CHAPTER VI.

ON THE ROAD.

Rules and Regulations.—So many different equipments and types of apparatus are in use on the various lines in this country that it would be impossible, within the limited compass of this small handbook, to describe in close detail the exact method of operating such apparatus, and as different rules and regulations are issued by each company or corporation, no attempt will be made to lay down a hard and fast code of instruction for the motorman, but rather a general outline of how he may safely and efficiently operate his car and deal with such troubles as may arise.

First Essentials.—Motormen should remember that as public servants they may often find it necessary to exercise great patience and self-control in performing their duties and in dealing with dissatisfied people, but they will usually find that a cheery and polite reply will do much towards smoothing down any dispute which may occur.

When handling a car it is necessary to remember that the safety of the public is the first consideration, and that strict temperance is absolutely essential while on duty.

Reporting at Depôt.—In starting the day's work a motorman should report at the car depôt with plenty of time to spare, so that he may read any fresh notices which have been issued by the management, and have a look round the car allotted to him for the day.

Examine Car.—He should try both controllers to see they are working freely, examine all main switches and cut-outs for proper working, and try all the car lights and bells, together with the foot-gongs and sanding gear, and any other appliance necessary in running the car.

He should see that the hand brakes are working properly, and have a glance round to see that the car is equipped with point-shifter, spare fuses and lamps,

rubber gloves, ramp, and other tools according to the usual arrangements.

Leaving the Depôt.—Before starting the car the driver must see that the rear brake is off, and there is no person working underneath in the pit; and that the conductor has hold of the trolley cord to guide the pole round the sharp bends and curves generally existing in car sheds.

Going out of the depôt the speed must not exceed four miles per hour until clear of all points and crossings, and as soon as possible a test should be made with the various brakes with which the car is fitted.

If the brakes are found defective, or the motors or controllers not in working order, the car should return to the depôt for examination by the engineers, or another car may be secured.

Starting from Terminus.—Assuming that the car and equipment are in perfect order, the motorman proceeds on his way to the route starting-point, where he sees that the trolley-pole is turned in the right direction, with the wheel on the right wire, and that the controller handles, foot-tramps, and other platform gear are placed at the driving end of the car ready for starting.

On receiving the signal from the conductor he puts the reversing lever of the controller forward and brings the large handle smartly to the first " power " point, at the same time easing off the brake so that the car starts without jerking or straining.

A slight tap of the foot-gong should be given when starting, to warn passengers.

" Feeding up " Controller.—The controller handle is now brought gradually round to the first running point, —the full series,—each notch being rested on for such time as is necessary for the car to attain speed, and care must be taken that the handle is never allowed to rest between the notches, or slipped past a point without resting on it for the proper time.

If the speed of the car on the first running point is too slow the controller must be moved point by point to the second running notch,—the full parallel,—and the motorman, standing erect with one hand on the controller and the other on the brake handle, keeps a sharp look-out for vehicles and pedestrians in front or crossing the track.

Switching off Power.—On approaching a stopping place or nearing an obstruction the controller is switched right "off" with one smart movement, and the car allowed to run by its own weight until it becomes necessary to apply the brakes, which should be done gradually, and the car brought smoothly to a standstill exactly at the station or at a safe distance from the obstruction on the track.

Greasy Rails.—If the track is greasy and slippery, and it is found necessary to stop quickly, a little sand dropped on the rails will cause the car wheels to secure a good grip and prevent sliding or "skidding" them.

Skidding Wheels.—It is important to note that the brakes must never be applied so strongly as to keep the wheels skidding, as when this is done the braking effect is greatly reduced, and the car may slide forward a considerable distance, particularly when the track is greasy and the car is descending a steep incline.

Skidding is liable to damage the car wheels, and although it is sometimes difficult for the motorman to tell if the wheels are sliding or if it is simply a greasy rail, he should, if at all doubtful, slightly ease the brakes off and on to let the wheels revolve to some extent, and may apply a little sand until he feels the car well under control.

Setting Hand Brake.—When the ratchet handle of the brake has been set into the proper position it should be kept there, so that the motorman may know just where it will come to when the brake blocks are hard against the wheels.

Do not let the handle fly round at any time, as it annoys and alarms the passengers.

When the rails are slippery great care must be exercised to prevent the car from getting beyond control, and when approaching obstacles the speed must be kept within safe limits and no risks taken.

Rear Wheels Skid.—Sometimes the rear wheels of the car may start skidding first, as most of the weight is taken by the front axle when the car is running forward, especially on down grades.

In the same way where the car is fitted with double trucks the wheels of the rear truck are more liable to start skidding when the brakes are applied hard.

Quick Stops.—When power brakes are fitted to the car, and a quick stop is required, the ordinary hand brake may remain off and the power brake be applied to effect a rapid halt to avoid accidents.

Caution at Cross Streets, etc.—A warning tap of the gong should be given when approaching cross streets or passing a car on the opposite track, and when the other car is discharging passengers a bright look-out must be kept for anyone coming out from behind, and everything held ready for making a rapid stop if found necessary.

Traffic Cautions.—Avoid running up close to vehicles in front, and always make sure before passing them that they are clear of the track and not likely to swing round into side streets or lanes, and perhaps strike the car body with a projecting load.

