AMBIS Point Rodding & Wire System

Part One (of Three Parts)

Introduction to the Prototype

Introduction

We are aware there are many different designs to the components that were used in the prototype to make up mechanical connections from signal cabins to track and signalling objects. We are restricting our range of components to those that can produce, if not an accurate replica, a representative model of those parts by adopting the main variations that were reported upon in the 1930's.

Figure 1. An adjustable crank.

History

As railway traffic and complexity increased in the 1860's the controlling body the Board of Trade imposed signal and control safety measures on railway companies, often the result of serious accidents. The railway companies used different solutions to those impositions by the Railway Inspectors either through the use of contractors or their own factory products.

The actions of the railway policemen or the "Bobby" which had been employed to police train movements was being concentrated into cabins which were raised above the permenant way so that they could observe train movements. In doing so it became necessary to link point switches and signals to the cabin so the Bobby did not need to leave their cabin in most circumstances.

This step towards the signalling centres of the current era known as power boxes was limited by the effective operation of mechanical devices and the finite ability of the bobby or signalman to manage the railway traffic at their location. It was only gradually that devices were improved then standardised and the use of electricity began to replace the entirely mechanical methods initially used.

Electricity was first introduced through telegraph and block instruments, then track occupation and signal status feedback to the signal cabin, followed by colour light signals and track circuits and electrically operated point switches. Our interest in making model components ceases as the mechanical devices were superceeded.

AMBIS products

We support three types of mechanical connection from signal cabin to signals and trackwork, the round rod or tube connection, the galvanised inverted "U" or channel section rod and wire. You will need a range of tubes, wire and pins to complete the models plus the necessary glue products or soldering skills to assemble them. Some parts such as the bases for rodding runs and cranks are a matter of choice for the builder and their observation of the practices being modelled. What we supply are components to create the mechanical systems used by railways where these can be etched into sheet metal. These are

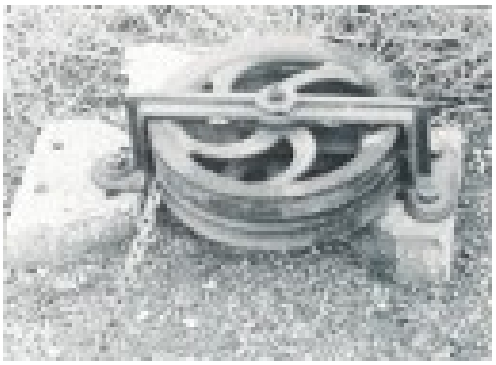

Figure 2. A two layer wire pulley, without a wire run to the top pulley.

- Cranks and their supports
- The "U" shape channel rodding
- Rodding stools - for channel rodding or round rodding
- Wire run supports

- Wire run pulleys
- Facing point lock mechanisms (simulated)
- Bolt locks (simulated)
- Wheel flange detectors (non working)

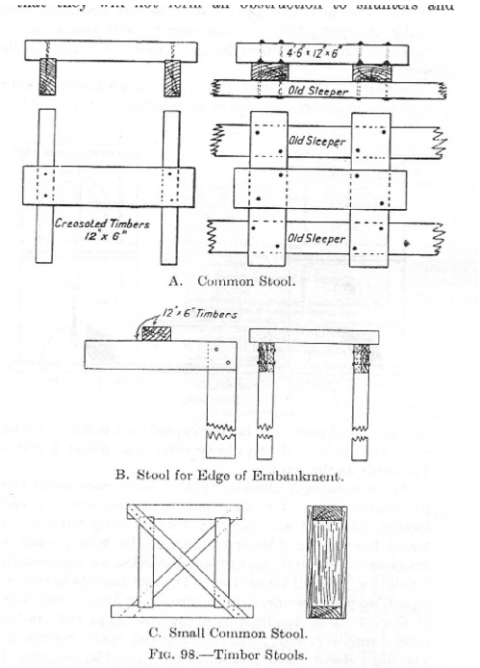

Figure 3. Some types of foundations for mounting rodding stools.

It may be possible to make all these components move but we would not rely on them to operate on a model to 4mm:1 foot scale. It is necessary that the builder insures an adequate insulation of these parts to avoid creating short circuits between the running rails where 2-rail electrification is used. We would recommend using thin double sided glass fibre based printed circuit board instead of flat metal parts - use the metal parts as templates. Be aware that the prototype has problems where wires pass beneath rails allowing intermittent contact between different electrical circuits, so use plastic rods or supplementary plastic insulation. We have made no specific allowance for track gauges or wheel clearances for the different modelling standards such as “OO”, “EM” or “S4". However a modeller working to ”S4"standards will not need to make as many compromises as others.

