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About this Standard

This manual describes the operation, maintenance and installation of 2 and 3 lever mechanical ground frames, the channel rodding drive from the ground frame to the points and of the non-trailable mechanical points equipment.

Typical locking for 2 and 3 lever frames is included.

It is expected that the maintainers using this manual will have received training in at least basic mechanical signalling.

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1. Introduction

1.1 Scope

This manual has been prepared for maintainers and installers of mechanical signalling equipment and describes the operation, maintenance and installation of 2 and 3-lever ground frames, the channel rodding drives from the ground frame to the points and of the non-trailable mechanical points equipment.

Typical locking for 2 and 3-lever ground frames and the methods for calculating the position of compensators in channel rodding are included.

Trailable mechanical points are covered in equipment manual SC 073402 00 EQ.

It has been assumed that the users of this manual will have at least completed training in basic mechanical signalling.

1.2 Referenced publications

SC 07 34 02 00 EQ	Mechanical Trailable points
SMS 15	Signalling Technical Maintenance Plan
SMS 16	Signalling TMP Service Schedules

1.3 Definitions

‘In one way’ locking

Means that with the points normal and the facing point lock lever normal, the facing point lock is engaged but that with the points reverse, the facing point lock cannot be engaged.

‘In both ways’ locking

Means that with the points normal or reverse and the facing point lock lever normal, the facing point lock is engaged.

‘Out one way’ locking

Means that with the points normal and the facing point lock lever normal, the facing point lock is disengaged. The facing point lock lever must be pulled reverse to engage the facing point lock. The facing point lock cannot be engaged with the points reverse.

‘Out both ways’ locking

Means that with the facing point lock lever normal the facing point lock is disengaged. The facing point lock lever must be pulled reverse to engage the facing point lock with the points either normal or reverse.

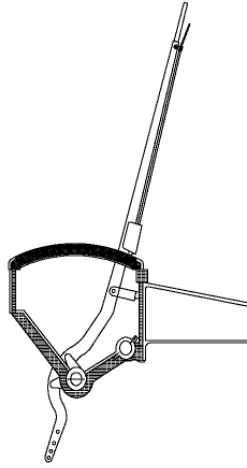


Figure 2.1.1 - Type E ground frame



**Figure 2.1.2
2 Lever Type G ground frame**



**Figure 2.1.3
Type F single lever**

2. Equipment description

2.1 Physical description

2.1.1 Mechanical ground frames

There are three types of mechanical ground frames in common usage, these being;

Type E manufactured by McKenzie and Holland in 2, 3, 4, 5, 6, 7 and 8 lever variants. In this machine the tails of the levers project below the frame as shown in figure 2.1.1. While still in common usage, this machine and major parts for it, have not been manufactured for over 25 years and it should not be used for any new work.

Type G was manufactured originally by NSW railway workshops in 2, 3, 4, 6 and 8 lever variants. In this machine the tails of the levers are contained within the frame as shown in figure 2.1.2. In later years, this machine has been manufactured by a number of suppliers with a steel frame in place of the original cast iron frame.

Type F single lever in which connection to the channel rodding is above the lever fulcrum is shown in figure 2.1.3. This single lever provides the operator with far less mechanical advantage than type E and G machines and is not suitable for driving more than a single end of points. Its use in any main line points, even if trailing, is to be avoided.

There may also be a small number or recently built Westinghouse 2 and 3 lever ground frames in use on the Illawarra line between Waterfall and Wollongong. These machines are similar to (but not the same as) Type G ground frames. If removed from service, these machines should not be re-used.

2.1.2 Channel Rodding Drive

The standard method in NSW for driving points from an interlocking machine is by way of rodding made from a rolled steel channel section, the dimensions of which are shown in figure 2.1.4.

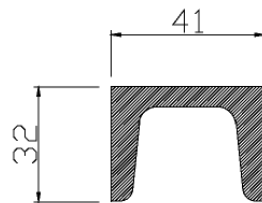


Figure 2.1.4 - Channel rodding



Figure 2.1.5
Channel Rodding A frames and Stands

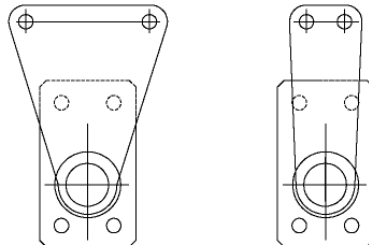


Figure 2.1.6 - Deflecting Crank



Figure 2.1.7 – Elevating crank



Figure 2.1.8 - Adjusting Crank

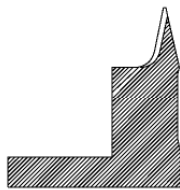


Figure 2.1.9
Assymetric Switch
Tangential Turnout



Figure 2.1.10
Conventional 60kg switch

This channel section has not been manufactured for several years and any new installation or repair to existing installations is reliant on stocks of channel in stores and at maintenance depots.

The channel is carried on, and guided, by cast iron rollers in “A” frames which are fixed to concrete block foundations with suitable brackets as shown in figure 2.1.5.

Change in direction is accomplished with either 90° angle cranks, or, for small angular changes, with deflecting cranks, examples of which are shown in 2.1.6. Changes in height can be accomplished with elevating cranks as shown in figure 2.1.7. The amount of movement in the rodding, normally about 125mm where it leaves the ground frame lever, can be increased or reduced using adjusting cranks illustrated in figure 2.1.8.

Since the channel is made from steel, it will expand and contract according to its temperature. This change in length is taken into account by using compensating crank assemblies (compensators) which are described in more detail in section 2.2 – Principles of operation.

While there are still a small number of *round* rodding installations on some class 5 branch lines, there are few, if any, details of components for this type of drive and no description has been included here.

2.1.3 Mechanical points

This manual does not include a description of the permanent way aspects of the turnout except those necessary to identify the type of turnout.

For the purposes of this manual there are two basic types of turnout:

Tangential, where the switch is machined from a reduced height, thick web section as shown in figure 2.1.9 and

Conventional, where the switch is machined from the same steel section as the stockrail, shown in figure 2.1.10.

Tangential turnout types are defined by turnout radius and crossing angle with the radius being the more important descriptor for the application of signalling equipment. At present all tangential turnouts are made from 60kg rail.



Figure 2.1.11 -Typical Facing Point



Figure 2.1.12 - Typical Catch Point

Conventional turnout types are defined by switch length and crossing angle with the switch length being the more important descriptor for the application of signalling equipment. Conventional turnouts may be made from (60lb, 71½lb, 80lb)[#], 47 kg (94lb), 50kg (107lb) and 60kg rail.

A typical mechanical facing point layout is shown in figure 2.1.11 and consists of front and back rods connecting the switches together, a lock rod, facing point lock, extension pieces and detector rods and a detector.

Drive is connected to the front rod through a cradle and bobbin assembly.

Connection from the channel rodding to the points drive is through an adjusting crank and to the facing point lock plunger through an adjusting crank and angle crank.

A trailing point installation is similar except that there is no facing point lock or connections.

A typical catchpoint installation is shown in figure 2.1.12. This catchpoint is shown in 'trailing' configuration, without facing point lock. If a facing point lock is required on a catchpoint, then it is treated similarly to a full set of points except that no backrod is fitted and guides are provided to support the free ends of the front rod and lock rod.

[#] There is no metric equivalent of these rail sections. All are old standard, no longer manufactured, and there is considerable variety of cross section within each.

2.2 Principles of Operation

2.2.1 Compensation

Compensation is provided in the channel rodding to minimise the effect of expansion and contraction of the length of the channel rodding between the interlocking machine lever and the points caused by variations in temperature.

If, for example, a 100 metre long channel rodding run is installed when the temperature is 20°C, then at a temperature of 10°C the rodding will be 11.3mm shorter and at 40°C, the rodding will be 22.6mm longer.

Since at any one location the temperature of the steel channel itself can easily range between 0°C and 60°C, it is obvious that without the provision of compensation it would be impossible to hold a set of points in the closed position using a channel rodding drive.