When approaching a stopping place where there is not sufficient room for vehicles to draw clear of the rails, do not keep "ding-donging" at the gong, but follow slowly after the vehicle to the station, and give the driver a fair chance to draw clear further on and allow your car to pass.

A motorman soon gets acquainted with the local carters and lorrymen and can exercise a "give and take" policy with considerable advantage to himself.

Look out for Children.—The driver must keep his eye on pedestrians crossing the street with their backs turned towards him, and for children swinging on the rear end of cars and other vehicles.

When passing schools and public institutions the utmost care should be exercised to prevent accidents.

Passing Horses.—When passing close to heavily-laden horses the motorman should be ready to stop at once, as the horse may stumble and swerve across the track before the car and cause a nasty accident.

Horses standing at the side of the street without attendants may wheel round on hearing an approaching car; or even if the driver is present, he may turn the vehicle across the track unless he receives full warning from the gong and whistle.

If horses become restive as the car is passing them, the driver should slow down, and, if necessary, stop altogether until they calm down.

The motorman should speak if a horse is restive, and this will to some extent lessen the fear of the animal.

If the road is greasy and a horse is unable to start its load, a handful of sand may be thrown at its feet to assist it out of the way.

When any vehicle becomes disabled and is blocking the track, the motorman should leave the car in charge of the conductor and assist to clear the road to prevent stoppage of traffic.

Cautions at Cross-Overs, etc.—Keep a look-out for cars swinging out of side-lyes or turning at cross-overs, as a considerable number of serious collisions occur at these places, owing to want of care on the part of the motormen.

Conductor's Signals.—Always insist on the conductor giving clear and distinct signals, and do not start if in doubt at any time as to the meaning of the signal given.

Look out for Passengers.—Keep a sharp look-out for passengers wishing to board the car at stopping places and cross streets. Remember you are running the car to collect passengers, and not simply for your own amusement.

Overtaking Cars.—When overtaking a car in front do not run close up, but always endeavour to keep some considerable distance between cars going over the same route. It looks bad to see three or four cars all running close together and leaving a gap of half a mile or so between them and the next car.

Cross Traffic.—When overtaking a car at a stopping place always leave room for people to get across the street, and at cross streets room must be left for all cross traffic.

Passing Section Insulators.—As the car passes under a section insulator the controller must be switched "off" until the trolley wheel has passed, and care should be taken not to stop the car with the trolley resting directly on the insulator.

If this latter occurs the brake should be eased off to allow the car to run some little distance from the insulator, or, if on a dead level, the pole may be turned to make contact with the live trolley wire and the car be moved ahead.

Facing Points and Crossings.—Very great caution must be exercised when approaching facing points, as the wheels may take the wrong line, and a collision result with an approaching car or vehicle on the other track.

Always slow down at all crossings and points, to prevent jolting the car and damaging the trucks and wheels.

Obstructions on Track.—Keep a look-out for articles lying on or between the rails, and always remove anything likely to cause damage to the cars.

Even a small piece of iron lying on the rail may break or bend a car axle, and any hard substance in the rail groove may chip and break the flanges of the wheels.

Avoid Racing.—Avoid racing with other vehicles to secure first place at junctions. During fog, or when running on badly-lighted roads, be careful to reduce the speed so that a stop may easily be made in the distance clearly seen ahead, and never take it for granted that the line is clear.

Reducing Speed.—If it is necessary at any time to reduce speed the controller must be brought smartly to the off position, and afterwards fed up to the position desired.

Feeding Controller when Running.—When the controller is switched off for a little, as is necessary at a section insulator or when passing a car on the opposite track, the motorman need not feed up again so slowly as when starting from rest, but should move the handle round at once to the notch which agrees with the speed at which the car is actually travelling at the moment, and then feed up to full speed as usual from that point.

Care must be taken not to swing the controller round past the proper notch, as the car may receive a severe jerk, or the automatic switch may open.

Operation of Controller.—When switching off the controller do not use too much force, as it may damage the mechanism considerably and cause unnecessary wear and tear.

On no account is the controller to be moved back a notch or two; it must be moved right "off."

Never move back from the first power notch when starting the car from rest, as it may burn the contacts severely. In fact, it is always better to wait until the car has got into motion or feed up to the second notch before switching off.

From Series to Parallel.—Always move quickly from

the last series notch to the first parallel one, as only one motor is in operation for the moment when changing the connections from series to parallel, and a heavy flash may be set up at the controller contacts if moved slowly round.

How to Start the Car.—When starting a car from rest the motorman should remember that to turn the current on too quickly may cause the wheels to slip and not secure the best tractive grip on the rails.

When the motors are connected in series the same current is passing through both, and more value is got from the current for accelerating than when the motors are in parallel and each receiving half the total current taken from the line.

It is important, therefore, for the motorman to get as much acceleration on full series as possible before moving round to the parallel positions.

Rule for Acceleration.—A general rule for acceleration on the level is to increase the speed of the car at the rate of one and a half mile per hour per second. For example : on a car designed to run at a maximum speed of eighteen miles per hour on the level the controller handle may be moved round from the first to the last position in, say, ten seconds.

For cars designed to run at higher speeds the controller handle will require to be moved round at a slower rate, and for lower speed cars it may be fed up more quickly.

When the line is a small one the motorman should be careful not to start the car very quickly, as it throws an unnecessary strain on the machinery in the power station, and also causes a loss of power in the feeder cables and return circuit.