- The use of DCC control systems instead of traditional analogue controls can put a higher current through running rails, necessitating better insulation standards.

Where to Start

Firstly you need to design a rodding layout. There is no single method on how to connect the signal cabin to pointwork or signals or where to run the rodding in relation to trackwork.

- Note that in areas such as sidings or where there was any regular movment on foot, rodding and wires would not be run without safety measures being applied such as a timber cover being installed over wires or rodding.

There is one rule which you need to be aware of which needs to be followed - the push movement in rodding must equal the pull movement applied. This is to overcome expansion issues of lengthy metal connections. You need around 4 inches of travel at a prototype point switch, initiated by about 7 inches of travel at the signal cabin lever, so the last connection is always an adjustable crank to apply only the movement needed.

- Models may require as much as 9 inches of movement (3 mm) for point switches.

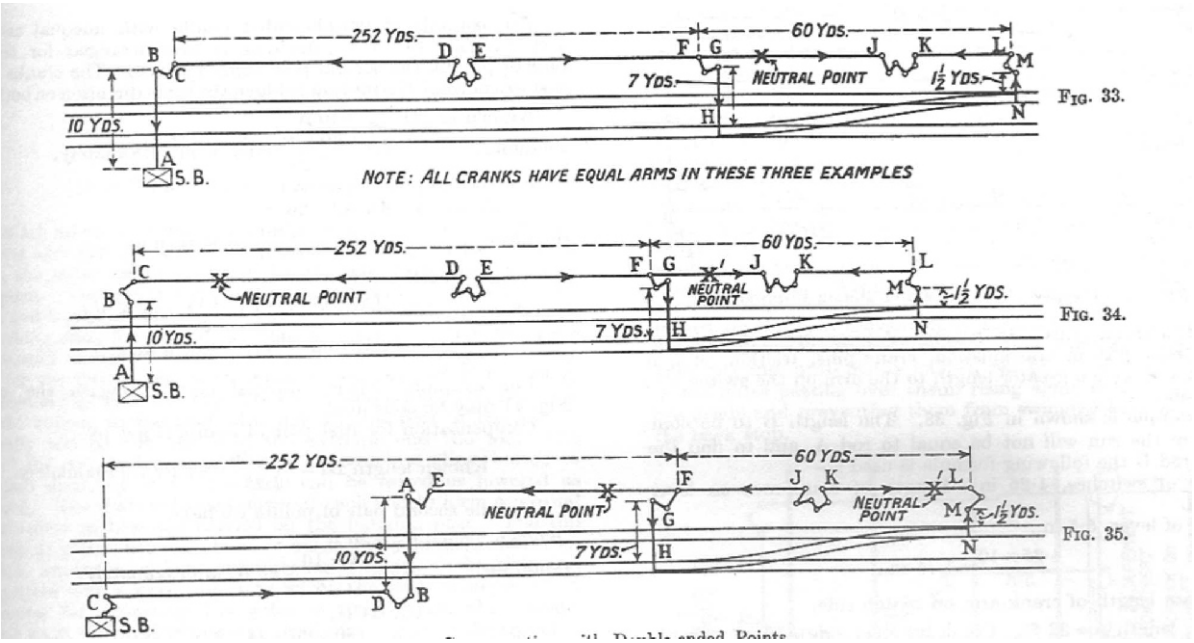

Figure 4. An example of different compensation requirements for a rodding run operating a crossover, push length equals pull length.

The need to include tolerences for movement loss is a major issue that makes a working model rodding system difficult, if not impossible to achieve at 4mm: 1foot scale over long distances. A wire system is different from a rodding system. It works on a pull only principal with a gravity worked return to normal. Although movement at a signal is probably around 6 inches (150mm) the actual pull at the signal cabin can be much greater.

- A two wire system was common in Europe and was used by the LMS is during the 1930's as it allowed a longer distance operation than was available to a rodding system. We are making no specific allowance for this method of operation.

Single wire operation was common for signal operation in the UK especially for more remote signals. But because of the extra movement in the wire, cranks could not be used, pulleys were used to change direction of the wire instead, using a chain around the pulley.

- Whilst some railway companies used rodding for signals located near to a signal cabin this only appears to apply to where lower quadrant semaphore signals were in use.

