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MINUTES OF MEETING SCHEDULED FOR FRIDAY 20 MAY 2020, AT THE SURREY HILLS NEIGHBOURHOOD CENTRE, 1 BEDFORD AVENUE, SURREY HILLS, VICTORIA

The SRSV meeting scheduled for Friday 15 May 2020 was cancelled.

This cancellation was due entirely to the restrictions imposed on public gatherings announced by the Victorian Government in response to the COVID-19 (Coronavirus) pandemic.

The next meeting is scheduled for Friday 17 July, 2020 at the Surrey Hills Neighbourhood Centre, Bedford Avenue, Surrey Hill, commencing at 20:00 hours (8.00pm).

SIGNALLING ALTERATIONS

The following alterations were published in WN 16/20 to WN 23/20, and ETRB A circulars. The alterations have been edited to conserve space. Dates in parenthesis are the dates of publication, which may not be the date of the alterations.

14.04.2020 **Tottenham Yard** **(TON 128/20, WN 16)**
On Tuesday, 14.4., Tracks 14 to 20 in the 2nd Classification yard, part of the Common User area, Tottenham East Yard, were booked out of service due to track and turnout condition. The points leading to these roads have been secured to lie for No 3 Road, East Yard.

20.04.2020 **Pakenham East Train Depot** **(SWP 5/20, WN 16)**
On Monday, 20.4., Caulfield Group Operating Procedure 21 (Pakenham East Depot) was reissued. The changes relate to clause 21a (Communications Process).

(21.04.2020) **Swan Hill** **(SW 63/20, WN 16)**
Operating Procedure 124 (Swan Hill) was reissued. SW 114/19 is cancelled.

(21.04.2020) **Cheltenham – Chelsea** **(SW 217/20, WN 16)**
Signalling Diagram 19/20 (Cheltenham – Chelsea) replaced 11/20 due to the closure of Cheltenham and Mentone stations (see SW 149/20).

21.04.2020 **Kananook** **(SW 203/20, WN 16)**
On Tuesday, 21.4., the Kananook bypass track was booked out of service.

Points 637 and 622 leading to the bypass track were secured normal. Baulks were provided at Homes KAN737 and KAN722. Derails 637 and 622 were electrically isolated. The theatre indicators on Homes KAN706 and KAN753 were electrically isolated.

Home KAN726 was provided with TPWS(OSS).

(Front cover). The interlocked gates at Lydiard Street, Ballarat, were spectacularly demolished just after 2330 on the night of Saturday, 30 May, by a runaway VLocity. The VLocity forming the 2216 Southern Cross – Wendouree service, reportedly suffered a transmission failure descending Warrenheip bank, with leaking oil destroying adhesion. The speed through Ballarat was reported to be 97 km/h, and the VLocity ran as far as the Doveton Street level crossing before stopping. From a human perspective, the accident was fortunately a light one – the driver and one passenger were injured and required hospitalisation. From a signalling perspective, the accident was unfortunate as the two Down side gates and gate posts were destroyed. The destroyed parts would not be easily replaced. One of the destroyed gate posts is shown in January 2013. Photo Andrew Waugh

The interlocking, FEP and Railview data was updated to support the commissioning of the Kananook Sidings.

25.04.2020 **South Dynon** **(TON 143/20, WN 17)**

On Saturday, 25.4., the Up end access to the standard gauge Passenger Car Sidings was secured to lie for the dual gauge road due to derailment damage to hand points VL06 and VL07. Track closure devices have been installed at the Up end of the Passenger Car sidings. The sidings remain accessible from the Down end.

01.05.2020 **Wendouree** **(SW 65/20, WN 17)**

Between Tuesday, 28.4., and Friday 1.5., Up Home 102 was relocated 10 metres in the Down direction.

Diagram 62/19 (Wendouree – Ballarat) replaced 66/17.

04.05.2020 **Moorabbin** **(SW 237/20, WN 17)**

Between Friday, 1.5., and Monday, 4.5., the point machines on Crossover 603 were upgraded to clamp lock SPX Mk3 type.