Starting on Greasy Rails.—In starting the car on a greasy rail the controller handle should never be brought past the first notch until the wheels have gripped the track and the car has got well started.

If the wheels are allowed to fly round when starting, and sand is dropped freely on the rails, a great strain is thrown on the motors and gearing. The motorman should therefore get the wheels to grip when the first notch is applied, and gradually increase the power as the car accelerates in speed.

Should the wheels again slip, switch right off and feed up again, at the same time applying sand.

Stopping on Hills.—When coming to a standstill on a hill or greasy track a little sand may be dropped, so that the car comes to rest on the sand, and is able to start off again without slipping.

Avoid stopping on hills or curves if possible, as it requires a great effort to get up speed again, and consumes extra current.

Running Notches.—Only the full series and full parallel notches are to be employed for continuous running.

The intermediate points are to be used for starting up the car, and must not be used for any length of time, otherwise a large proportion of the current is wasted in simply heating up the rheostat, and is not used to propel the car.

How Rheostats are Damaged.—Again, running for long periods on the resistance notches is apt to damage the rheostat or make one section hotter than another, and thus affect the smooth working of the car in starting or in stopping with the electric brake.

Running on "Full Series."—After coming to the full-series notch the car should be allowed to attain its maximum speed on that point before moving further round, otherwise power is wasted needlessly.

For heavy pulling on inclines the full-series notch is easiest on the motors, but is generally too slow for every-day work, and as cars are usually fitted with motors of sufficient power to mount the steepest hills without undue straining, it is preferable to run at full parallel, and thus climb the hill quicker and save current and time.

Coasting.—When a motorman is learning his business he is rather apt to apply the brakes too strongly, and often throws a lot of unnecessary work on himself which could be avoided by the exercise of a little judgment and coolness.

When a car is running fast it represents a considerable amount of stored energy, which will cause it to run a long distance after the controller is switched off.

A skilful motorman, by correctly estimating the distance he can coast with power off, will be able to run

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A skilful motorman, by correctly estimating the distance he can coast with power off, will be able to run

with very little exertion spent on the brakes, and with a much less consumption of current from the trolley wire.

Economy in Current.—Of course, on some routes where the time is cut down to a minimum, or when the car has been delayed, it is necessary to approach stopping places at rather high speeds, but there is always plenty of scope for economising in current consumption during a complete journey or in a full day's work.

When recording meters have been fitted on cars and systematic tests made it has been found that an intelligent and expert driver can run his car with much less current than a careless or ignorant motorman, while at the same time keeping up to time and collecting as many passengers.

How to Save Power.—The main point is to take advantage of all grades to run with power off, and to switch off as soon as possible when approaching stations or obstructions, and allow the car to drift along by its own momentum.

When starting the car it is important not to rest too long on the resistance notches, especially the parallel ones, but to feed up the power properly as the car accelerates, always taking into account the nature of the track and the power and weight of the car.

The full-series notch may be used for slow running through traffic or when only a short distance has to be traversed before stopping, but on a clear road the full parallel notch should be employed, as the current is then being used to the best advantage and the most economical results obtained.

When approaching a steep incline, endeavour to get up speed before striking the rise.

Speed at Curves, etc.—When approaching curves slow down to a safe speed (four miles per hour), as a great strain is thrown on the car axles and truck if taken round sharp bends at high speeds, and the trolley is very apt to leave the wire at these points.

When running through cross-overs, frogs, and complicated overhead junctions, always run slowly and with power off if possible, and be ready to stop instantly should the trolley leave the wire.

Trolley off.—A motorman can usually detect the instant the trolley jumps the wire by the sudden slackening in speed if the controller is on, or by the quiver of

the trolley wire in front, and by stopping the car promptly he may prevent considerable damage being done to the pole and line.

Replacing Pole.—When the pole springs off at any time care should be taken not to allow it to rub against the trolley wire, as the usual protective tape on the pole may be wet or worn off, and the current from the trolley wire may get to ground and cause the "ground indicator" to act, if such appliance is fitted on the car, or if the trolley standard is directly connected to the rails the rush of current from the trolley to the rails may open the station circuit-breaker and render a long section of the route dead. Only the "head" of the pole should be allowed to touch the trolley wire.

Neither must the pole be allowed to touch both guard and trolley wires at the same instant, or a short circuit may be established and burn the wires through or open the station circuit-breakers.

Reversing Car.—When it is necessary to set back the car the conductor should be signalled and the car moved very slowly back, after seeing that the line is clear to the rear.

It is advisable to turn the pole into the proper direction before running backward, especially at curves or at crossings of the overhead wires.

Emergency Stops.—Sometimes it may be necessary to stop the car very quickly to prevent an accident, and in such emergencies very much depends on the coolness and promptitude of the driver.

The power brake with which the car is fitted should be applied at once, and sand dropped as freely as possible on the track to prevent the wheels skidding and to secure the best possible braking effect.

Reckless Motormen.—Occasionally it may be impossible to stop a car in time owing to another vehicle drawing suddenly across the track, or the rails may be unusually greasy, but an alert and cool motorman, by prompt action and good judgment, can very often avert a collision where a foolish or reckless man would fail.

It is no credit to a motorman to allow his car to get beyond control at any time, or to take dangerous risks when he is perfectly well aware that his car cannot be stopped in the distance at disposal.