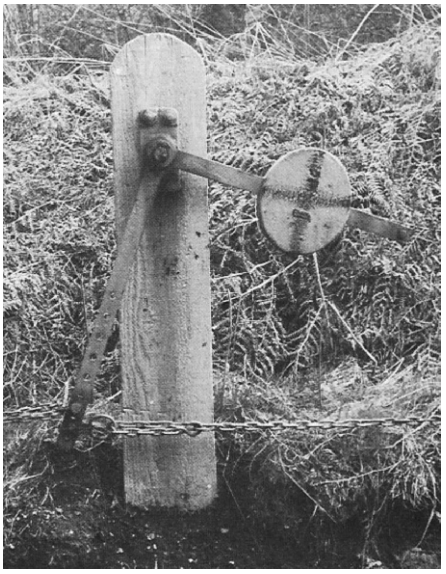

Figure 5 - A "multiplier" for remote signal operation by a pull wire.

AMBIS suspects that wire operation was adopted "randomly" because of its greater operation range and through the addition of new requirements without entire signal box and rodding replacement schemes becoming necessary. But there is no apparent observable rule. Some railway signal cabins used rod systems for most purposes and some include wire supplements, others used the "U" channel rodding and wire operation. It has been noted that the LNWR started to use channel rodding after its patentening in 1874 by F W Webb. It is clear though that later signalling practices only used the "U" channel. The round rodding system - possibly a gas pipe was prone to sudden failure from internal rusting and only a Victorian era practice, but these could have remained in use through the 1960's.

- We have no evidence that “U”channel was used for signals.

The distance from a signal cabin that devices were allowed increases over time. As labour became more expensive, railway traffic may have reduced and/or to reduce communication needs. Some railways such as the Midland Railway/LMS centralised signalling operations from perhaps three small signal cabins for one railway station, down to one with perhaps a ground mounted lever frame unlocked for use by the signalman for more distant pointwork.

Board of Trade limitations on the distance of mechanically worked facing points from signal cabins.

Year	1874	1877	1885	1900	1908	1925
Distance (yards)	120	150	180	200	250	350
Scale Distance (1:76.2) (approximate)	5 feet	6 feet	7 feet	8 feet	10 feet	14 feet

Many railway models will not be sufficiently long to necessiatate the use of more than one signal cabin to overcome any distance limitation. For modellers other factors are likely to determine the use of more than one signal cabin.

As a rule of thumb rodding supports would occur at about 8 feet intervals (2.4m) for a straight run, reducing down to 5-6 feet (1.6 to 1.8m) for curves. Tables showing adjustment requirements suggest runs of up to 1100 feet were commonplace for rodding by 1946 (about 14 feet or 4.2m at 4mm:1 foot scale).

- Note that prototype curves are much larger than commonly found on models, rodding will be too inefficient to operate around model “minimum radius” curves. So use straightish runs joined by cranks on tight curves.
- Similarly for signal wires these could be enabled to negotiate tighter curves by using horizontally mounted pulleys

Wire runs were supported on posts at about at varying intervals depending upon the number of wires carried - about 24 feet (about 9.2m) intervals would be an average distance but for a single wire this could be 30 feet (11m).

For distant signals located perhaps 2000 yards from a signal cabin about 24 inches of pull would be required at the signal lever using a pulley multiplication system within the signal cabin, whereas nearer signals may be directly linked to the lever. Some railways used extra balance weights to “multiply” the effect of a signal lever for wire mounted remote signals. In Scotland where main lines were often single lines this resulted in some complex arrangements.

Observe Prototype Signalling Practices

Unless you are working with a prototype of which you have a signal box diagram you will need to create one from which the rodding system will need to follow. One way of doing this will be to start from the most remote device you need to operate remotely by a signalman then work out a route back to the signal cabin adding other device links en-route.

Runs can cross trackwork under rails, between sleepers, but rarely did so near to other equipment such as point switches and crossings.

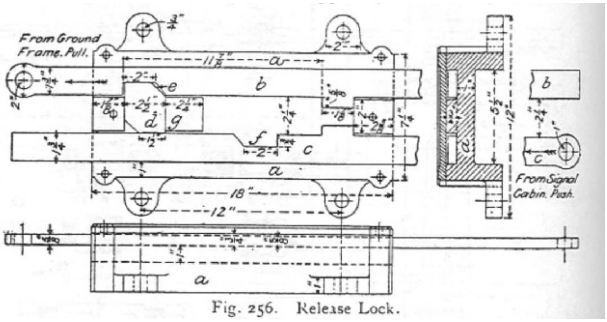

Figure 6 A mechanical lock using tappets, between signal cabins or to a ground frame from a signal cabin

Each rodding installation will probably be based upon the company practices, the whims of the individual engineer and local circumstances. For example it appears the NER had a signal for any conceivable train movement whereas other railways e.g. Midland Railway seemed to limit the extent of facing points and ground signals it used, may have widely relied upon flags for shunting movements close to a signal box and used rods to operate its lower quadrant signals.