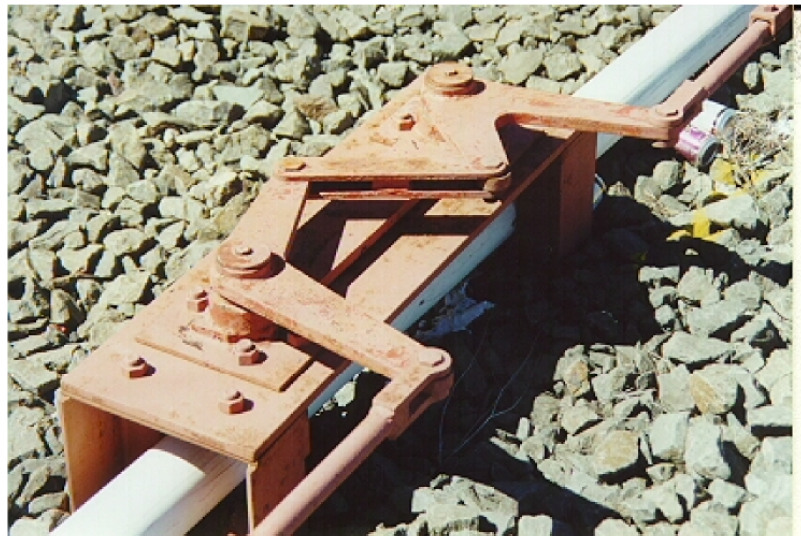


Figure 2.2.1 – Standard compensator

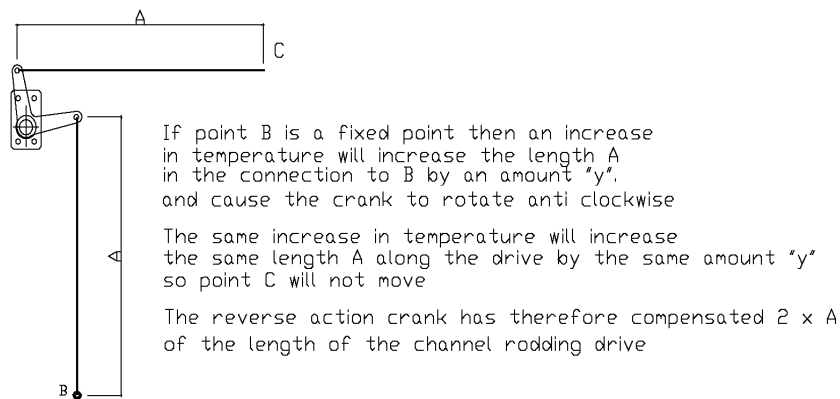


Figure 2.2.2 – Reverse action crank

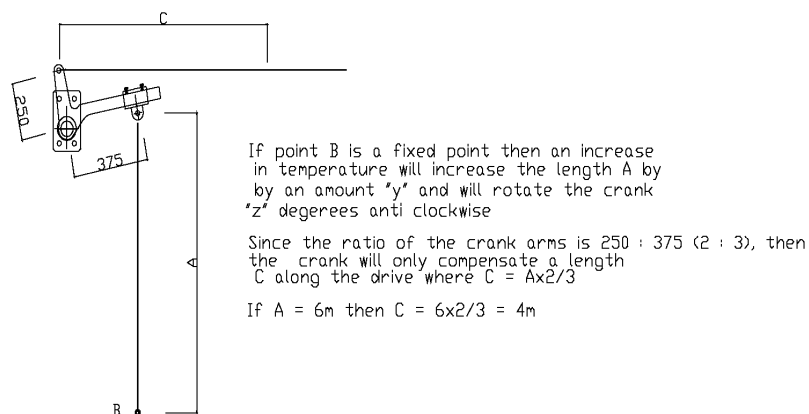


Figure 2.2.3 – Unequal arm cranks

2.2.1.1 Types of Compensator

The most common form of compensation is the compensating crank assembly (commonly called 'compensator') shown in figure 2.2.1. There were two versions of this assembly, the "old pattern" capable of compensating up to 180 metres of channel rodding and the standard, illustrated, capable of compensating up to 400 metres.

However any crank which reverses the direction of movement of the channel rodding will automatically provide compensation for at least part of the channel rodding as shown in figure 2.2.2.

2.2.1.2 Unequal Arm Cranks

If any unequal arm crank is used, whether even or reverse action, then because of the multiplying or dividing effect of the crank, temperature variation will not cause the same amount of movement in each leg of the run. This difference, as shown in figure 2.2.3, will need to be taken into account when calculating the position of the compensator.

2.2.1.3 Shaded Sections of Channel rodding

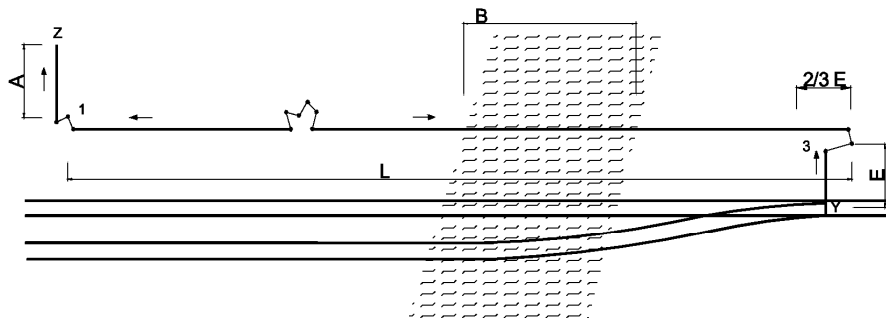
Where part of a channel rodding run is in permanent shade, such as under a long bridge, or in a cutting where it is not exposed to direct sunlight, allowance must be made for the difference in temperature rise in the exposed and shaded parts of the run.

If the shaded part of the run is less than 10 metres in length, it may be ignored when positioning the compensator, since the imbalance will be minimal and can be taken up in the "spring" on the points.

If between 10 and 20% of the run is in permanent shade then the compensator can be repositioned as shown in figure 2.2.4, if the shaded section is more than 20%, it can be separately compensated as shown in figure 2.2.5.

Compensation for Ground Frames

Compensator locations for typical 2 and 3 lever ground frame operated points are shown in figure 2.2.6.



With no shading the location of the compensator for this layout would be $(A+L-2/3 E)/2$ from Z. However if a section is permanently shaded as shown, then the shaded portion will neither be as hot in daytime or as cold at night as the unshaded portion.

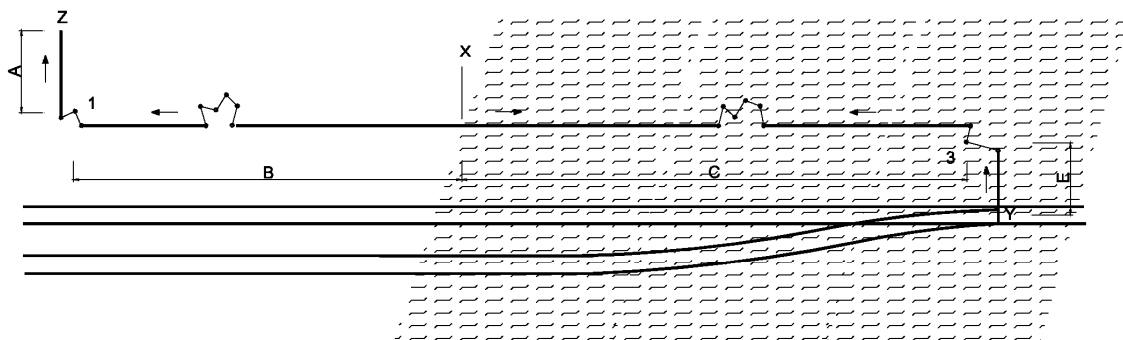
It is reasonable to assume that the shaded part will only expand and contract about half as much as the unshaded portion.

Its equivalent length is therefore only half of its actual length and the compensator should be placed at $(A+L-2/3 E-1/2 B)/2$ from Z.

For example, if $A=10\text{m}$, $L=120\text{m}$, $E=6\text{m}$ and $B=20\text{m}$, then the position of the compensator will be $(10+120-4-10)/2 = 62$ metres from Z. If there was no shading the position would be $(10+120-4)/2 = 67$ metres from Z.

Relocating the compensator in this manner is only effective where the shaded portion is less than 20% - 25% of the overall length of the run and is only necessary when the run is more than 100 metres long.

Figure 2.2.4 – Partial shade up to 20%

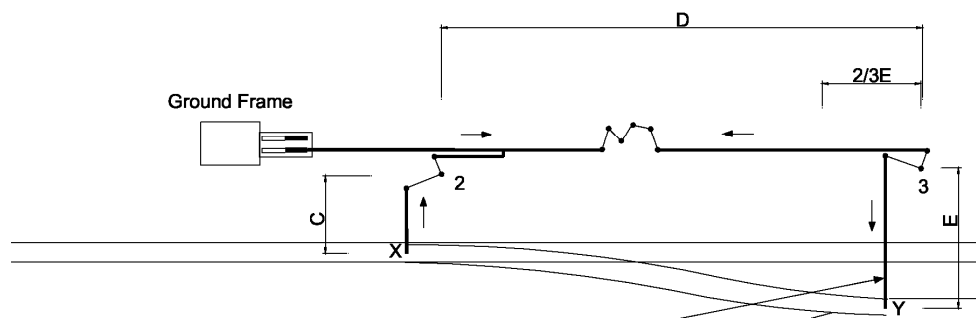


With a large part of the run in permanent shade, as shown, then the shaded and unshaded parts will expand and contract at completely different rates and it is advisable to divide the run into two parts with X being assumed to be a fixed point.

