LOCOMOTIVE CORRESPONDENCE COURSE, FIREMEN ENGINEDRIVERS.

LESSON NO. 16.

TRAIN HANDLING AND BRAKE MANIPULATION.

When the train has been marshalled and the locomotive attached, the Enginedriver should see that the Hose Coupling between the locomotive and the first vehicle on the train is properly connected and that the corresponding Brake Pipe Cocks are fully open. The train brakes are to be tested by and advice received from the Train Examiner that the Air Brake is in good order, and on how many vehicles, if any, the Air Brake is not operating. The Enginedriver now waits for the Guard to give the right away signal and, assuming all signals are at "Proceed" and other regulations have been complied with, the whistle is sounded and the regulator opened to start the train on its journey.

STARTING.

When starting a goods train, the locomotive should be started slowly and kept at a uniformly low speed for about a locomotive length to enable the coupling slack to be "run out" gradually and evenly. This practice should be adopted as a general rule regardless of the length of the train. It has to be remembered that when a train is being started, each vehicle in succession is brought from a stationary condition to the speed of the locomotive at that moment. If the locomotive speed is increased whilst the coupling slack is being run out, very severe slack action inevitably occurs, particularly on long trains.

Should it be necessary to reverse the locomotive to obtain coupling slack for starting, it must be eased up slowly and should not be again reversed until the entire train has stopped. If it is necessary to apply the train brakes when easing up, the locomotive brakes should be prevented from applying by means of the hand release Valve, or the Independent Brake Valve on A-6-ET equipment, if fitted, whilst the train brake application is being made.

When an assisting locomotive is employed at the head of the train the driver of the second locomotive should not commence steaming until the entire train has been started by the leading locomotive. If it stalls then the Driver of the second locomotive can carefully assist to start the train when signalled to do so by the Driver of the leading locomotive. Should both locomotives commence steaming together when the coupling slack is closed in, very severe coupling slack action might result.

When a train has been stopped by an application of the Air Brakes, sufficient time must be allowed for the brakes on the entire train to release before any attempt is made to restart it.

Vehicles should not be started from rest especially during shunting movements with the air or hand brakes applied as wheel-sliding and rough coupling slack action on long trains is almost certain to occur, due to the high efficiency of the brakes at low speed.

In order to ensure prompt release of the train brakes when a locomotive is recoupled to its train after being cut off for locomotive requirement or transportation purposes, or when a fresh locomotive is attached to the train, the Driver should check that full Main Reservoir pressure has been established before coupling up to the brake pipe.

RUNNING.

The Driver should frequently observe the Air Pressure Gauges and be prepared to act promptly if any unusual condition is indicated. He should watch the Pressure Gauges as far as possible during brake

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applications and releases in order to manipulate the Air Brake equipment efficiently.

Uniform and correct regulation of the Brake Pipe and Main Reservoir pressures has an important bearing on good brake operation. Therefore, the Driver should determine from the Air Pressure Gauges that the Feed Valve and Air Compressor Governor are functioning correctly. The uniform regulation of Brake Pipe Pressure is particularly important as any variation permitted by the Feed Valve is almost certain to cause "sticking brakes."

Maximum Main Reservoir pressure is also important as it governs the efficient release of the train brakes in recharging the auxiliary reservoirs. Too low a pressure retards the release and recharge, whilst too high a pressure causes unnecessary wear of the Air Compressor and is a waste of fuel. The Duplex Air Compressor Governor of the A-6-ET brake equipment, properly adjusted, provides high Main Reservoir pressure, only at the time required, and reduces Air Compressor labour at other times.

If the standard Brake Pipe pressure cannot be maintained with the Automatic Brake Valve in Running position, it must not be placed, and left, in Release position except in the event of a Feed Valve failure, or on a long grade. In any such case, however, the Driver should take particular care to insure that the Brake Pipe pressure is not being reduced because of some irregular cause, and if in doubt, the train must be stopped and the cause of the irregularity ascertained.

<u>COUPLING SLACK ACTION.</u> Damage to the draw gear of rolling stock on moving trains, and to the loading contained therein, is caused by coupling slack action which is the amount of slack movement that may occur between adjoining vehicles when coupled together. The total length of the coupling slack depends on the number of vehicles in the train.

There are two kinds of coupling slack, <u>loose slack</u> and <u>spring slack.</u> Loose slack is that which exists between adjoining vehicles without any compression of the buffer springs and Spring slack is the additional movement permitted between the vehicles when these springs are compressed. Spring slack also reacts and helps to drive the slack in the opposite direction, thereby increasing the train shocks. Under existing conditions, the total amount of loose coupling slack on a train of 70 vehicles may be as much as 20 ft., and combined with spring slack it would be considerably more.