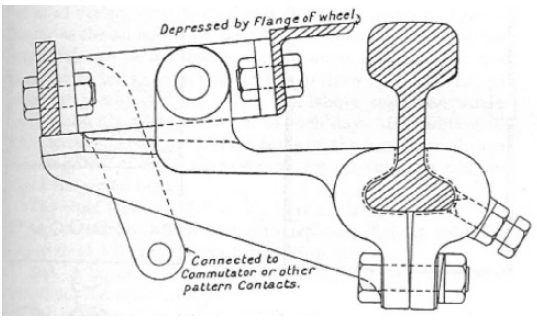

Figure 7. A balanced bar treadle design

There are some devices not commonly modelled which would require levers in a signal cabin and a connection to their location. These include:-

1. Detonators
Warning devices set off by the pressure of a wheel annoucing the approach of a signal to a train driver in dense fog (we have no intention of producing any components for this specific purpose).

2. Gongs
These were used as a safety device for warning purposes, such as within tunnels preceeding pointwork such as at London, Kings Cross Station.

3. Mechanical locks between signal boxes for common signals or points. These were common in areas of dense signal cabins where their block sections overlap but can also be used between ground frames and signal cabins. This was a practice known to be used by the Midland Railway before electric interlocking became available.

- see Figure 6 for an example

4. Train on track detectors and treadles not directly linked to point switches. These devices could be linked mechanically to signal boxes although an electrical connection would be more commonplace. This device could be required where the signalman could not see such as, the distant end of a loop line where a train could block the use of an adjacent track; if an engine release crossover was fouled; or the end of a bay platform obsured byan awning where stock could have been shunted and then forgotten by a signalman.

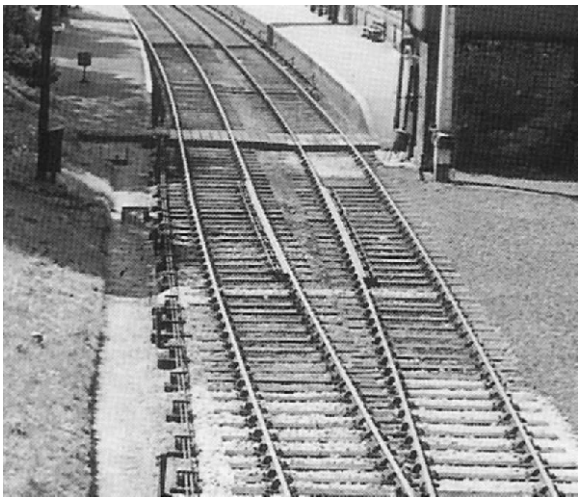

Figure 8. Epping Station, before electrification. A detector fitted to both lines, the signal cabin was located at the other end of the platforms. Here the line continued to Ongar and changed to a single track.

A treadle using a counterbalance would normally be raised to rail head height, so that any passing stock would depress the treadle and thereby indicate the occupancy of the track by a railway vehicle. It must be able to detect at least one wheel so that there has to be an allowance for different length of rolling stock being used.

- See Figure 7 for a section through a balanced bar

The treadle needs to span more than the longest distance between any wheels in a train. A rule of thumb based upon coach designs is as follows:-

Shorter bogie coaches (e.g. 48 feet long) with long wheelbase bogies (e.g. 10 feet) - 21 feet
Shorter bogie coaches (e.g. 48 feet long) with short wheelbase bogies (e.g. 8 feet) - 26 feet
Longer coaches (e.g. 61 ft 6 inches) 35 feet
Articulated coaches …40 feet