It should always be kept in mind that on a given line

a car can only be stopped in a certain minimum distance, and that to throw the brakes on so hard as to skid the wheels is certainly a foolish proceeding if good results are required to prevent an accident.

Descending Steep Grades.—Before descending long steep grades particular attention should be paid to the condition of all the brakes, both hand and power, and the sanding gear tried, so that the hill may be descended safely, and an emergency stop made if found necessary on the way down.

Avoid letting the car attain a high speed during the descent, as the braking power necessary to stop increases greatly with the higher speeds, and the wheels may start skidding if the rails are at all greasy.

Skidding on Grades.—If the wheels start skidding when descending a hill the brake should be eased off slightly and sand dropped until the car is well under control.

On no account is sand to be dropped while the wheels are locked, or they may be badly damaged thereby.

When a mechanical slipper brake acting on the rails is fitted to the car it is usual to apply it slightly at the top of the hill, so that it may readily be brought into action to effect a quick stop, or it may be used to control the car all the way down if the grade is very steep.

To prevent Cars running back.—On some lines, where the grades are very severe, the cars are fitted with a device which is brought into operation when on the ascent, and which prevents all possibility of the car running back down the hill, by slipping under the wheels and "spragging" them immediately the car starts backwards.

Power off Line.—If the power is cut off from the trolley wire at any time the controller handle must be brought to the "off" position and the car lights switched on, so that you may see when power is again restored.

If the power has been off for some time, and a considerable number of cars have to start, do not pass the half-speed notch for a few minutes, so as to give the power station a chance to take up the load, and each car should be allowed to get into motion before the others put on power.

Leaving Platform.—A motorman should never leave the car platform without first switching off the current and taking the controller handles with him.

He should also see that the car brakes are left on, so that there may be no risk of a runaway occurring.

Track under Repair.—If the track is being examined or repaired the motorman must be careful to slow down at such points and give ample warning of his approach, so that the workmen may have time to remove any obstructions from the line.

Tower Wagon.—When the tower-wagon staff is at work on the line, stop the car at a safe distance and ascertain whether you may run past.

The conductor should be ready to pull down the trolley-pole if the platform of the wagon is turned across the track, and the car should get up sufficient speed to coast past with power off.

Disabled Cars.—In the event of a car becoming disabled in a busy street it should be pulled or pushed out of the way by another car to prevent stoppage to the service.

When a disabled car is being pushed by another, the driver of the rear car should arrange to get signals from the driver of the first car and also from the conductor of his own car before starting.

The driver of the front car stands ready to signal in the usual way if a stop is found necessary, and the two cars are only allowed to run at a slow rate, especially on grades or at curves and points.

When towing or pushing another car the pole of the car not in use must be tied securely down, clear of all bridges.

Unusual Noises.—Any unusual noise in the car should be attended to at once, to prevent a breakdown occurring.

Bent Axles.—If an axle becomes bent it may cause the car to swing when running, and the car must be run slowly at points and curves where it is liable to be derailed.

Broken Wheel Flanges.—The flanges of the wheels after long running become thin, and are liable to crack and break off, and may catch on the brake blocks when these are applied by the driver.

Rain and Dirt in Controller.—The door of the controller must always be kept properly closed, to prevent

dust getting inside and causing bad contact at the fingers and drum.

If rain penetrates to the interior of the controller it may cause the current to leak from the " live " parts to the outer case, and may charge the case so that the motorman receives a shock on touching it. If the controller case is connected to the rails, as is usually done, the rush of current caused by the leak may blow the car automatic switch or safety fuse.

" Ground " on Controller.—When a leak occurs in a controller it generally shows its presence by a heavy flash, or by smoke issuing from the cover, and on opening the door the defect can probably be detected by the woodwork and insulation being blackened.

Snow.—Do not allow snow to accumulate on the top of the controller, as it may find a way into the case and cause trouble. It is a good plan to carry a cotton sweat rag to wipe up any moisture in the controller, or to clean up generally.

Ice on Trolley Wire.—If the trolley wire becomes coated with sleet or ice, it may be necessary to wedge the trolley wheel to prevent it turning, and to scrape the icy covering from the wire. This should only be done with the knowledge of the line superintendent, and the car must never be set back when the wheel is wedged, otherwise the pole will be certain to buckle.

Badly Running Trolley.—If the trolley wheel leaves the wire frequently, even on straight lines, it may be due to the tension springs requiring adjustment, or the trolley head may be loose and canted to the side.

Running " Bang Road."—If at any time it becomes necessary to run on the wrong side of the road, the greatest care must be exercised to prevent collisions with other vehicles.

Getting New Car.—When a car becomes defective, and it is necessary to run it into the depôt for examination, the motorman should if possible telephone before he arrives, so that another car may be ready for him on his arrival.

Caution passing Poles.—On some lines the cars run very close to the poles which carry the trolley wire, and motormen must be cautious not to lean out from the car platform, or they may strike the pole and get knocked off the car.

How to Operate Electric Brakes.—The motorman should make himself expert in the use of the electric brake if his car is fitted with it. In this case the controller will have several " brake " notches in addition to the usual " power " points, and the brake is brought into operation by moving the controller handle to these points when the car is running. On these notches the car motors are connected so that they act as *generators*, and the amount of current taken from them is regulated by the rheostat, which is all in on the first brake notch, and is gradually cut out of action as the controller handle is moved round to the last brake position.