It is obvious also that, with no coupling slack, starting and stopping shocks could not occur; neither could it occur if the draw gear was all held in tension, or the buffer gear held in compression. Shocks and damage result from the sudden change from one condition to the other. This can occur when starting a stationary train or whilst it is running, or when it is being stopped. When coupling slack is run in or out rapidly, one part of the train attains a higher speed than the other. The resultant shock is caused by the stresses set up in the draw gear in suddenly making the speed of both parts uniform. The extent of the shock will depend partly on the differemce in speed of the vehicles in the train and partly on the weight that must be suddenly altered in speed.

Coupling slack action cannot be prevented, but it can be effectively controlled and its harsh effect reduced if the Driver acquires a knowledge of its various causes as a result of practical observation, and then anticipates and counters it by proper train handling and brake manipulation. Smooth train handling therefore depends entirely on the ability of the Driver to control the coupling slack and prevent it being changed suddenly.

Coupling slack cannot be changed both gently and quickly and the Driver must realize this fact when steam, brake or grade action is about to change the slack when the train is being started, stopped or is running. When the coupling slack is changing under any of these conditions, ample time must be allowed by the Driver for the run of

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slack to be completed before taking any action that would tend to hasten the change or reverse its direction; otherwise, severe shocks will be produced. No attempt should be made to open the engine regulator following the release of the brake until the Driver has satisfied himself, by observation of the Pressure Gauge, that sufficient Brake Pipe pressure has been restored, and sufficient time elapsed to ensure that the brakes are properly released on the rear vehicle in the train.

In considering the reasons for slack movement, it should be fully realised by all concerned that, for any given brake application a greater degree of retardation will be obtained with an empty than with a loaded vehicle, the braking effect being inversely proportioned to the gross weight. It should be further understood that the brakes do not apply, or release, simultaneously throughout the train, the head end brakes responding both in application and release ahead of those at the rear.

The ideal arrangement of a train of empties and loads would be to so alternate them as to produce a uniform degree of retardation throughout the train, but this would obviously be impracticable. Placing the loaded vehicles at the rear causes a very severe run-in of train slack when brakes are applied. This is very damaging to the draw gear. The rebound of the buffer springs can result in broken buffers, etc.

On the other hand, the marshalling of the empties behind the loaded vehicles will result in a severe run-out of slack during brake application, that will, in many cases, be beyond the capacity of the Enginedriver to avoid entirely although there is much that can be done to minimise its effect.

The fact that a b roken buffer gear shows an old flaw is not, in itself, sufficient reason for its being broken. Some of these broken buffers have obviously been flawed for long periods, and in many cases would have continued in service had not some unusually severe shock been imposed. It can be taken for granted that the Enginedriver who is continually breaking drawgear is the one who, by rough handling of trains, is creating defects in new ones.

The secret of smooth train handling lies in the ability to control the slack so as to prevent it running in or out harshly. When so controlled no buffer gear in fair to good condition will be damaged. Slack action cannot be prevented, but by Enginedrivers acquiring a knowledge of the various causes for it, and exercising forethought in the use of steam, train brakes and independent locomotive brakes (or hand brakes), it can be generally controlled to the extent of avoiding damage to draw gear. The heavier the locomotive and the longer the train, the greater the care required.

Before an Enginedriver can be expected to handle a long train satisfactorily, it must be in a condition that allows of it being so handled. Excessive brake pipe leakage should be avoided, as not only is there a waste of air, causing overheating of the compressor, but also it may be impossible even to maintain the specified train pipe pressure. It also takes away from the Enginedriver ability to control the amount of brake application, and contributes also to brake sticking, etc.

When a train is running and steam has been shut off for the purpose of applying the brakes under normal conditions to reduce speed, ample time should be allowed for the coupling slack to run in gradually before the brake application is commenced, and even then the brakes must be applied in graduations.

If the coupling slack, due to grade conditions, is either in or all out prior to the brakes being applied, any brake on tending to run it in the same direction could not cause any ere shock. As a general rule, whilst the train is running ward, a condition where all slack has run in is the most vourable for an application of the brakes, and where the slack has in out, for the release of the brakes.

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With no slack in the trains and ~~the drawgear in good condition,~~ trains could not be broken in two. The same holds true with the slack all in or all out, provided it is held so. The damage arises from its sudden change. When slack runs in or out rapidly, one part of the train gradually attains a higher speed than the other, and the shock is the result of the drawgear having to suddenly make the speed uniform at the instant the slack is all in or all out. The force of shock depends mainly on the difference in speed that must instantly be made uniform and on the weight that must suddenly be altered in speed. Weight is an important factor in this connection, but change in speed is more so, as the shock imposed varies with the square of the speed. For this reason a sudden change in speed of 3 miles per hour will cause nine times the shock of a speed change of 1 mile per hour.