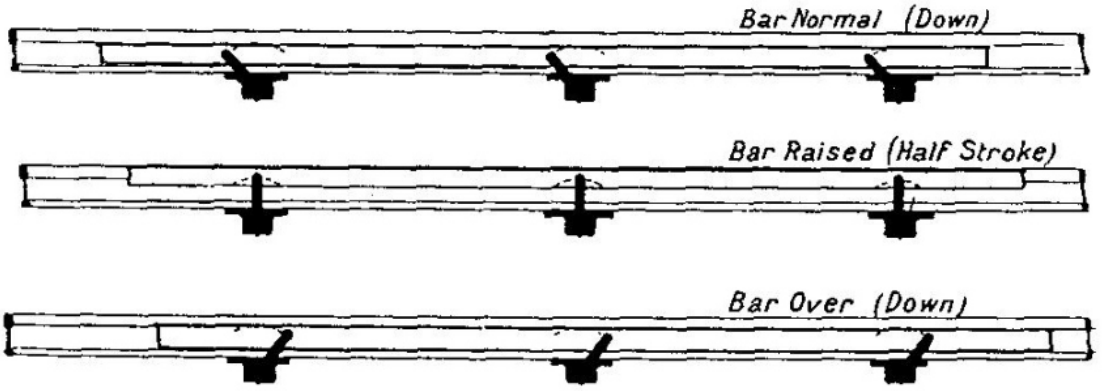

Figure 9. The operation of a fouling bar, in mid throw a wheel would prevent its operation. This would be used to enforce the facing point lock.

For longer coaches such as the GWR 70 foot stock it would probably mean that electrical track circuits would need to be installed as very long (heavy) mechanical detectors could not readily be operated by a signalman.

After the introduction of track circuitry the converse became true, moving stock with too short a wheelbase were not able to be detected as the switching time for the electrical circuits could be unreliably too short.

Balanced treadles could be linked mechanically to a signal box but it more likely that they would be linked to an electrical switch lighting actuating an indicator or electrically operated locks in the signal box.

The version of a fouling bar used to lock facing points is operated by the signalman - see figure 7. This requires the bar to be raised to prove there was no train to be present at the point. If the treadle cannot be mechanically raised by the signalman then the bolt locking the point switch could not be withdrawn thereby allowing the point switch to be moved by another signal cabin lever.

- The published diagram for the "standard" facing point lock in the 1930's refers to a 40 foot long treadle - see figure 17.

5. Facing point locks is where there is a facing point on arunning line for passenger trains to cross. Normally aa point switch would need to be secured by a second lever before the relevent signals could be alteres. This inhibits a signalman from pulling "off" the relevant signal without reversing the lie of the point without first reversing relevent signals (to halt).

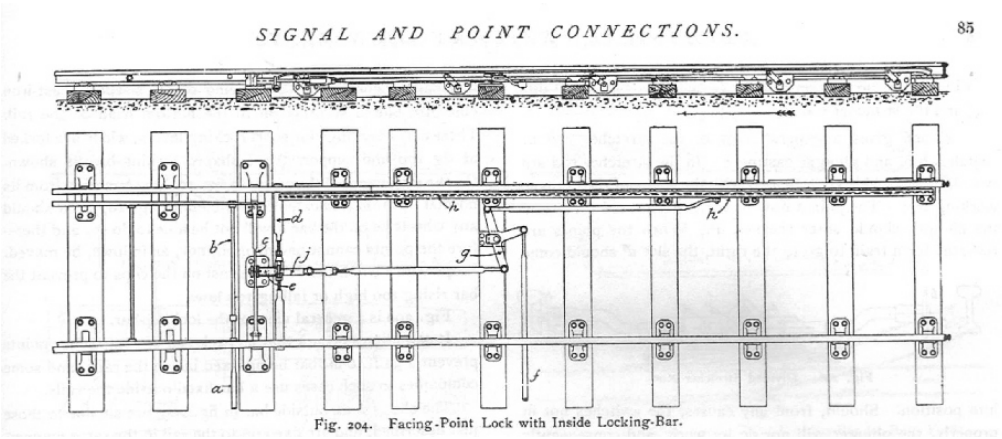

Figure 10. A "T" crank worked basic facing point lock with locking bar

It was common that an unbalanced treadle (one raised by a lever) was linked to this lock lever so that should a train be traversing that pointwork the signalman would be inhibited from releasing the facing point lock.

Later signalling practices did generally replace the wheel detector with an electric track circuit.

Initially the detector was aligned with the switch blades of pointwork, but this was very complex to install and maintain. As an alternative some companies used wheel tread detectors, located outside the track gauge e.g. GER see photographs of Liverpool Street Station and illustrated by Figure 11.

Apparently the LNWR standardised on a 37ft 6in wheel flange detector and the GER 30 ft detectors.