The run is then separately compensated between Z and X and between X and Y

If the run is 90% or more shaded, then the unshaded portion may be ignored and the run can be compensated as if it is all in shade.

Figure 2.2.5 – Partial shade greater than 20%



A deflecting or elevating crank may be required at this point. Compensation will be unaffected.

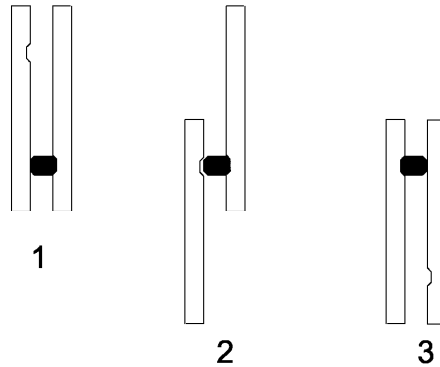
Where the distance between the ground frame and X is less than 8 metres, there is no need to compensate this length.

The location of the compensator from X will be $(C+D-2/3E)/2$.

FIGURE 2.1.6 – Ground frame compensation

2.2.2 Two and Three Lever Ground Frame Locking

Where a 2 lever ground frame is used to drive a set of facing points, No 1 lever is always used to drive the facing point lock and is also the lever which is released by the key from the releasing switch or signal box, or the key on the staff or the operators key.



1	Frame locked, points normal and locked – annett or operators key can be removed
2	Frame unlocked, No 1 lever reverse – points normal but unlocked
3	Frame unlocked, both levers reverse – points reverse but unlocked.

Figure 2.2.8
2 Lever Ground Frame locking

No 1 lever when in the normal position (facing point lock engaged) locks No 2 lever in the normal position (points closed normal). When No 1 lever is pulled reverse it releases No 2 lever which can then be pulled to move the points to the reverse position. When No 2 lever is in the reverse position, No 1 lever cannot be restored to normal.

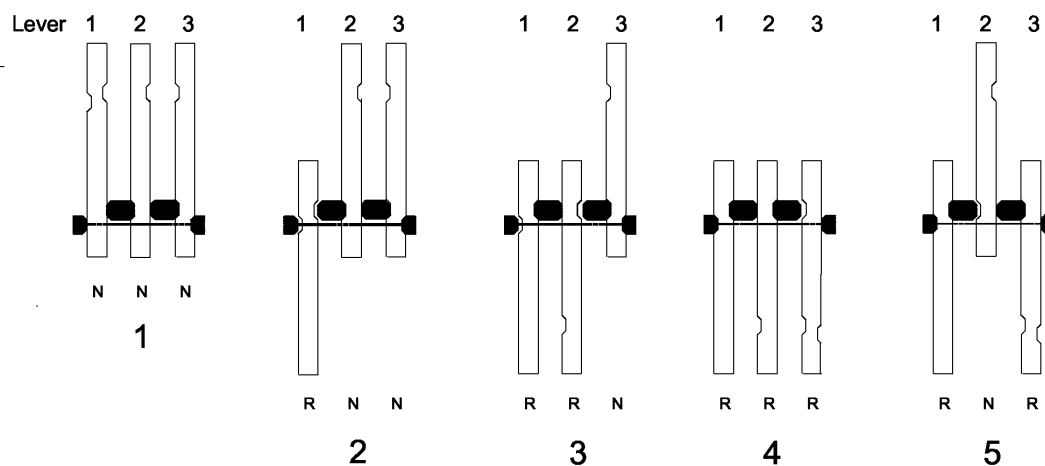
Facing points operated by a 2 lever machine can only be locked one way and are described as being “in one way”.

Locking within the locking box is shown in figure 2.2.8

With a 3 lever machine, No 1 lever is the lever released by the key from the releasing switch or signal box, or the key on the staff or the operators key but No 1 lever does not operate the facing point lock.

The facing point lock is operated by No 2 lever and the points by No 3 lever.

No 1 lever in the normal position locks No 2 and No 3 levers in the normal position.



1	All levers normal – frame can be locked and annett/operators key removed.
2	Frame unlocked, lever 1 reverse – points normal and locked.
3	Frame unlocked, levers 1 and 2 reverse – points normal but unlocked.
4	Frame unlocked, all levers reverse – points reverse but unlocked.
5	Frame unlocked, levers 1 and 3 reverse, lever 2 normal – points reverse and locked.

Figure 2.2.9

3 Lever Ground Frame Locking

When No 1 lever is pulled to the reverse position it releases No 2 and No 3 levers but No 3 lever remains locked by No 2. When No 2 lever is pulled reverse it releases No 3 lever and locks No 1 lever in the reverse position. No 3 lever may now be pulled to operate the points reverse and when pulled it also locks No 1 lever in the reverse position. No 2 lever is then restored to normal to engage the facing point lock with the points reverse. No 1 lever cannot be restored since it is still locked reverse by No 3 and the key cannot be removed from the annett or operators lock on the lever.

Points operated by a 3 lever machine are locked both ways and are described as being “in both ways”.

Locking within the locking box is as shown in figure 2.2.9

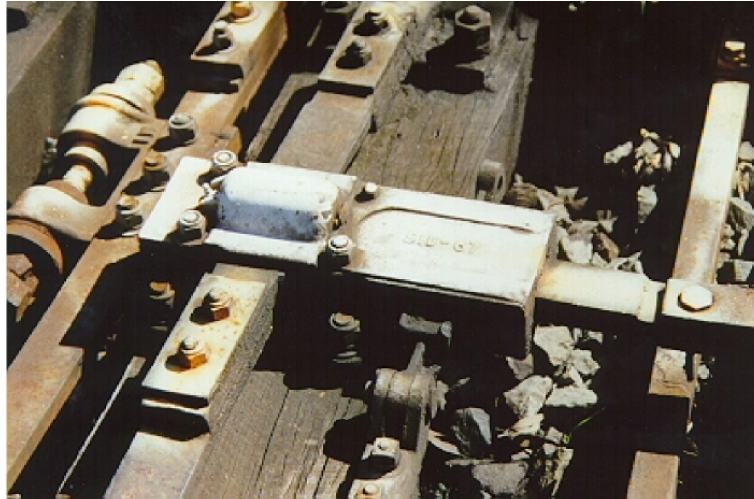


Figure 2.2.10
Type D Mechanical Facing Point Lock

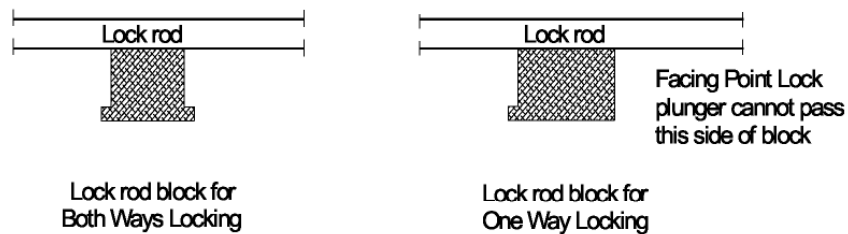


Figure 2.1.11
Lock rods for “both ways” and “one way” locking

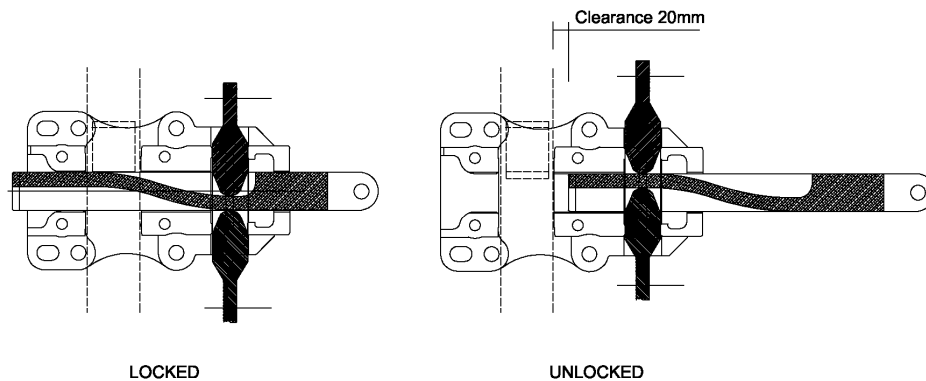


Figure 2.1.12
Facing Point Lock in Locked and Unlocked Positions

2.3 Facing point Lock

The standard type D mechanical facing point lock is shown in figure 2.2.10.