REDUCING SPEED AND STOPPING.

Refer to Air Brake Handbook Page 116, Clauses 67-73 and Page 118 Clauses 80 - 87.

RELEASING BRAKES.

In order properly to release the brakes after an application has been made, particularly on long trains, it is essential that as much pressure as possible be built up in the Brake Pipe above that remaining in the Auxiliary Reservoirs. For this purpose, it is necessary that a large volume of compressed air be maintained in the Main Reservoirs at a pressure of at least 25 lbs. higher than that normally carried in the Brake Pipe. Then to provide the maximum excess pressure on the Brake Pipe side of the Triple Valve pistons (to insure their movement to release position) it is also necessary to reduce the pressure in the Auxiliary Reservoirs to their lowest value whilst the brakes are applied. The nearer the brakes are applied to a full Service application the more prompt and certain will be the release, and it is very undesirable, therefore, to attempt the release following a light brake application from standard Brake Pipe pressure. Should circumstances necessitate a light application being made to stop a train, the Brake Pipe reduction should be continued to 15-20 lbs after stopping before the release is attempted.

Whilst it may be necessary under certain running conditions to make a light brake application for slowing down without it being practicable to increase the Brake Pipe reduction before releasing, such proceedings should be avoided as far as possible.

When the train brakes are released at low speeds the coupling slack shock produced can be materially reduced by application of the Independent or Straight Air Brake on the locomotive, particularly if the head of the train is on a straight track and the rear end on a curve, as the retarding power of the locomotive brake will assist to prevent the harsh running out of the coupling slack. As a general rule, however, no attempt should be made to release the brakes on long trains after a light brake application has been made, and in no circumstances when the train is running at low speed.

The minimum speed at which the brakes of a goods train can be released without causing severe coupling slack action and possible "Break aways" depends on how heavily they have been applied, the length of the train, whether the coupling slack is then bunched or stretched, and whether the track conditions such as "humps" and curves do, or do not, favour releasing. These conditions must be determined by the Driver and where adverse releasing conditions are presented he must, if necessary, allow the train to come to a stop before releasing.

When releasing the brakes the proper length of time to leave the Automatic Brake Valve in Release position depends chiefly on the length of the train and whether a full Service or Emergency brake application has been made. After a full Service brake application has been made on a standing or running train, the Brake Valve should be placed in Release position for a period of one second for each five vehicles on the train, and then returned to Running position. For example, with a train of 30 vehicles, the Brake Valve must be placed

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in Release position for 6 seconds: with 40 vehicles, 10 seconds and so on. After the Brake Valve has been placed in Running position following the above periods, it must be left in that position until the Brake Pipe pressure has equalised; then it must be again placed in Release position for two seconds to make a "Kick off", and then returned to Running position. The object of the "Kick off" is to release any brakes on the leading vehicles that may have reapplied as a result of a slight overcharge.

If the locomotive has been detached from the train for some time or a Coupling Hose has burst the Brake Pipe pressure may be exhausted. Under these or similar circumstances, the Brake Pipe has first to be recharged from the Main Reservoir to a pressure of approximately 50 lbs. to equal that in the Auxiliary Reservoir. A further substantial increase in Brake Pipe pressure will then be necessary to insure the release movement of the Triple Valves. The Brake Valve, therefore, must be left in Release position for reasonably longer periods before it is returned to Running position than that stipulated for Releasing after full Service applications. One or two "Kick Offs" must then be made to release any brakes that may have reapplied as a result of a slight overcharge.

It follows from the above that the most favourable condition for releasing brakes on a long train is with maximum Main Reservoir pressure and the brakes almost fully applied; and that the most adverse release condition is presented when the Brake Pipe pressure is very low, or when it has been completely exhausted by improper brake manipulation, or by an emergency application resulting from the train accidentally dividing or such other irregularity.

After releasing the brakes whilst the train is running, the engine regulator should not be opened until the Driver is satisfied that the brakes are completely released and, even then, it should be opened gradually to avoid the possibility of severe coupling slack action.