As the motors are driven by the car wheels, it will be understood that a strong braking effect will be produced if a heavy current is demanded from them. The amount of current which the motors will generate depends on the speed at which the car is running and on the amount of rheostat in action.

Coasting on Electric Brakes.—It becomes necessary, therefore, for the motorman to learn the value of the different brake notches, and this knowledge can best be acquired by allowing the car to coast down a grade while controlled by the electric " brake " only.

It will be found that with the controller handle on the first brake notch the car will run at a fairly high speed down the hill, and that this speed will be practically constant during the descent. If now the handle is brought round to the succeeding brake notches the speed is further reduced, until finally, on the last notch, the car comes to a standstill or runs very slowly indeed down the grade.

Electric Brake won't hold Car at rest.—If the car stops altogether the current from the motors stops, and the car is free to move off again, only to be brought up by the motors at once starting to generate current and checking the motion of the wheels as before.

It will now be understood that the electric brake may bring a car to a standstill or allow it to coast down grades at various speeds, yet it is unable to hold the car stationary on inclines, and the hand brake must therefore be applied to prevent the car from slowly working down to the foot of the hill.

Application of Hand Brakes with Electric Brakes.—It is important to note that when the electric brake is

used no other brake acting on the car wheels or axles is to be brought into action, or the wheels may be skidded and the generation of current by the motors stopped.

When applying the electric brake care should be taken not to bring the controller handle past the brake notch which agrees with the speed at which the car may be running, and afterwards to move slowly to the next notches, pausing on each until the full effect has been experienced.

Rapid Stops.—For very rapid stops with this brake the controller handle should be brought round rapidly to a suitable notch to give maximum effect without skidding the wheels, and sand should be dropped freely on the track; the controller handle is fed round to the last brake point as the car slows down.

Operating on Brake Notches.—When coasting down a grade with the electric brake in action the motorman may ease back a notch or two if he finds it necessary, but he should always wait on each notch until after its full effect has been obtained, and must never move back from a notch just as the braking effect is increasing strongly.

Never switch from the first brake notch to the " off " position until the speed of the car is down to six or eight miles per hour, or until the brake has exerted its full effect on that notch, otherwise destructive flashing may occur in the motors and controllers and damage them considerably.

Magnetic Brakes.—Cars fitted with electro-magnetic brakes are operated in the same way as those fitted with the rheostatic form, and have the advantage of requiring less current from the motors to produce the same braking effect, as a portion of the power is utilised in the brake magnets instead of being wholly absorbed in heating the car rheostat.

Several types of magnetic brakes are in use, but the operation of all of these is exactly the same as for the rheostatic type.

Service Stops with Magnetic Brakes.—To effect an easy stop with the magnetic brake, care should be taken to keep the strain on the magnets once they have been brought into operation, and not to let the magnetism die away before moving to the next notch, as this may cause an unnecessary jolt to the car.

When applying the brake with the car running slowly, it is sometimes rather difficult to prevent a jolt when the brake magnets come into operation, and it will be found better to get the brake into action slightly at the higher speeds, and have the motors and magnets excited ready for any increased effort that may be necessary.

When the controller is provided with a large number of brake notches it becomes much easier to apply the electric brake smoothly at all speeds.

Magnetic Brake holds Car for a time.—It will generally be found that the magnetic brake will hold the car on an incline for a short time after bringing it to rest; but, of course, for long stops, or where the incline is rather steep, it will be necessary to apply the hand brake to hold the car.

With some forms of magnetic track brakes it may be found that, after bringing a car to rest on a heavy grade, a difficulty is experienced in applying the hand brake.

This may be due to the track magnets thrusting the car axles slightly apart, and thus putting the handle of the wheel brake off the usual adjustment.

The trouble may be avoided by applying the hand brake just before the car comes to rest, and easing off the magnetic brake at the same time.

Several types of electric brakes are described in Chapter V.

Methods of stopping Car.—It may be judicious at this point to examine the different methods by which a car may be stopped when fitted with a series-parallel controller with " brake " notches.

The rules given are applicable for a car running backwards or forwards, and the motorman is advised to memorise and practise them, so that if at any time one of the methods fail he can immediately apply the next and stop the car at once.

Particular attention is called to the rules relating to the position in which the reverse lever of the controller must be placed when applying the different methods enumerated.

Hand Brake.—The first method is by the ordinary hand brake with which all electric cars are fitted, and which can be applied to stop the car running in any direction, the only precaution necessary being not to skid the wheels.

Electric Brake.—The second method is to apply the electric brake by placing the reverse lever in the **same direction** as the car is moving in, and then moving the large handle to the brake notches.

Reversing.—The third method is to reverse the motors by placing the reverse lever in the **opposite** direction to that in which the car is running, and then to bring the large handle to the first or second power notch.

Last Resort.—The fourth method is to switch off the automatic or canopy switch, and bring the large handle round to full parallel, after placing the reverse lever in the **opposite direction** to that in which the car is travelling.

Extra Brakes.—If the car is fitted with mechanical slipper brakes these can be brought into action if necessary.