(05.05.2020) **Book of Rules** **(WN 18)**

Revision 7 of the 1994 Book of Rules and Operating Procedures is planned to come into effect on 1.7.20. This revision will include the:

- Inclusion of content from permanent circulars
- Deletion of rules relating to obsolete infrastructure and practices
- Standardisation of terminology to accord with current practice.
- Retention of existing section, rule, and clause numbers

This revision will not require changes to operational practices or training.

(05.05.2020) **Wyndham Vale** **(SW 68/20, WN 18)**

Diagram 20/20 (Wyndham Vale) replaced 80/19 as in service.

(05.05.2020) **Corio – North Shore** **(SW 66/20, WN 18)**

Diagram 12/20 (Corio – North Shore) replaced 76/19 as in service.

(05.05.2020) **Ararat** **(SW 67/20, WN 18)**

A new Stabling Siding (No 2 Road) was provided. The new siding leads from the existing stabling siding (which has been renamed 'No 1 Road') and is located on the Down side of the existing siding. The points leading to the new siding are worked by a WSa lever. Both sidings have a clear length of 81 metres.

The new siding is currently booked out of service and the points are secured to lie for the existing siding.

Diagram 2/20 (Ararat) replaced 26/19.

07.05.2020 **Kananook** **(SW204 /20, WN 17)**

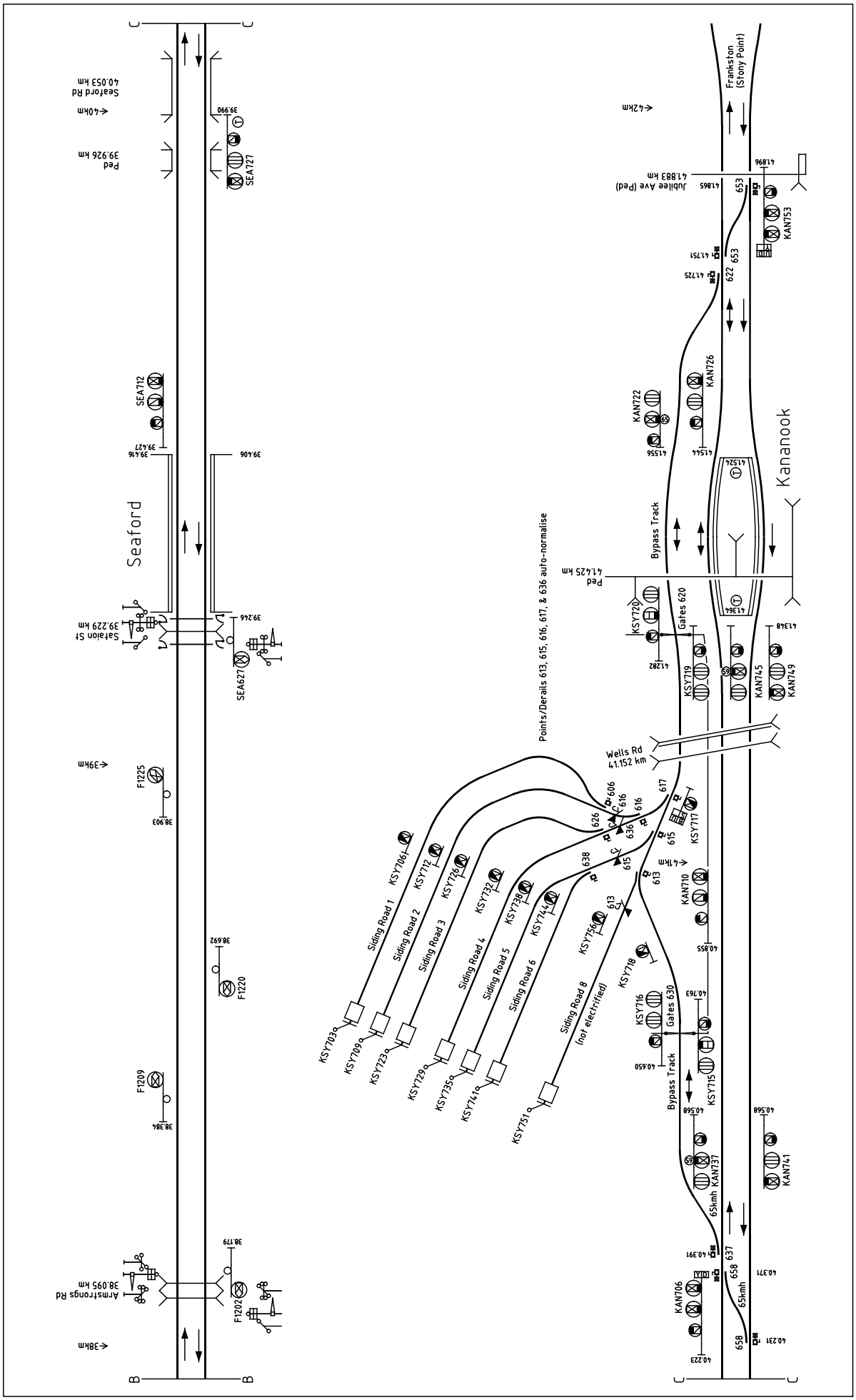
On Thursday, 7.5., the Stabling Sidings were provided. There are six Stabling Sidings (Nos 1 – 6), each 189 metres in clear and holding one 6 car EMU. There is also an unwired seventh siding (No 8), 183 metres clear, for stabling non-electrified vehicles.