The facing lock operates by driving a locking plunger in beside a block fixed to the lock rod between the switches. Depending on the type of block on the rod, the lock is able to be engaged only with the points in the normal position, “one way locking”, or with the points normal or reverse, “both ways locking” as shown in figure 2.1.11.

The Type D facing point lock is provided with a cross or detection slide, operated by the lock plunger, which, when connected to an electrical or a mechanical detector, provides an indication that the facing point lock is engaged. Note that the cross slide does not necessarily indicate that the lock plunger is disengaged but only that it is either “engaged” or “not fully engaged”.

Figure 2.2.12 shows the facing point lock in the engaged and disengaged positions.

3. Operational and Functional Checks

3.1 Check Intervals

The tasks and tests listed herein are to be carried out at the intervals specified in the baseline Signalling Technical Maintenance Plan SMS 15 and Service Schedules SMS 16 or at the intervals specified in the approved tailored Technical Maintenance Plan for the region, district or line section in which the equipment is situated.

3.2 Ground Frames

3.2.1 Ground Frames – Interlocking Test

3.2.1.1 Ground Frames fitted with Electric Locks

Before requesting the release from the signaller check that no lever in the frame can be moved.

Request the release and confirm with the signaller that the release has been given. Check that the indicator is illuminated.

Press the button and pull No 1 lever part way reverse. Restore No 1 lever to normal and attempt to again pull reverse without pressing the release button. The lever should not move from normal.

3.2.1.2 Ground Frames fitted with Annett Locks or Operators Locks

Obtain the key which unlocks the ground frame observing the relevant safeworking rules.

Annett Lock

Test the wards on the annett lock key with the appropriate gauge and check that the inscription on the key is correct.

Check that the inscription on the key matches the frame identity (not applicable to key staffs).

Test the wards on the annett lock face with the appropriate gauge.

Check the operation of the annett lock.

Check that the annett key cannot be removed from the lock when No 1 lever is out of the normal notch.

Operators Lock or Fortress Lock

Check that the operators key or Fortress key cannot be removed from the lock when No 1 lever is out of the normal notch.

3.2.1.3 2 Lever Frames – Typical “In One Way” facing point or Trailing Point Application

Check that No 1 lever cannot be moved from the normal position.

Unlock the frame with the annett or operators key.

Without moving No 1 lever, check that No 2 lever cannot be moved from the normal position.

Pull No 1 then No 2 levers reverse. With No 2 lever reverse ensure that No 1 lever cannot be restored to normal.

Restore Nos 2 and 1 levers to normal and re-lock the frame.

3.2.1.4 3 Lever Frames – Typical “In Both Ways” Facing Point Application

Check that No 1 lever cannot be moved from the normal position.

Unlock the frame with the annett or operators key.

Without moving No 1 lever, check that Nos 2 and 3 levers cannot be moved from the normal position.

Pull No 1 lever reverse. Without moving No 2 lever, check that No 3 lever cannot be moved from the normal position.

Pull No 2 lever reverse. Check that No 1 lever cannot be moved from the reverse position.

Pull No 3 lever reverse. Check that No 1 lever cannot be moved from the reverse position.

Restore No 2 lever to the normal position. Check that Nos 1 and 3 levers cannot be moved from the reverse position.

Pull No 2 lever reverse, then restore Nos 3, 2, and 1 levers to normal in order to re-lock the frame.

3.2.1.5 2 and 3 Lever Frames – Other Applications

Where 2 or 3 lever frames are used for other applications, reference should be made to the locking table for the particular application to determine the sequence in which levers are to be operated to test the locking.

3.3 Channel Rodding Drive

Check that there is no foreign matter obstructing channel rodding, A frame rollers, cranks or compensators.

Check for lost motion between ground frame and points.

If two persons are present:

One person should operate the ground frame while the other looks for loose pins and/or crank bearings and any movement of A frames.

If only one person is present:

Unload the FPL and points drives in turn by pulling the levers out of the normal notch, then check for loose pins and crank bearings.

or

Mark the channel rodding against an A frame either side of the compensator and measure any difference in movement when the levers are pulled from the normal to the reverse position.

Not that there will always be *some* lost motion through a compensator or crank but this should not exceed 3 to 4mm for a compensator and 1 to 2mm for a crank.

A single person can check for A frame movement by observing any lift or sideways movement of the channel rodding as the lever is being pulled.

Check that cranks and compensators are operating on centre or close to on centre.

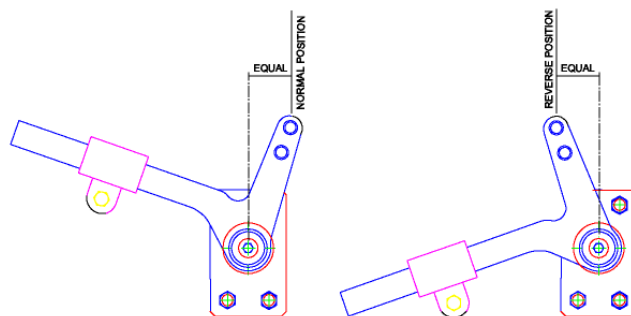


Figure 3.3.1 – On centre crank operation

If there is excessive lost motion the cause must be corrected. Do not simply extend the adjusting crank beyond 80% of its capacity to compensate for lost motion except as a temporary expedient.

Lost motion can be caused by:

- Loose or worn pins and bushes in cranks and jaws
- Loose or worn crank bearings
- Movement in channel rodding A frames and blocks
- Missing or defective rollers in A frames permitting the channel rodding to bend or spring.

If a crank is significantly off centre, i.e. more than about 20 mm difference between the centre to normal and centre to reverse dimensions, it will cause too much sideways movement of the rodding and lead to binding, extra effort on the lever and loss of spring on points.

Where any crank or compensator is significantly off centre the channel rodding will need to be re-cut to bring the crank or compensator back on centre.

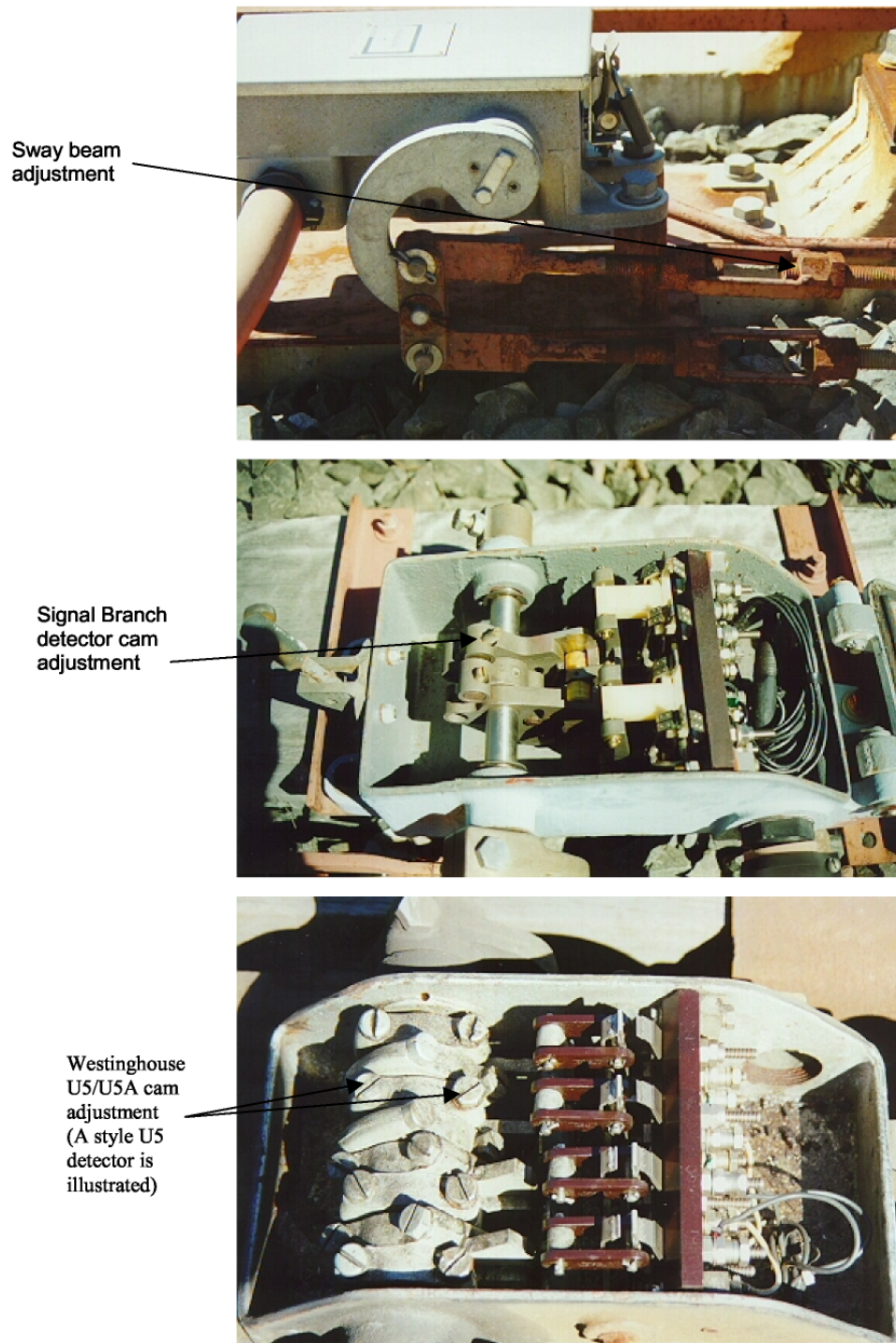


Figure 3.4.1 – Detection adjustments

3.4 Points

3.4.1 Trailing Points

Test the “spring” on the points.