Braking at Rear Platform.—A motorman should remember that if all the brakes fail to act at one platform, yet it may be possible to stop the car from the other controller, or the conductor may be signalled to apply the rear hand brake, while the motorman sees it is quite free at his end.

"Emergency Stop" Controllers.—When the controller on the car is not arranged with several brake notches, but has simply an " emergency stop " position, this should be applied if the hand brakes fail, or when a rapid stop is necessary, to avoid an accident.

Runaways on Hills.—A number of accidents, due to cars getting beyond control when descending steep inclines, have been caused by the motorman applying the hand brakes so hard as to skid the wheels, and then not having the sense or courage to slack off this brake when applying the electric methods mentioned above.

Power failing when ascending Grade.—When ascending a hill, and the power failing, either through the automatic switch or fuse blowing, or through the current being cut off at the power station, switch off the controller and apply the hand brake to prevent the car running backwards.

Car running back on grade.—In the event of the ordinary brakes failing to hold the car, the electric brake must be applied to the last brake notch with the reverse lever pointing **backwards,** or the reverse lever should be pulled over into the " emergency stop " position, if this type of controller is fitted on the car. Of course, if air brakes or mechanical slipper brakes are fitted, these can be used to prevent the car running back down the hill.

If it is found impossible to reduce the speed of the car with any of the above-mentioned brakes, which is very improbable, the " last resort " method may be used to effect a stop, as previously described.

When stopping on a hill, and the hand brakes failing to prevent the car from running back, apply a notch of power to take the car forward, or to hold it while the rear hand brake is being applied by the conductor.

Special Controllers.—Some controllers are so arranged that they apply the electric brake automatically when the car starts running backwards; but the motorman will receive special instructions from his superintendent if his car is fitted with this unusual form of controller.

Operating Air Brakes.—When the car is equipped with compressed air brakes it is necessary for the motorman to see that the operating valve on the platform is set to the " running " position, and that the proper pressure is reached in the air reservoir soon after leaving the depôt.

When the air-pump is driven direct by the axle of the car it will have to run a little before the reservoir becomes properly charged.

If the pump is driven by a separate small electromotor it must be started before leaving the depôt, so as to fill up the storage tank to the proper working pressure, as indicated by the pressure gauge on the car platform.

In working with air brakes the motorman should endeavour to use as little air as possible.

When making a service stop, the operating valve should be turned round to admit air to the brake cylinder slowly, and when the brakes are acting sufficiently the valve should be moved back to stop the supply of air.

Do not apply the brake too strongly, as it will then be necessary to allow some of the air to escape, and another application may be found necessary to stop the car at the station.

To stop very quickly the air should be turned full on, while sand is dropped freely on the track rails. When

the rails are slippery care must be taken not to skid the wheels, and if this occurs the operating valve must be moved quickly to the release position for a moment or two to allow the wheels to revolve.

When stopping at a station the brake should be released slightly as the car comes to rest, to avoid jolting the car.

When the car has been stopped the valve should be brought to the release position to be ready to start again, and care is necessary to have the brake off when applying power to start the car from rest.

If stopping on a hill, it will be necessary to keep the brake on to prevent the car running backwards, or the hand brake may be applied to hold the car stationary while the air is allowed to escape from the brake cylinders.

Some types of air brakes are described in Chapter V., to which the reader is referred.

Running to Depôt.—After the day's work is finished and when the car is running to the depôt, the motorman must still take care to run cautiously and take no risks. Although there may be no passengers aboard, the car should be run at the usual speed, and the usual caution exercised at all points and crossings.

Run slowly into the depôt, and leave the car safe for the night with the switches off and the hand brake on.

The pole should be turned and taken off (unless the lights are required by the cleaners), and must not be allowed to rub against the trolley wire.

Before going home, report to the depôt foreman any defect which may have occurred during the day, so that it may be examined and repaired.

CHAPTER VII.

FAULTS AND BREAKDOWNS.

Common Faults.—In the following pages are mentioned some of the common troubles and faults which may occur on an electric car, and the probable causes of these are stated, to enable motormen to quickly locate and rectify the defects or secure assistance without unnecessary delay.

Some of the faults mentioned can only be remedied in the depôt, but others are easily put right on the road, and the car may continue in service.

Handy Tools.—A motorman should always carry a screw-driver and a pair of cutting pliers.

A smooth file and a small piece of emery-cloth will also be found handy at times.

No Delay.—No time should be wasted when anything unusual occurs, but a start should be made to locate the defect as soon as possible, to prevent delay to other cars.

Always report any breakdown, however small, to the proper quarter, in order that the car may be examined by the depôt men at night.

Electrical Defects.—In dealing with defects on the electrical equipment it should be remembered that the car lights will serve to indicate if the power is on or off the line, and that by trying each controller separately the motorman can ascertain whether the current is getting down that length or if the fault lies in the controller or motors.

An Example.—Suppose, for example, that the car refuses to start when the controller handle is moved round as usual.

Ascertain if the pole is on the wire and if the lights will burn when switched on.

See that the main switches are "on," and also if the fuse is in proper order.

Try the car with the **rear** controller, and if it starts all right there, you may be sure that the current is getting down to the motors and that they are in working order.

The defect may be in the front controller, which should now be examined for bad contacts at the fingers and cables.

Open Circuit.—If the car refuses to start at both controllers with the car lights burning brightly, it indicates that the current is not getting down through the main switches and fuse block.