The most common cause of Triple Valves Pistons failing to move to release position, when the train brakes are being released, is improper brake manipulation by the Driver, whereby the Brake Pipe pressure is not quickly and substantially increased above that remaining in the Auxiliary Reservoirs. This is caused either by the release being attempted after too light an application has been made resulting in the Auxiliary Reservoir pressure not being sufficiently reduced, or by the Brake Valve not being left in Release position long enough to provide a rapid increase of Brake Pipe pressure on the vehicles at the rear of the train. The handle of the Brake Valve, therefore, <u>must not be moved</u> alternately between <u>Release</u> and <u>Running</u> positions whilst the initial release is being effected as this destroys the continuous flow of air at Main Reservoir pressure to the Brake Pipe which is so essential for the rapid increase of Brake Pipe pressure necessary to insure a prompt release of the brakes on the rear vehicles of the train.

Triple Valves may also re-apply irregularly on vehicles at the head of the train as a result of an auxiliary Reservoir overcharge caused by the Driver moving the handle of the Brake Valve alternately, and unnecessarily, between Release and Running position after the train brakes have been fully released and recharged.

The Driver's purpose may be to insure that all brakes are released, but generally it produces the opposite effect, and is therefore a very bad practise, particularly when the train is approaching a heavy ascending grade.

If the Brake Cylinder Pressure Gauge on locomotives fitted with A-6-ET brake equipment shows, after releasing, that the locomotive brake has "crept on", it generally indicates an Auxiliary Reservoir overcharge at the head of the train. In such a case the locomotive brakes must not be released by the Independent Brake Valve but a "Kick Off" must be made with the Automatic Brake Valve.

By studying the effect of the Air Brake operation on the smooth handling of long goods trains, and by analysing his daily experience

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in practice, a Driver can become proficient in anticipating the possibility of severe coupling slack action or brake releasing difficulties and by then exercising the necessary care in his train handling and brake manipulation he can avoid any adverse operating results.

GRADE BRAKING.

Train running safety down long heavy falling gradients in so far as air brake control is concerned, involves recognition of the fact that the effectiveness of any brake is greater at low speed than at high. Not only is the holding power of brake shoes considerably lower at high speed, but the stopping distance of trains varies as the square of the speed; thus, the stopping distance of a train at 30 miles per hour will be approximately two-and-a-half times as great as at 20 miles per hour. Efficient manipulation of the air brake equipment by the Enginedriver therefore is necessary to enable him to safely control the speed of the train as well as to maintain sufficient reserve braking power to make a stop on the grade should it be necessary. Any attempt to make up time down a grade is to be deprecated.

Before starting down a heavy grade the Enginedriver should know the number of effective brakes on the train, so that he may determine if the brake equipment is adequate for the control of the train. Further, to test the effectiveness of the brake, he should make a brake application very shortly after leaving the summit, before the train has reached a high speed. Although a standing brake test may indicate that the air brake equipment of the train is in good order the braking efficiency can only be determined by the retarding effect of the first running brake application made.

The retarding effect of the air brake during serial braking on long grades is chiefly dependent on prompt recharge of the Auxiliary Reservoirs during the release period. Some Enginedrivers are inclined to make a succession of small brake pipe reductions, and allow the brakes to remain applied for quite a long period. The idea is that they try to obtain a uniform speed down the grade. This method of brake manipulation is undesirable because with long holds brake pipe leakage tends to reduce the brake pipe pressure further than necessary, also the braking force of the train will be reduced by brake cylinder piston leather leakage.

The diagram, Fig. 1, illustrates an example of what can take place when the brakes are held on for a long period. With the brakes held on for approximately 1½ miles, as shown, the brake pipe pressure dropped to 40 lbs., owing to the method of brake manipulation and brake pipe leakage. During the release period the brake pipe pressure only increased to 58 lbs. pressure before another brake application was found necessary. The low brake pipe and auxiliary reservoir pressure results in the brake cylinder pressure also reducing as shown. Should this method of brake manipulation be continued on a grade a dangerous position would arise very quickly.

The graph, Fig. 2, shows the relation between brake cylinder pressure and brake pipe reduction for various piston travels. It will be noticed that with 8" piston travel and 70 lb. brake pipe pressure, a 20lbs. reduction will produce a brake cylinder pressure of 50lbs. and is known as a equalised reduction. A further brake pipe pressure reduction would not increase the brake cylinder pressure and this should be remembered. Should the auxiliary reservoir be recharged to say 60 lb. pressure only, the maximum brake cylinder pressure obtainable would be approximately 43 lbs. The importance of obtaining a complete recharge of the auxiliary reservoirs is apparent.