For the end of points closest to the machine, spring may be checked by steadily pulling the lever to the normal or reverse positions until the switch lays up against the stockrail without any pressure. At this point the lever should be approximately the thickness of the catchrod block out of the normal or reverse notch.

For the end of a crossover or the catchpoint furthest from the machine, it is better to check the points themselves by levering the switch away from the stockrail with a 600mm pinch bar or similar. This should not require undue effort and the switch should return firmly to the stockrail when pressure is released.

If the switch cannot be moved off the stockrail or requires excessive force to move, the spring is too great.

Adjust spring at the bobbins on the front rod if required.

Test the electrical detector settings by placing a 4.8mm gauge between the switch and stockrail 75 to 100mm from the tip of the switch. Detectors contacts should be open.

Repeat with a 3.2mm gauge. Detector contacts should be at the point of making or be just made.

Repeat with a 1.6mm gauge. Detector contacts should be made.

Adjust the detector rods on slide type detectors such as the ML and Westinghouse HM2/3 or the sway beam or cams on Signal Branch and Westinghouse U5/5A detectors if necessary (figure 3.4.1).

Repeat all tests for the reverse position.

3.4.2 Facing Points

Carry out the same tests as for trailing points. Note that the facing point lock must be disengaged to carryout spring tests.

In addition test the facing point lock by placing a 3.2mm gauge between the switch and stockrail immediately behind the lock rod. It should not be possible to engage the lock.

Repeat with a 1.6mm gauge. It should now be possible to engage the lock, although it may rub against the side of the lock rod block.

Adjust the lock rod if necessary. Repeat all tests for the reverse position.

Test the facing point lock detection. Detector contacts should not make until the plunger has completed 2/3 of its stroke (130 to 140mm of the 200mm stroke) to the engaged position.

Adjust the turnbuckle at the detector crank if required.

4. On System Maintenance

4.1 Tasks

The tasks to be carried out for on system maintenance of ground frames are as listed in the Signalling Technical Maintenance Plan Service Schedules SMS 16, schedule SS 05 21 02 and for channel rodding and points in schedule SS 07 34 01.

The intervals at which these tasks are to be carried out are as specified in the baseline Signalling Technical Maintenance Plan SMS 15 or in approved tailored TMPs which apply to the line or section in which the equipment is located.

4.2 Tools and Materials

The following tools and materials are recommended for carrying out the on system maintenance tasks:-

Adjustable spanners 200, 300 and 375mm

Two each 24 and 30mm ring/open end spanners (or socket set)

Ball peen hammer

Podger

Combination pliers 200mm

Forked spanner for annett lock cover

Shovel

Brush cutter (petrol powered)

Lubricating Oil SAE 80-90

Long nose pliers 160mm

600 grade wet and dry paper

Screwdrivers flat blade 200, 250 and 300mm

Cheese cloth

Facing Point Lock and detection gauge with 1.6, 3.2 and 4.8mm blades

4.3 Instructions

4.3.1 Ground Frames

Examine the condition of the frame and floorplates for any sign of cracking. Pay particular attention to the base of the end frames where they are secured to the foundation. Cracks in cast iron frames cannot be successfully field repaired and these must be replaced if cracked. Steel frames can be repaired by welding.

Check:

- That the bolts securing the frame to the foundation are tight and not seriously corroded,
- That the bolts securing the floorplates to the frames, the locking box brackets to the frames and the locking box to the brackets are secure.
- That the lever shaft bearing caps are secure and that the lever bearings are secure.

Check that the catchrod handle is properly secured to the lever with split pins installed and spread, that the bolts securing the catchrod box to the lever are secure and that the catchrod engages fully in the notch in the floorplate when in the released position.

Examine the condition of the catch rod block and the floorplate for grooving of the block (to be no more than about 2mm) or rounding off of the edge of the notch in the floorplate.

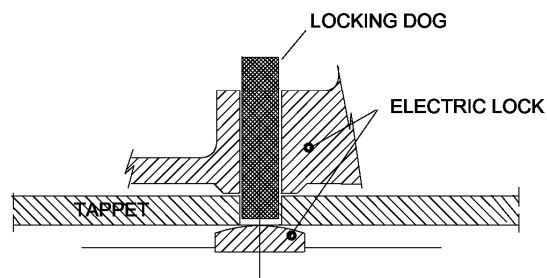
Check that the bolts securing the annett lock to the lever are tight, the bolts securing the annett lock cover are tight and that the key hold cover does not jam in the open position.

Check that split pins are installed and spread in the connections between the levers and the channel rodding.

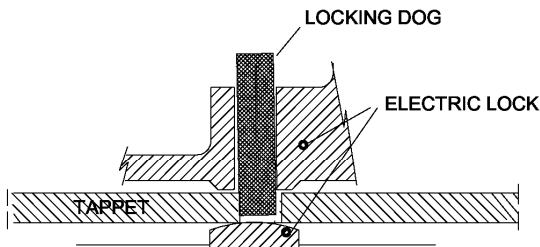
Remove the locking box cover and clean and lubricate the tappets and slides. During this task removal of the locking is to be avoided.

Replace the locking box cover ensuring that the cover bolt(s) is tight and the cover is secure.

Note: A dry lubricant may be used in place of oil for locking box lubrication. However this requires that the tappets and locking dogs be removed and the box, tappets and dogs be thoroughly cleaned with an appropriate solvent to remove oil residue before the dry lubricant is applied. It will then be necessary to carry out an interlocking test after the locking box is re-assembled.



Correctly Adjusted Tappet



Incorrectly Adjusted Tappet
Probability of 'Ledging' or
failure to lift

Figure 4.3.1 – Electric lock tappet adjustment

Lubricate the lever bearings and the pins in the catch rod handle and connections to the channel rodding. Wipe any excess oil off the catchrod handle and lever.

4.3.2 Electric Locks

Examine the condition of the weatherproof cover over the electric lock and ensure that it is not permitting water to enter the lock.

Remove the weatherproof cover and check that security of the bolts securing the lock to the frame, and the extension to the locking tappet (or if mounted opposite to the locking, the lock tappet to the lever).

Examine the air gap between the pole face and the armature and ensure that the stop screw is standing proud of the armature face and that there is a 0.5mm (0.4 to 0.6mm) gap between the armature and the pole face when the lock is lifted. Ensure that the locknut on the stop screw is tight.

Lift and drop the lock several times to ensure that the locking dog is dropping cleanly into the hole in the tappet and that it does not rub or ledge on one side of the hole as shown in figure 4.3.1.

Examine the condition of the lock drop contacts and clean if necessary with cheesecloth. If heavy contamination or burning is evident, first clean with 600 grade wet and dry paper, then burnish with cheesecloth.

Check that the contacts do not make until the dog is engaged in the tappet by at least 5mm. Adjust if necessary by carefully bending the spring contact finger.

Clean the contact block and check that wiring connections are secure and insulation is undamaged.

4.3.3 Channel Rodding

Check that "A" frames are secure on the stands and that the stands are secure in the ground. Any stands which are leaning away from vertical or are significantly higher or lower than adjacent stands are likely to be loose in ground.

Check that all rollers are present and that no rollers are twisted due to badly worn or missing axles.

Check that cranks and compensators are secure on the baseplates or foundations and that the baseplates or foundations are not moving in the ground.

All cranks and compensators with this type of cap have sintered bronze main bearings which do not require lubrication.