Car "Grounded."—Sometimes the car won't start owing to it having run into a dirty rail, but in such a case the lights will not burn properly, and the trouble will generally be evident on looking at the wheels and track.

Dirty Contacts.—When the contacts of a switch or a controller become burnt or dirty, they should be cleaned with fine sand-paper or carefully scraped with a knife-blade or smooth file.

It takes very little dirt to cause trouble sometimes, and when examining a controller for bad contact the motorman should start at the first finger and work carefully over the remainder, so that one examination will suffice and the car will not be delayed unduly.

Of course, it may be that the defect can be seen at once after opening the controller-door.

A little vaseline or graphite should be rubbed on a contact which has been cleaned, to prevent the surfaces cutting when in action.

Necessary Precautions.—When working with any part of the power equipment always take care to have the main switches off, to guard against receiving shocks or getting burnt.

Fuse, or Switch "Blows."—When the automatic switch "blows" or the fuse melts it indicates that too much current is being taken from the line, and this may be caused by the motorman starting the car too quickly, or by a "ground" having developed at some point of the circuit, possibly in the motors or in the controllers.

Detecting Leak.—To ascertain where the leak exists it is necessary to cut out first one motor and then the other, unless the defect is plainly evident elsewhere.

Cutting out Motors.—When cutting out a defective

motor from circuit by means of the "cut-outs" in the controller, it is advisable to do so at both ends to prevent trouble when driving the car from the other platform.

Only one motor should be cut out at a time, as when both "cut-outs" are moved over the connections made are such that the trolley current gets direct to the rails, and the switch or fuse would "blow" when the controller handle was brought to the power notches.

Running with one Motor.—When running with one motor care should be taken to start slowly and run easy in order not to strain the motor unduly.

Leak in a Motor.—If a leak develops on No. 1 motor the switch or fuse will probably blow before the third or fourth notch is reached, but if the defect is in No. 2 motor they may not blow until the full-series notch is passed.

Generally a ground in a motor is caused by the covering of the armature coils becoming damaged, or it may be due to carbon dust and oil gathering at the end of the commutator or on the brush rocker, and allowing the current to get to the motor-shaft and rails.

Again, the leak may occur on the field-magnet coils, and cause an abnormal rush of current to "earth."

Short Circuits.—When a "short circuit" occurs between the segments of a commutator or between two armature coils the motor will spark violently, and the defective coil will overheat and become charred.

Open Circuit.—If a broken connection occurs in an armature it will show its presence by causing heavy flashes at each revolution.

Weak Fields.—When a "short circuit" exists between the layers of a field-magnet coil, the car may start slowly and take more current than usual, and afterwards run at abnormal speed or blow the automatic switch.

A "short" on a field coil will generally cause a constant flare at the commutator, and the same effect will be produced if the strength of the magnetic field is reduced by one coil being wrongly connected with the other ones, or by a "ground" to the outer case.

Grounds in Controller.—When a ground occurs in a controller it may charge the handles and outer case; but if the outer case is in metallic contact with the rails

the rush of current will blow the fuse or the automatic switch.

If the defective controller is first disconnected from circuit by removing its cables, the car can be driven from the other platform.

If the ground is on the " T " cable or finger it will only be necessary to remove this one cable, and if the defect is on the main contact drum it will not be necessary to remove any of the cables if the controller is left at " off " position and all fingers are clear.

Defects.

When the Car won't start on first power notch:

May be due to bad contact at controller fingers or cables.

May be broken circuit in rheostat if trouble is apparent at both controllers.

When the Car won't start until "full series" notch is reached:

May be defective rheostat or broken circuit on cables leading to rheostat.

When the Car won't start until "full series" is passed:

May be due to an open circuit in one of the motors or on cable leading to a motor. See that the brushes are pressing down on commutator.

If the fault lies in a motor the trouble will show at both controllers. If the car starts when the controller handle is midway between the series and parallel notches the open circuit will be in No. 2 motor; but if it does not start until the first parallel notch is reached the defect will be in No. 1 motor or its cables.

The trouble may be due to bad contact at controller fingers.

When the Car won't start on any notch:

May be caused by fuse melting, or switches may be off.

Power may be off line.

Try rear controller, and if trouble only shows itself at front controller it may be due to open circuit at " T " finger or cable.

Car may be standing on dirty rail.

When the Car won't speed up properly:

May be due to bad contact at controller fingers or cables.

If both controllers act in the same way it may be due to a defective rheostat or motor.

When the Car won't start and the car lamps refuse to light:

Power may be off line.

Cable from trolley head may be broken.

Car may be on dirty rail.

When the Car starts with unusual jerks, but runs all right on "full series" and "full parallel":

May be due to short circuit in rheostat or rheostat cables.

Rheostat cables may be crossed and inserted in wrong terminals.

When the Car runs all right on series notches, but with only one motor, when on parallel notches:

May be due to fingers in controller not making contact to allow current from No. 1 motor to get to rails on parallel notches.

When the Car labours in starting, and runs faster than usual afterwards:

May be due to short circuit in field magnet coils.

When the Controller Handle cannot be moved from "off" position:

The " interlocking gear " may be sticking, and should be pulled clear of main drum.

When the Controller Handle cannot be moved past "full series" notch:

A motor " cut-out " may be out of place, or the " cut-out catch " may be fouling the main drum.