The following signal alterations took place:

- Homes KAN706 & KAN753 will now display a Medium Speed Warning indication for movements towards the Bypass Track.
- The route indicator on Home KAN706 was altered to display 'Y' for movements to the Bypass Track and 'D' for movements to the Down line.
- The route indicator on Home KAN753 was altered to display 'Y (Yard), 'D' (Down line), and 'U' (Up line).
- TPWS (TSS) was provided at Homes KAN737 & KAN722. TPWS (OSS) was provided at KAN726.
- Derail/Crowders 622 and 637 were abolished.
- The existing train stabling compound gates KSY620 & KSY630 were replaced by new gates located just over one train length from the outlet Home signals.
- Homes KSY715, KSY716, KSY719, & KSY720 were provided. Dwarfs KSY706, KSY712, KSY717, KSY718, KSY726, KSY732, KSY738, KSY744, & KSY756 were provided.
- Points 606, 613, 615, 616, 617, 626, & 638 were provided. Derail/Crowders 613, 615, 616, & 636 were provided. All points are equipped with Unistar in-bearer point machines, and all Derails/Crowders with electro-hydraulic point machines.
- Axle counters are the primary method of train detection.
- The train stabling location boards in the Bypass track were removed.

Signalling Diagram 21/20 (Bonbeach – Frankston) replaced 5/20.

Caulfield Group Operating Procedure 6e (Kananook Route Indicator for Stabling Sidings') was deleted.


Seaford
Kananook
Frankston (Stony Point)
Seaford Rd 40.053 km
Ped 39.926 km
Station St 39.229 km
Armstrongs Rd 38.095 km
Jubilee Ave (Ped) 41.883 km
Ped 41.425 km
Wells Rd 41.152 km
Bypass Track
Gates 620
Gates 630
Points/Derails 613, 615, 616, 617, & 636 auto-normalise
Siding Road 1
Siding Road 2
Siding Road 3
Siding Road 4
Siding Road 5
Siding Road 6
Siding Road 8 (not electrified)
65kmh
SEA727
SEA712
SEA627
F1225
F1220
F1209
F1202
KAN753
KAN726
KAN722
KAN720
KAN745
KAN749
KAN710
KAN706
KAN741
KAN737
KSY703
KSY706
KSY709
KSY712
KSY723
KSY726
KSY729
KSY732
KSY735
KSY738
KSY741
KSY744
KSY747
KSY751
KSY715
KSY716
KSY717
KSY718
KSY719

(12.05.2020) Ballarat (SW 72/20, WN 19)
The Ballarat Yard tracks on the Up (or North) side of the Independent Track were abolished. These include No 6 Road, No 7 Road, No 8 East, X and Y Tracks, and the Ballarat Goods Yard Nos 4, 5, 6, 7, 8, 9, & 10 Roads. These roads were booked out in TON 187/12.