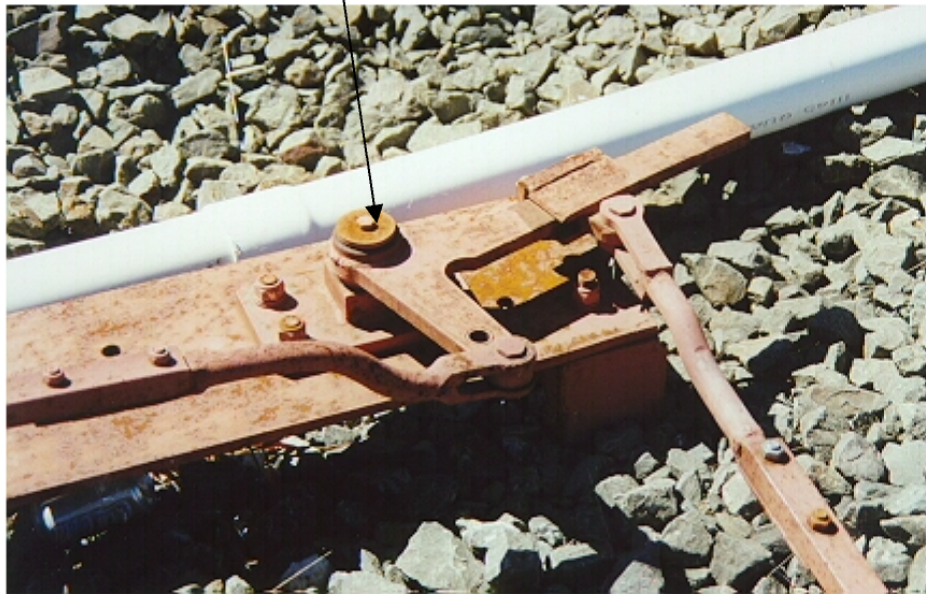


Figure 4.3.2 – Cranks and compensators with self lubricating bearings

Lubricate the connections on compensators and cranks and the bearings on older style cranks. Do not lubricate the main bearings on cranks fitted with sintered main bearings, figure 4.3.2.

Clear any potential obstructions away from the vicinity of the channel rodding and cranks.

4.3.4 Points

Check that chair bolts and screw spikes are secure and that there are no bolts or switch stops likely to become dislodged and foul the switch or rodding.

Check that the switches are bearing on, or within 1.5mm of the 'A' and 'B' chairs.

If possible observe the behaviour of the points under a train to determine whether there is "pumping" around the 'A' and 'B' timbers or whether the switch is kicking up as wheels pass over the heel.

If permanent way defects are found either correct the defect or report the defect for correction by civil staff in accordance with local work instructions.

Check that bolts securing the front rod, back rod, extension pieces and lock rod are tight.

Check that the facing point lock is properly secured and that there is no movement between the lock and sleeper. Check that the bolts securing the angle crank in the four foot are tight and that the crank base shows no signs of movement.

Check that all pins are fitted with split pins and that the split pins are properly spread.

Lubricate the facing point lock plunger and cross slide.

Lubricate the lock rod where it passes through the facing point lock.

Lubricate pinned connections at the facing point lock, angle crank and detector.

For Signal Branch and Westinghouse U5 detectors, clean the detector and examine the condition of and tension of the contacts. Tension should be sufficient to prevent "bobbing" (opening under passage of a train) but not so high that it leads to grooving in the moving contacts.

Contacts should normally only be burnished with cheesecloth. If heavier cleaning is required, this should be carried out only as a temporary expedient pending replacement of the contact as soon as possible.

For ML, Westinghouse U5A, HM2 and HM3 detectors, clean the detector.

Check that the detector is secure and that there are no signs of movement on the sleeper or baseplate.

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5. Fault Diagnosis

5.1 Ground Frame, Channel Rodding and Points

Where a fault occurs with a ground frame or the channel rodding drive or the mechanical points, it will be obvious due to the simple open nature of the equipment. Provided that the equipment is correctly installed and not expected to perform beyond its capabilities, failures will be due to visible wear, fracture or movement of “A” frame or crank foundations in the ground, stockrail movement at the points or loose fixings and fasteners allowing components to slip out of position.

5.2 Electric Locks

There are two failure modes for electric locks, fail to pick up and fail to drop. In both cases, it is possible that the cause of the failure is not directly related to the electric lock but is in the circuitry between the electric lock and the controlling signalling interlocking.

If the lock fails to pick up, first check that there is power at the lock coil. If power is present, check that the locking dog is not jamming in the tappet.

If power is present and there is no indication that the locking dog is jamming then the electric lock itself is defective and must be replaced.

If power is not present, the fault lies in the circuitry between the signalling interlocking and the electric lock and must be traced through the circuits to the electric lock.

If the lock fails to drop and remains fully in the up position, the fault is due either to residual magnetism within the coil or to an extraneous supply maintaining power to the lock circuit.

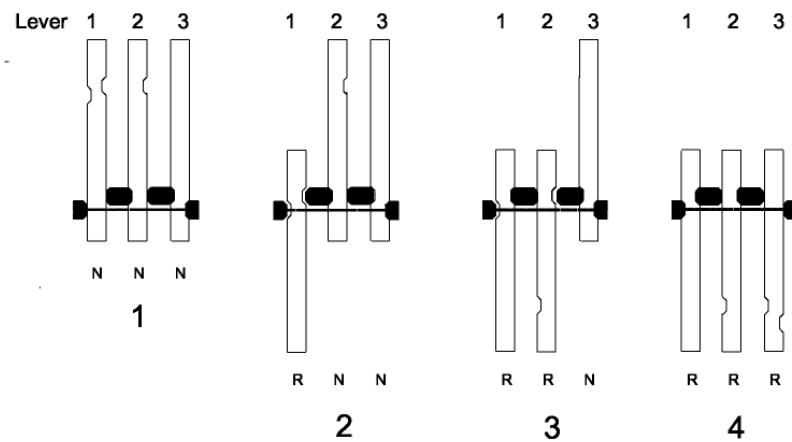
Provided that the air gap between armature and pole face has been maintained, residual magnetism is unlikely and is even more unlikely to hold the lock up for any length of time.

If the lock drops only part way then the fault is due to the dog ledgeing on the tappet.



Figure 6.1.1

Backdrive fitted to ground frame operated points
(The backdrive components and connections are identical to those used with electric switch machines)



- 1 All levers normal - frame can be locked and annett/operators key removed
- 2 Frame unlocked, lever 1 reverse - points normal and locked
- 3 Frame unlocked, levers 1 and 2 reverse - remote end of crossover reverse and locked
- 4 Frame unlocked, all levers reverse - both end of crossover reverse and locked

Figure 6.1.2

Locking for 3 lever machine operating claw locks

6. Installation

6.1 Ground Frame

6.1.1 Application

The Type G ground frame is suitable for operating the following maximum combinations of points or any lesser combination:-

- A crossover constructed from 60kg rail provided that:
 - The ground frame is placed no more than 5 metres from one end of the crossover.
 - Neither end of the crossover requires a backdrive.
 - The two ends of the crossover are not more than 75 metres apart.
- One end of points plus a catchpoint constructed from 60kg rail. The points may have a backdrive as shown in figure 6.1.1.
- A single end of tangential points of 190 or 250 metre radius provided that the points are fitted with claw locks. Claw lock installation is covered in the Claw Lock Manual SC 07 31 08 00 EQ.
- A 1900 or 250 metre tangential crossover provided that a 3 lever machine is used with lever 2 driving the remote end of the crossover and lever 3 driving the closest end. Locking for this machine must be as shown in figure 6.1.2. (Note that no separate facing point lock is required with claw locks)
- A crossover plus single catchpoint constructed from 53kg or lighter rail provided the frame is located within 5 metres of one end of the crossover.

Ground frames must not used to drive:

- Any crossover which requires backdrives both ends, eg 60kg 9150 switches or 1 in 15 turnouts
- Any tangential turnout larger than 250 metre radius.

The Type F single lever should not be used for any new applications.

6.1.2 Location

The ground frame should be located between 3 and 5 metres from the points in the main (or more important) line with the centre line of the closest lever 1830mm from running face, figure 6.1.3.

For a main line crossover the ground frame should be located at the most convenient end taking into account the space available and the nature of the ground onto which the machine is to be mounted.

Wherever possible, the machine should be mounted so that the operator is facing the points worked by the ground frame.