One of the fingers may be bent inwards.

When the Controller cannot be switched off:

Power must be turned off by main switch and car stopped at once.

A finger or loose screw may be catching on main drum, or the " arc shield " may be rubbing hard on it.

When a shock is got on touching Controller Case:

May be due to moisture getting into controller and allowing current to leak from fingers or cables.

Use rubber gloves or touch only wooden handle.

Car should be run to depôt as soon as convenient, especially if it is rear controller which is defective.

When Controller Fingers are defective:

Clean off burnt matter with file or emery-cloth.

A broken finger may be replaced by taking one from the rear controller.

When heavy flashes occur in a Controller:

Contacts require cleaning, or water has gained entrance.

Handle may be operated too slowly or not brought fully to notches.

When Controller Handle turns round easily without the usual decided "click" at the lines:

"Star wheel" roller and lever may be broken, or spring may have given way. Handle should be moved carefully to lines when running car to depôt.

When Controller Handle is jammed on power or brake notches and car is being towed to the depôt:

Fingers on small reverse drums should be insulated by inserting a layer of paper under each, or brushes may be removed from motors in order to prevent any "electric brake" action when car is being towed home.

When the Automatic Switch or Fuse "blows" with Controller Handles at off position:

May be due to leak between fuse and "T" finger of controller.

Car should be towed to depôt, if it cannot be driven by rear controller after taking out "T" cable from front controller.

When the Automatic Switch blows immediately Controller Handle is moved to first power notch:

Probably due to a leak in controller on main drum or some finger.

When the Switch or Fuse blows when feeding up on series notches:

Probably due to ground in No. 1 motor or its cables. Motorman may be "feeding" too quickly.

When Switch or Fuse blows after passing full series:

Probably due to ground in No. 2 motor or its cables.

When a "ground" occurs at the Trolley Head or on the Trolley Cable:

If the trolley standard is connected direct to the rails by a "ground cable," the resulting rush of current may open the circuit-breaker in the power station and make the line dead. Pole should be removed from overhead wire at once, to allow power to be restored and car towed to depôt.

If signal lamps or other indicators are connected to the trolley standard, the leakage current will show its presence by operating these to warn motorman. Pole should be pulled down until passengers have been removed from top deck, after which it may be replaced and car run in.

When a Motor sparks badly at the brushes:

Brush may have jammed in holder, or may not be pressing hard enough on commutator.

Commutator may be oily or require cleaning.

Commutator may require re-turning to take out "flats" and rough spots.

Sparking may be due to short circuit in magnet coil or armature.

When a knocking or grinding noise is heard in a Motor:

Bearings may be worn and armature may be striking pole-pieces.

Armature binding wires may be slackened.

When the Bearings of a Motor become heated:

Oil should be freely applied and bearing allowed to cool off a little.

Run very slowly to terminus or depôt for examination.

When a Motor Gear-case falls down on roadway:

Gear-case may be held up from inside of car to allow car to be taken off main track.

Car may run in opposite direction without case actually jamming.

When the Gear Wheels run very noisily:

May require greasing, or may have slackened on axle. Should be examined as soon as possible.

When a Car Axle breaks or becomes bent:

Car may be run to depôt with other motor, or may require another car to assist.

Broken axle may have to be held up from inside of car to prevent motor from sticking on road surface.

When the Car Wheels make a loud hammering noise at each revolution:

Due to "flats" on wheels. Flats are caused by allowing the wheels to "skid," and can often be prevented by a little care on the part of the motorman.

When Electric Brake fails to act properly on some notches:

May be due to bad contact at controller.

Fingers must be kept very clean and in good contact to obtain good brake action.

Commutators and brushes should be clean.

When Electric Brake acts very harshly on first brake notch:

May be due to "equaliser" fingers not making good contact.

The "equaliser" fingers are those which connect the positive ends of the magnet coils of the two motors together on the brake notches, and are generally at the bottom of the controller.

When the Trolley Pole leaves the overhead wire frequently:

Tension springs may require tightening, or adjusting screw may be wrongly set and prevent pole from reaching wire properly.

Trolley head may be canted to one side and require adjustment.

When the Trolley Wheel chatters or squeals whilst running:

May require oil.

May have worn down too far, and requires renewing, otherwise it may damage overhead wire.

When one circuit of Lamps goes out:

May be due to burnt-out or defective lamp, which should be replaced.

A burnt-out lamp can be detected by its blackened appearance or broken filament.

Lamp fuse may have melted and requires renewal.

Bad contact may exist in the lighting switches, or an "open circuit" may have occurred in the lighting circuit wires or in a lamp holder.

When all the Car Lamps refuse to light:

Power may be off.

Lighting switches may be making bad contact.

Lighting fuses may have melted.

Car may be on dirty or "dead" rail.

When a Lamp Fuse blows:

Current may be getting to rails by some "ground" on the lighting wires, possibly at some of the outside lights which are exposed to the weather.

When Signal Bells refuse to ring:

May be defective bell or battery.

May be defective contact in "push."

When Signal Bells ring continuously:

May be due to short circuit on bell wires, or the contacts in one of the pushes may be sticking together.

If the former, disconnect bell from circuit by removing wires, and if the latter, screw off push cover and draw contact spring clear, or insert paper between. See that none of the pushes are jammed in.

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