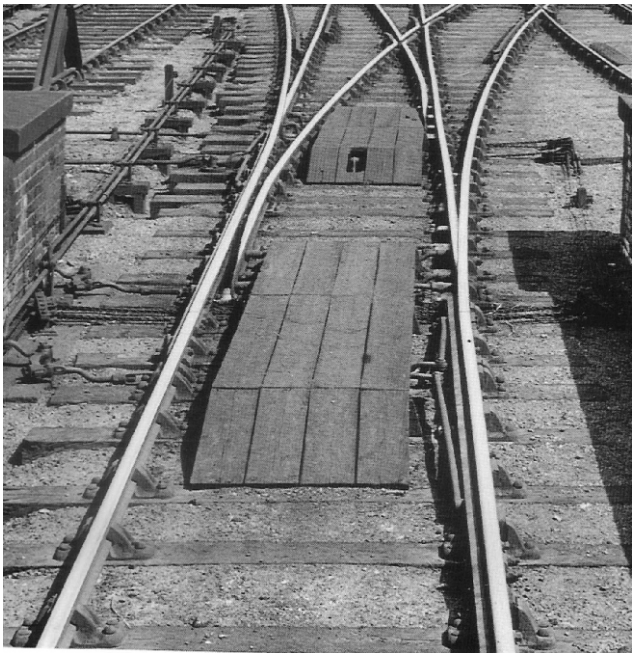

Figure 11. Ongar station approach (GER), a wheel flange fouling bar for the first switch, whilst the second has a wheel tread fouling bar - both in the lowered postion.

However some railways used the “economic facing point lock” e.g. Midland Railway. This allowed the wheel detector, facing point lock and point switch lever to operate from one signal box lever. This made its operation difficult for a signalman because all the components were quite heavy to move at once, but saved on the need to extend an existing lever frame, so these were only practical if the point switch was located near to the signal cabin.

- See Figure 13 for the economic facing point lock

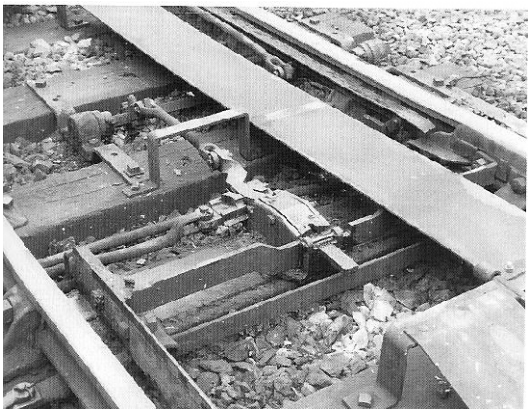

Figure 12. A standard facing point lock with the cover removed, the locking bar connected by a vertical crank. Note the detectorconnections fitted to the switch blade and lock.

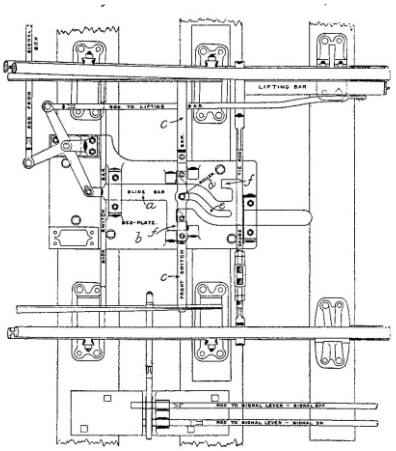

Figure 13. The Midland Railway economic facing point lock

6. Bolt locks

This is a reduced version of a facing point lock. These lock a point in place without the necessity to prove the point switch was clear of any rolling stock. They may be used on non passenger carrying lines which would include the exits from private sidings or goods yards. These points could be operated by a hand lever by the pointwork, but the bolt lock operated by the signalman, would control its use.

- See Figures 15 and 16 for examples of a bolt lock usually placed centrally between running rails (the “four foot”)

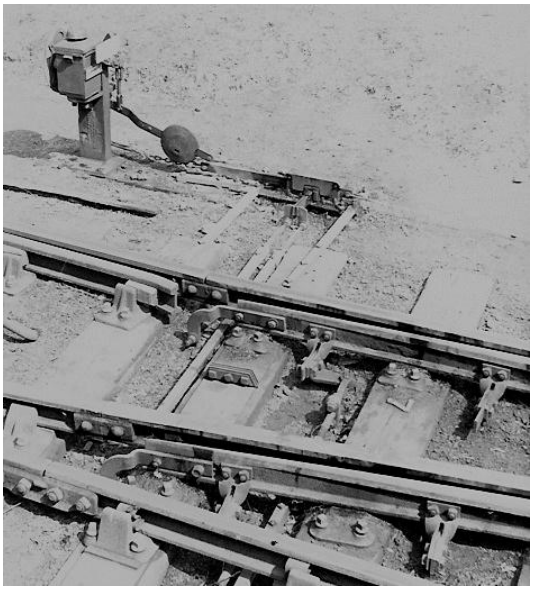

Figure 14. A ground signal whose movement is locked by the selector connected to the point switch.