Hand Points E at the Down end of the Independent Track have been abolished and the track straight railed. These points were booked out on TON 159/18.

Hand Points D at the Up end of the Independent Track remain secured normal (see TON 187/12)

Amend Diagram 98/12.

13.05.2020 Somerton (TON 172/20, WN 20)
On Wednesday, 13.5., No 3 Rd was booked back into service. No 4 Rd remains booked out.

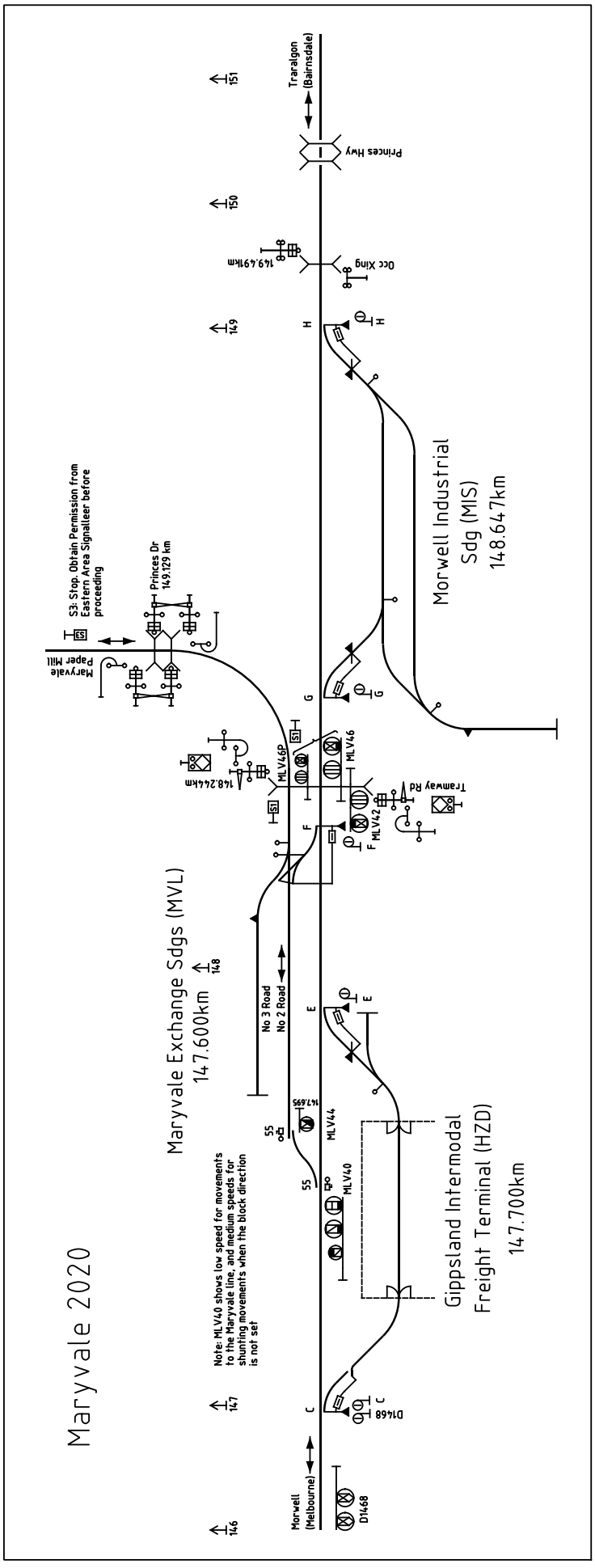
14.05.2020 Mentone (SW 289/20, WN 20)
After the passage of the last train on Thursday, 14.5., Balcombe Rd was closed to road and pedestrian traffic due to grade separation works. The level crossing protection equipment was removed.

16.05.2020 Maryvale Exchange Siding (SW 69/20, WN 19)
On Saturday, 16.5., Automatic D1468 was converted to a Home signal, retaining its number. The TPWS equipment was retained.

17.05.2020 Maryvale Exchange Siding (SW 70/20, WN 19)
Between Saturday, 16.5., and Sunday, 17.5., the points at the Up end of the siding were motorised.