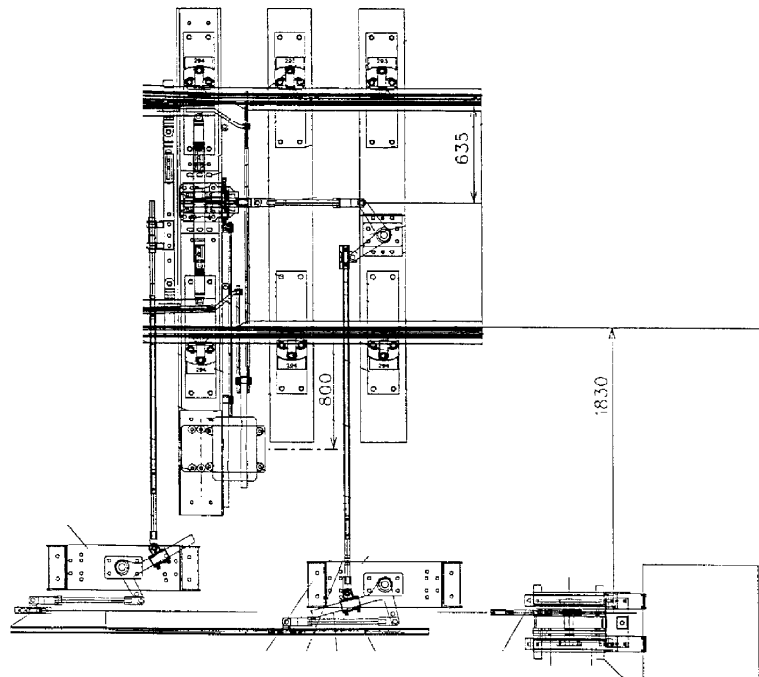


Figure 6.1.3 – Ground frame location

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Figure 6.1.4



Figure 6.1.5

Ground frames should not be mounted between tracks unless there is at least 300mm clearance to structure gauge from the closest lever on each side.

Where a track or signalling plan or working sketch shows the location of a ground frame relative to the points, this location should be adhered to unless there is reasonable justification to relocate such as lack of space, bad ground, poor access or obstructions to the channel rodding drive.

Figures 6.1.4 and 6.1.5 show typical ground frame and channel rodding drive locations.



Figure 6.1.6

6.1.3 Foundations

6.1.3.1 Type E Ground Frame

Type E ground Frames should not be used for any new installations.

6.1.3.2 Type G Ground Frame

The original foundation for a Type G ground frame was made from reclaimed rails mounted in pre-cast concrete footings. More recently this built up foundation has been replaced by a concrete slab or concrete slab and steel

frame as shown in figures 6.1.6 and 6.1.7. The steel frame may be made up of angle or channel sections.

Handrails should be provided each side of the platform as shown in figure 6.1.6 and one or two steps to the operating platform, depending on height above ground, are required.

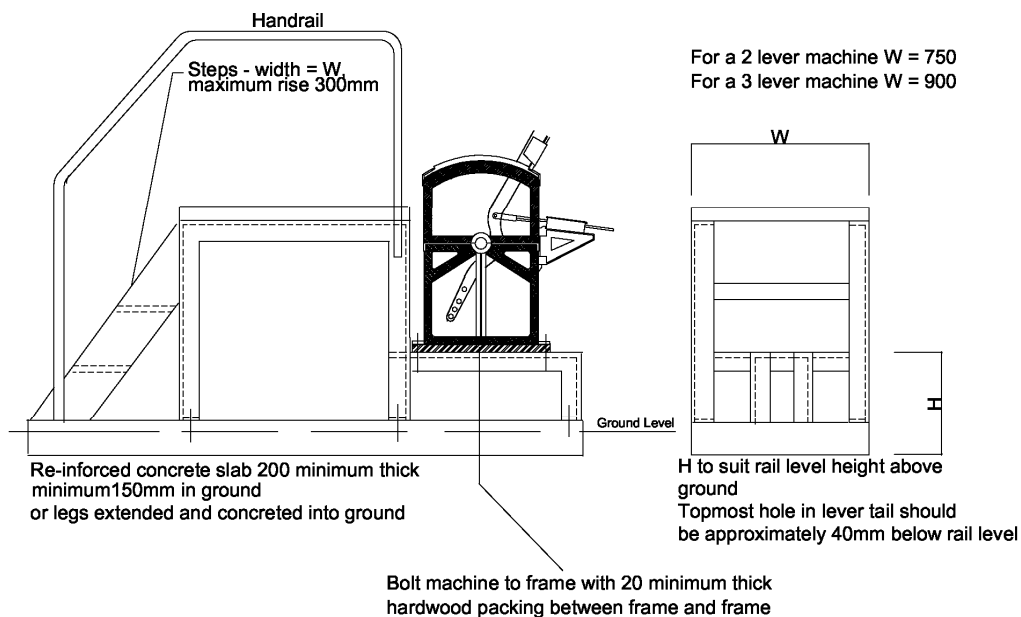


Figure 6.1.7 - Type G foundation

6.1.3.3 Type F single Lever

The Type F single lever should not be used for any new installation.

6.1.3.4 Westinghouse Ground Frame

A foundation similar to the Type G foundation was used for these machines.

6.2 Channel Rodding and Cranks

Channel rodding should be installed so that the top of the rodding is approximately 25mm below rail level. This will permit maximum sets of 76mm in connections between the channel rodding and cranks and compensators and 76mm maximum sets where it is necessary for the run to pass under tracks.

However, in areas with very high ballast profiles, it may be necessary to install the channel rodding at a lower level to ensure that the A frames blocks are secure in the ground. If it is necessary to mount the channel rodding

lower, it will not be possible to mount the adjusting cranks at the points on extended sleepers and these must be mounted on separate stands.

To install a channel rodding run proceed as follows:

Determine whether the cranks at the points are to be mounted on extended sleepers or on a separate stand.

If a separate stand (or stands) are necessary, determine the position (locate from the tip of the points, or, if the point rods are already installed, from the front rod) and height required, mount the stands and concrete securely into the ground.

If a separate stand is used for each crank it is of benefit to mount both in a single concrete foundation.

Determine the position of the compensator(s) and concrete the stand(s) into the ground, figure 6.2.1.

Determine the location of any other cranks required, such as deflecting or elevating cranks and concrete the stands into the ground.

Allow at least 72 hours and preferably 96 hours for concrete curing before the cranks are mounted onto the stands.



Figure 6.2.1

Install the A frames, stands and foundations at maximum 2 metre centres, ensuring that the A frames are in line (or in a smooth, gentle curve) and are all at the same height relative to rail level.

If necessary, in soft ground or where the concrete block cannot be fully buried, add additional concrete around the block so it that will remain secure and stable and not lift when the channel rodding is used.

Fit the connections (joints) to the ground frame, cranks and compensators.

The channel rodding can be placed in the A frames and fixed to the ground frame but must not be cut to length or drilled for crank or compensator connections until the points equipment has been installed (refer 6.3 below).

Since the closest end of points to the ground frame is normally connected to the channel rodding by a drop lug, figure 6.2.2, it is simpler to commence cutting in the channel rodding at the points furthest from the frame.

Place the ground frame levers at mid stroke, the points at mid stroke and, facing point lock (if fitted) at mid stroke and the compensator(s) at mid stroke



Figure 6.2.2 – Drop lug connection to channel rodding

Measure and cut and/or drill the channel rodding and the bolt joints to the cranks and compensators to the channel rodding with the appropriate sized 12mm or ½ inch hexagon or tee-head bolts.

Check the operation of the channel rodding and points but do not carry out final adjustments or testing at this stage.

Return to the end of points nearest the frame and place the ground frame levers, the points and the facing point lock at mid stroke.

Mark and drill the channel rodding for the lugged fishplates and bolt the fishplates to the channel rodding.

Check the operation of both ends of points and test spring, facing point lock and detector adjustments.

6.3 Facing Points

The following set up procedure assumes that the turnout has been installed in the track and has been ballasted, lined, leveled and tamped. If set up off site, the procedure is essentially the same except that no testing can be carried out and it will be necessary to re-adjust the lock rod, the FPL plunger

position and detector rods after the turnout is installed in the track. Note that even if cranks have been set up on centre off site, they may be slightly off centre when the turnout is installed due to minor twisting of the turnout. If fixed length rods have been used, it is not necessary to cut-in new rods if the cranks are within, or can be brought within, $\pm 20\text{mm}$ of centre.

1. Before commencing installation, examine the turnout and ensure that:
 - The correct timbers have been installed (refer to Drawing M10-301 Appendix A). (Note: if cranks are to be mounted on separate stands extended timbers are required only for detectors).
 - Chair bolts and studs are tight and studs are not fouling any part of the switch.
 - Each switch lays up to the stockrail correctly when barred closed and remains against the stockrail when the force is removed. (Note: with dry chairs it will probably be necessary to bar the switch in several places).
 - With the switch closed against the stockrail, any gap between the tip of the switch and the stockrail is less than 1mm.
 - Note: It is not uncommon for a switch to close up hard just back from the tip but leave a small gap at the tip. This gap, if small, can sometimes be corrected by adjusting the back rod relative to the front rod (i.e. spreading the back rod slightly). Care is required here however, since spreading the back rod may distort the opposite switch. If the gap is more than about 1mm, it cannot be corrected with the signalling equipment and the switch must be crowded.
2. Fit the front and back rods to both switches
3. Close one switch (usually the normally closed switch) against the stockrail and clamp closed. Note: It is better to use a G-clamp at the rail head rather than a point clip since this will avoid introducing switch roll)
4. Adjust the front and back rods so that the other switch is open 114 – 115mm.
5. Release the clamp and bar the points over and back several times to check how each switch is laying against its stockrail. Adjust the rods as necessary to correct any deficiencies. Make sure to maintain the 114 – 115cm switch opening.
6. Remove the cover from the facing point lock and remove the plunger and cross slide. Place the facing point lock casting onto the “A” timber with the centre of the lock at a distance of 635mm from running face on the normally closed switch side.
7. Fit the lock rod and extension pieces to each switch. Hand tighten only sufficient bolts to hold the lock rod in position.
8. Align the plunger casting so that at mid stroke it is at right angles to the lock rod and the lock rod is centred in the notch in the lock casting.