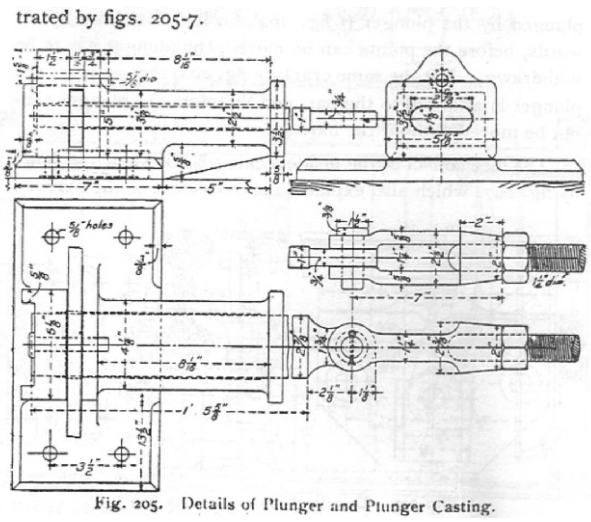

Figure 15. A bolt lock, usually placed in the centre of the "four foot" way.

An alternative method for operation more distant from the signal cabin would be a staff that is given by the signalman to a shunter, as when it is removed from its housing it could be used to unlock a ground lever frame located adjacent to the pointwork (this can be called an Annetts key).

By removing the staff (e.g. Annetts key) from the signal box this would lock the signals and block instruments in the signal cabin that related to the switches to be operated by the ground frame/pointsman.

The textbook arrangments are really just that as some photographs of fittings at Butterley (preservation centre) show.

Figure 16. A bolt lock, on a narrow gauge railway (Leighton Buzzard) is usually placed in the centre of the "four foot" way - uses a more usual design of lock

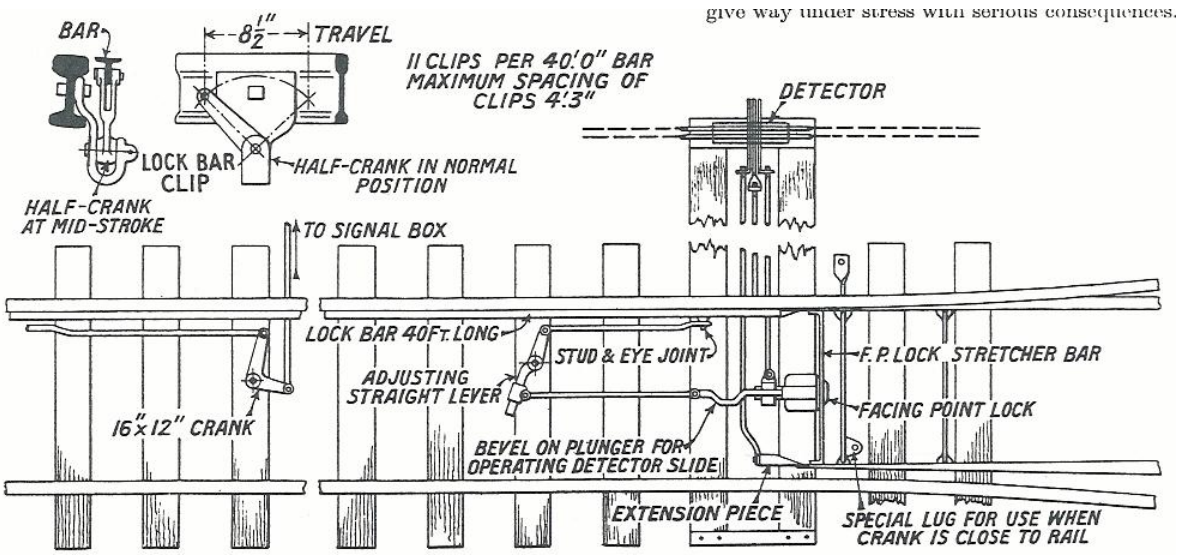

Figure 17. A "standard" Facing Point lock (c1930's), with fouling bar and signal selector. Note the reference to a 40 foot detector.

Figure 16A. A point with three detectors. The point seems to be operated by an "economic lock" entering from the crossing end of the point and with no detector bar. (Taken c.2000 Midland Railway Centre)

Figure 16B. Details on point rodding (channel section), an adjustable crank and signal wire pulley. The pulley is arranged to operate one of two ground signals, determined by the detectors (in Figure 16C) and "floats".