On descending grades braking safely rests on two combined factors names SPEED LOW and PRESSURE HIGH. The train must be reduced to a sufficiently low speed during the brake application so that after release ample time will be provided to recharge auxiliary reservoirs before the train accelerates to a speed that necessitates the next brake application being commenced. When a brake application is made it is preferable to make a definite substantial reduction and bring

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the train down promptly to the desired speed ~~before the release is~~ made. The amount of reduction necessary to control the train must be left to the Enginedriver's discretion, but the principle of making definite substantial reductions should be followed. This method of operation will reduce the consumption of air to a minimum, the air admitted to the brake cylinder not being discharged to atmosphere until it has performed sufficient work in retarding the train.

The graph shown in Fig. 3 has been produced from actual grade braking tests conducted in New Zealand and illustrates the advantage of low speed brake releasing. The upper curve shows the recharge rate of the Auxiliary Reservoir on the last vehicle of a 70 vehicle train. When a 20 lb. reduction is made it takes approximately 180 seconds to obtain a complete recharge and 100 seconds to obtain 65 lbs. auxiliary reservoir pressure. The lower curve shows the approximate acceleration rate on a 1 in 50 grade with a train load of 700 tons. It will be noticed that when the train speed was brought down to 10 M.P.H. and the brakes released after a 20 lb. reduction, in 100 seconds the speed was up to 30 M.P.H. In 100 seconds the auxiliary reservoir pressure on the last vehicle was charged to 65 lbs. If the brakes had been released at 20 M.P.H., which is quite common practice with some Enginedrivers handling trains on grades, in 50 seconds the speed would be up to 30 M.P.H. and the auxiliary reservoir pressure in this case would only be 57 lbs. Enginedrivers are quite familiar with the fact that the train speed does not reduce as soon as the brakes are applied but continues to increase for some time, ~~therefore,~~ the ~~brakes must~~ be applied before the train is allowed to reach too high a speed.

To illustrate further the general principle of grade braking, two trainagraph records of actual tests conducted by the Department are included in this lesson. The trainagraph is an instrument that records the actual brake pipe pressure, auxiliary reservoir pressure, brake cylinder pressure and time between each 1/4 mile peg on a chart. When a test is being conducted the instrument is connected to the brake set on the last vehicle. From the Trainagraph chart obtained, a trainagraph record is drawn.

The National-Park-Raurimu trainagraph record (Fig.4) covers the control of a train consisting of two Ka. locomotives, 72 vehicles and a train load of 735 tons excluding the weight of the locomotive. The record shows a good example of speed control, and it will be noticed that on each application the speed was brought down to approximately 10 M.P.H. and, during the release period, not allowed to exceed 30 M.P.H. The brake pipe and auxiliary reservoir pressure maintained was such that a stop could have been made on any section of the grade. Had the speed been brought down to 5 M.P.H. the auxiliary reservoir pressure would have been increased further. During the run full use was made of the release position of the Driver's Brake Valve and the tender hand brakes on both locomotives were used. The locomotive tyres were not overheated on reaching Raurimu.

Fig. 5 is a portion of a trainagraph record taken on the Mamaku gr[illegible]. The train in question consisted of one AB. locomotive, 3[illegible] vehicles and a train load of 379 tons, excluding the weight of the locomotive. It is interesting to note that when the stop was made at Ngatira the auxiliary reservoir on the last vehicle was fully recharged to 70 lbs. During the release period the Driver' Brake Valve was left in the release position, and, by referring to Fig. 5, the advantages of this method of brake manipulation on heavy falling grade is clearly illustrated.

<u>GENERAL.</u>

During serial braking on long grades care must be taken to avoid overheating the locomotive tyres, and with efficient manipulation this can be avoided and the following method of handling is suggested.

After the Automatic Brakes have been applied, the air brakes on the locomotive can, if brake manipulation is efficient, usually be

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safely immediately released by means of ~~the Independent Brake Valve~~ on locomotives fitted with the A-6-ET. brake equipment, and by means of the hand Release Valves on locomotives fitted with Straight Air brake equipment. Before releasing the Automatic Brakes on the train, the locomotive brakes may, only when necessary, be reapplied by means of the Independent or Straight Air Brake Valve, as the case may be, and used to retard the train whilst the Auxiliary Reservoirs are being recharged, but in such a manner as will avoid overheating of locomotive tyres.

On locomotives not fitted with an Independent or Straight Air Brake, the following method is suggested.

After the Automatic brakes have been applied, the Retaining Valve on the tender should be closed and, if running conditions permit, the engine brake released by means of the hand Release Valve. The tender brake by means of the retaining valve will thus be utilised to retard the train whilst the release and recharge of the train brakes is being effected, in addition to which the tender handbrake may be applied.

Refer to Air Brake Handbook Pages 107 to 122 for further general information relating to the use of the air brake.