Note: If work is carried out on a very cold day, the clearance between the lock rod and the lock casting on the “B” timber side should be decreased by 1-2mm, if carried out on a very hot day this clearance should be increased by 1-2mm.

9. When satisfied the lock casting is correctly positioned mark the four holes to be drilled in the “A” timber.
10. Remove the lock rod and lock casting and drill the four holes 21mm diameter.
11. Bolt the lock casting onto the “A” timber with a 6mm packing plate under the casting.
12. Refit the lock rod and the extension pieces to each switch. (If the switch is drilled and countersunk for it, and if the extension piece provides for it, fit the 7/8 bolt through the lock rod and extension piece).
13. Refit the lock plunger and cross slide to the facing point lock. Bar the points to the normal position and clamp the switch to the stockrail. (Again use a G-clamp at the head of the rail rather than a point clip). Loosen and separate the serrated plates on both sides of the lock rod. Move the centre part of the lock rod so that the plunger can be pushed fully home. Move the centre portion of the lock rod back so that the block rests against the side of the plunger. Tighten one bolt in each serration ensuring that the teeth in the serrations are properly engaged.
14. Move the plunger in and out. It should operate with slight binding or be marginally clear. If tight, back off one serration.
15. For points locked one way (normal) proceed to step 17. For points locked both ways withdraw the plunger, remove the clamp, bar the points to the reverse position and clamp the reverse switch closed.
16. Push the plunger home and check its clearance from the block on the lock rod. If adjustment is required, it will be necessary to adjust the reverse side of the lock rod and the switch opening on the front and back rods.
17. Tighten both bolts in each serrated part of the lock rod.
18. Fit the adjustable, insulated, set shackle length to the plunger and to a 250 x 250 angle crank. Place the rank on the A2 timber with the crank are on centre, the shackle length aligned with the plunger and the plunger at the mid stroke position. Mark and drill the holes for the crank base. Fit the crank base and check that the crank and plunger move freely.
19. For points fitted with an electrical detector, fit the detector and baseplate (detectors and brackets if 2 signal branch detectors are used) to the “A” and/or “A1” timber where shown on the points layout. Fit the drop lug to the facing point lock cross slide

20. Fit the rod to the appropriate crank or slide on the detector(s). Move the points to the normal position and push the lock plunger fully home. Position the crank or slide in the detector so that the relevant contacts (NB the *normal* contacts in U5, HM3 and ML detectors) are well made. It will be necessary to position the other slides in HM3 and ML detectors so that the roller can fall into the notch. Mark and drill the rod and bolt it to the drop lug on the lock cross slide.
21. Fit the drop lug to the angle crank in the four foot and fit the cradle to the front rod.
22. Where the adjusting cranks are to be attached to the “A2” and “B” timbers place the baseplate between the “A2” and “B” timbers and place the adjusting cranks for the FPL and drive in their approximate positions. If the cranks are to be mounted onto a separate stand or stands refer to Section 2.5.
23. Adjust the clip on each crank to 410mm from crank centre.
24. Place the facing point lock plunger at mid stroke. Place the adjusting crank for the FPL at mid stroke (i.e. fixed arm at right angles to the channel rodding from the interlocking machine) and align the clip with the drop off lug on the crank in the four foot. Align the base of the crank with the baseplate.
25. Withdraw the lock plunger and place the points at the mid position. Place the adjusting crank for the drive at mid stroke and align the clip with the centre of the hole in the cradle. Align the base of the crank with the baseplate.
26. Mark and drill the baseplate and the “A2” and “B” timbers.
27. Bolt the cranks and baseplate to the timbers.
28. Place the adjusting crank for the drive at mid stroke, fit the driving rod and bobbins into the cradle and fit the 75mm set up joint to the crank. Mark and drill the channel and fit between the driving rod and set up joint.
29. Move the points to the normal position and place the lock plunger at mid stroke. Place the adjusting crank for the FPL at mid stroke and fit a 75mm set up joint to the crank. Mark and drill the channel and fit between the set up joint and the drop off lug on the angle crank.
30. Place the FPL lever in the interlocking machine at mid stroke, and all cranks and compensators in the channel rodding lead from the interlocking machine at mid stroke. Fit the appropriate set up joint to the adjusting crank and measure and drill for attachment to the channel rodding.
31. The FPL may now be adjusted to provide full 200mm travel and to be 20mm clear of the lock rod block with the lever in the reverse position.

32. Bar the points to the mid position and place the point lever in the interlocking machine and all cranks and compensators in the channel rodding lead at mid stroke. Fit the appropriate set up joint to the adjusting crank and measure and drill for attachment to the channel rodding.
33. The points may now be tested for correct operation normal and reverse. Adjust the clip on the adjusting crank to provide 18 to 22mm escapement at the bobbins.
34. Test the facing point lock and detection in accordance with Section 3.
35. Fit split pins to all turned pins and check that all bolts are tight.

6.4 Installation Procedure Trailing Points

1. Before commencing installation, examine the turnout and ensure that:
 - The correct timbers have been installed (refer to Drawing M10-301 Appendix A). (Note: if cranks are to be mounted on separate stands extended timbers are required only for detectors).
 - Chair bolts and studs are tight and studs are not fouling any part of the switch.
 - Each switch lays up to the stockrail correctly when barred closed and remains against the stockrail when the force is removed. (Note: with dry chairs it will probably be necessary to bar the switch in several places).
 - With the switch closed against the stockrail, any gap between the tip of the switch and the stockrail is less than 1mm.
Note: It is not uncommon for a switch to close up hard just back from the tip but leave a small gap at the tip. This gap, if small, can sometimes be corrected by adjusting the back rod relative to the front rod (i.e. spreading the back rod slightly). Care is required here however, since spreading the back rod may distort the opposite switch. If the gap is more than about 1mm, it cannot be corrected with the signalling equipment and the switch must be crowded.
2. Fit the front and back rods to both switches
3. Close one switch (usually the normally closed switch) against the stockrail and clamp closed. Note: It is better to use a G-clamp at the rail head rather than a point clip since this will avoid introducing switch roll)
4. Adjust the front and back rods so that the other switch is open 114 – 115mm.
5. Release the clamp and bar the points over and back several times to check how each switch is laying against its stockrail. Adjust the rods as necessary to correct any deficiencies. Make sure to maintain the 114 – 115cm switch opening.

6. For points fitted with a mechanical detector (wire lock) refer to Section 2.3
7. For points fitted with an electrical detector, fit the detector and baseplate (detectors and brackets if 2 signal branch detectors are used) to the “A” and/or “A1” timber where shown on the point layout.
8. Fit the extension pieces to each switch.
9. For a Signal Branch or U5/5A detector bar the points to the mid position and place the detector crank so that the hole in the end of the crank is vertically below the shaft. Fit the sway beam and detector rods and position the sway beam vertically. Mark and drill the detector rods from the extension pieces. Fit the rods to the extension pieces and sway beam. (If round rods with rubber brushes are used, no marking or drilling is required).
10. For ML and HM2/3 detectors bar the points to the normal position and position the slides in the detector so that the normal contacts are just made. Fit the normal detector rod (mark and drill if necessary). Bar the points to the reverse position and repeat for the reverse detector rod.
11. Bar the points to mid stroke and place the adjusting crank for the drive at mid stroke, fit the driving rod and bobbins into the cradle and fit the 75mm set up joint to the crank. Mark and drill the channel and fit between the driving rod and set up joint.
12. Place the point lever in the interlocking machine and all cranks and compensators in the channel rodding lead at mid stroke. Fit the appropriate set up joint to the adjusting crank and measure and drill for attachment to the channel rodding.
13. The points may now be tested for correct operation normal and reverse. Adjust the clip on the adjusting crank to provide 18 to 22mm escapement at the bobbins.
14. Test the detection in accordance with Section 3.
15. Fit split pins to all turned pins and check that all bolts are tight.

Appendix A

Point layout drawings