Figure 16C. Stretcher bars, dectectors and operating rods and a narrow cover obscuring the point operating mechanism (taken c.2000) at Midland Railway Centre.

7. Gate Locks
The use of gate locks particularly applies to level crossings. Although many level crossing gates were manually operated, unless it was a remote occupation crossing the gates, both vehicular or pedestrian would be locked in place and open to railway traffic or road traffic by by the signalman. There are a number of versions of how to operate level crossing gates from within a signal cabin. One involves using a “ships rudder” size wheel and spur gear and rack drive and larger than normal cranks superceeded the earlier versions of lever operation from c1880. The use of an alternative “screw thread” drive provided a mechanical advantage required to move heavy wooden gates manually. By 1905 the familiar red disc and lamp warning was required for crossing gates.

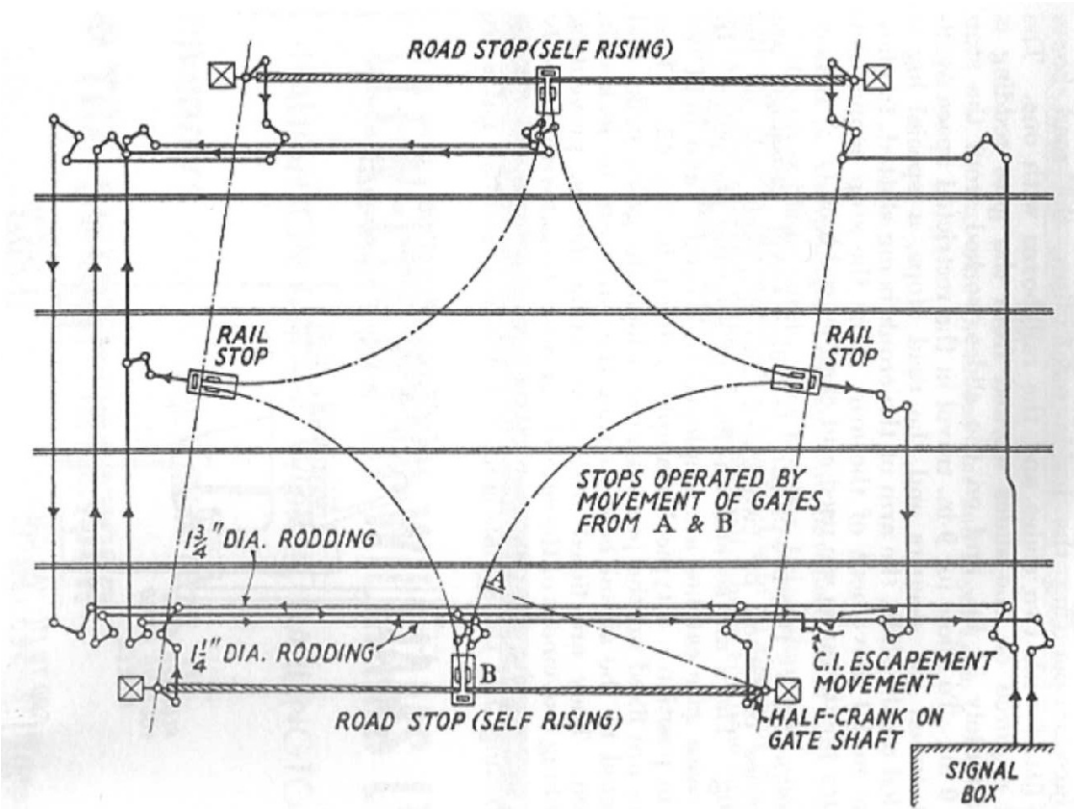

Figure 18. One arrangement for operating a four gate level crossing. Note the gate locks.

- End of Part One

General References

Railway Signal Engineering(Mechanical) LP Lewis - Revised edition 1932, reprinted by P Kay 1995
Mechanical Railway Signalling - H Raynar Wilson - 2nd edition Part 2 1904, reprinted P Kay
Railway Signalling & Communications, lectures of 1946 - reprinted by P Kay
Aspects of Modelling - Signalling, Nigel Digby, Ian Allan 2010, 978 7110 3427 3
A Pictorial Recod of LNWR Signalling, R D Foster, 1982, 86093 147 1
The Great Eastern in Town & Country series (Irwell Press) have a number of photographs showing track occupancy detectors and facing point lock devices.