side as explained in the foregoing and as illustrated in Fig. No. 4, but in addition remove the Union Link (13), and secure the free end of the Lap and Lead rod (12), to some convenient point to prevent it swinging and then proceed on the good side.

Fig. No. 5. If the Vertical Arm of the Bell Crank (shown in the cut away of Gear Frame (10), and the Lap and Lead Rod (12), is intact, or if the front cylinder cover or head is damaged, take down the Valve-rod (11) only, then centre the Valve (16), as illustrated by inserting the Valve-centring screw (23) and secure with the Valve-crosshead Locking screw (22).

The locomotive is now ready to proceed on the good side. It is not necessary to chock the Crosshead (14), or to remove the Connecting-rod (1), or the Eccentric Rod (3).

Should the Lap and Lead rod (12) or the Union Link (13), sustain damage, remove the broken parts and dismantle as described above.

If the Union Link (13), or its connection to the Crosshead (14), or the Lap and Lead Rod (12), should fail, remove the Union Link and damaged parts, centre the valve, secure the free end of the lap and lead rod if still up as described previously in the lesson and then proceed on the good side.

If the valve rod (11), or Valve-stem (attached to Valve (16) should fail / remove the Valve Rod, centre the Valve and proceed on the good side.

It is stressed that where it is necessary to remove the Connecting Rod, and Eccentric Rod and the Valve is centred, that the cylinder relief cocks be blocked open.

The attached photographs should give students a good general idea of the procedure to be adopted with any of the failures likely to be experienced with the Baker Valve Gear. The Special Instruction Book should also be referred to for further information on this subject.

An important point which students should bear in mind when dealing with Baker Valve Gear failures is that any breakdown located in front of and including the Vertical Arm of the Bell Crank would necessitate the centring of the Valve. On the other hand a failure occurring at the back of and including the Horizontal Arm of the Bell Crank would permit of the use of the Retaining Links and Brackets, thus enabling the Valve on the damaged side to function in the usual manner.

The photograph of the "Ka" locomotive illustrates how it would appear when prepared for towing.

The connecting rod, and eccentric rod have been removed from both sides. The crosshead is blocked at the front end of the guide bars by means of the piston chocks and clips and the expansion link is securely lashed to the guide bar to prevent any movement.

METHOD OF DEALING WITH "K" LOCOMOTIVE MOTION IN CASE OF SEIZURE OF DIE BLOCKS.

1. In the event of the die blocks seizing it should first be noted if the locomotive has stopped in a position, or can be moved to a position, which will allow the pin (A) coupling the eccentric rod to the expansion link on the disabled side to be extracted.

In certain cases the removal of the pin (A) may be prevented by :-

(a) its relation to the position of the connecting rod or slidebar.

(b) the damaged condition of the motion.

(c) the possibility of the opposite side being on dead centre or so placed as to prevent it being used for moving the engine.

The following procedure should then be adopted -

2. Cylinder cocks to be open.

3. Reversing lever should be left in the same position as when die block seized.

Reversing cylinder cocks must be kept closed and the air pressure maintained.

4. Slack back a few turns the bolts (B) holding together the Radius Rod Slider and notice if the reversing shaft arm tends to move as a result. If this is the case the reversing lever needs resetting to relieve the stress from bolts (one notch either way should accomplish this). When this is accomplished, complete the operation of removing nuts and bolts and dismantle slider. The Trunnion plates (C) can now be removed by operating the reversing lever until the plates are free to slide out of the holes in the end of the reversing shaft arm.

5. Dismantle union link first at the pin (D) and then at Gudgeon pin (E).

6. Centralise the valve on the damaged side and fasten in position with valve centring screw (F).

7. The motion on the disabled side is now uncoupled sufficiently to allow the opposite engine to be operated by steam in order to manoeuvre locomotive for the removal of pin (A).

8. If the operation described in clauses 6 and 7 cannot be performed owing to the opposite side being on the centre, then move the valve on the damaged side with a tommy bar just beyond the central position (front or back) and fasten it there by set screw (F) in order to give steam to front or back of the piston as required (the reversing lever position to correspond with the direction in which it is desired to move the locomotive) then give the minimum amount of steam to enable the disabled side to move locomotive so as to make the pin (A) accessible for removal. After removal of pin, centralise the valve as in Clause 6.

9. Remove the eccentric rod, fasten the expansion link and the lap and lead rod.

30/11/49.