The following signal alterations took place:

- Automatics D1482, D1483, & D1483P were converted to a Homes and renumbered MVL42, MVL46, & MVL46P respectively. The TPWS equipment was retained.
- Down Home MVL40 was provided at 147.631 km. TPWS was provided at this Home.
- Up Dwarf MVL44 was provided at 147.695 km.
- A Stop Board was provided 400 metres on the Down side



of Princess Drive for Up trains from the Maryvale Paper Mill siding. Permission to pass this Stop Board is granted by the Eastern Corridor Signaller.

- The existing hand operated point machines on Crossover D are now motor operated and are numbered Points 55.
- The existing key switch release, Crosslock, the E and F Pattern Annett locks, and the E & F Pattern Annett keys at Points D were abolished.
- Key switches to control Automatics D1482 & D1483 were abolished, as were the associated notice boards.

Operation

- To prevent operation of the Tramway Rd protection equipment by trains for the sidings, Homes MVL42 & MVL46 must be at stop before the train departs from Morwell or Traralgon.
- To operate Crossover 55, or release Points C, E, F, G, or H, for a train on the main line, Homes MVL40, MVL42, and MVL60 must be at stop and the train proved at a stand on the releasing track circuit. For a train originating in any of the sidings, the single line section Morwell – Traralgon must be clear with Homes MWL30 and TRG20 at stop before the points can be reversed.
- If it is necessary for a train to shunt over Tramway Rd, Signals MVL42 or MVL46 must be operated by the Corridor Signaller.

Diagram 4/20 (Morwell – Morwell Industrial Siding) replaced 90/19.

19.05.2020 **Pakenham Maryvale** **(SW 74/20, WN 20)**

The following Operating Procedures were reissued:

- 125 (Pakenham – Traralgon Defective Signals) due to the alterations at Maryvale. SW 13/19 was cancelled.
- 126 (Pakenham – Bunyip – Warragul) due to inclusion of instructions for the operation of Points A at Warragul (see SW 185/06). SW 469/18 was cancelled.
- 127 (Moe – Morwell) due to inclusion of instructions for the operation of Points A & B at Morwell (see SW 185/06). SW 5/20 was cancelled.
- 128 (Maryvale Siding) due to the alterations at Maryvale. SW 5/20 was cancelled.

SW 185/06 was cancelled.

21.06.2020 **North Geelong Yard** **(TON 181/20, WN 21)**

On Thursday, 21.5., the following tracks at North Geelong Yard have been booked out of service due to track condition:

- Nos 23 & 26 Roads
- The extensions of Roads 23, 24, 25, 26 and Sidings E on the Down side of the ladder road
- The lead towards Dwarf GLG88

24.05.2020 **Southland – Parkdale** **(SW 306/20, WN 21)**

At 0130 hours on Sunday, 24.5., an absolute occupation was granted between Moorabbin and Mordialloc for the grade separation works at Park Road, Charman Rd, and Balcombe Rd.

At Cheltenham, Homes 6, 12, & 18 and Automatics 2 & 20 were removed. Points 7 and Crossover 11 were removed. The signal panel was removed. The Park Rd and Charman Rd level crossing protection equipment was removed.

Automatic signals F687, F705, F727, F732, F746, F751, F760, F764, & F769 were removed.

The Balcombe Rd level crossing protection equipment was removed.

The Mitchell St pedestrian crossing and its equipment were removed (the crossing is closed).

25.05.2020 **Epping** **(SW 270/20, WN 20)**

On Monday, 25.5., the point motor on Points 031 was replaced by a Clamp Lock SPX Mk3 type.

25.05.2020 **Northcote – Croxton** **(SW 278/20, WN 20)**

On Monday, 25.5., the boom barrier mechanisms at Beavers Rd were replaced by Western Cullen Hayes mechanisms. The flashing light assemblies were replaced by LEDs.

25.05.2020 **Maryvale** **(SW 77/20, WN 21)**

On Monday, 25.5., alterations were made to the signalling data to correct issues.

(26.05.2020) **Dunolly – Robinvale** **(SW 76/20, WN 21)**

Signalling Diagrams 32/20 (Llanelly – Kurting), 30/20 (Korong Vale Loop – Borung), 26/20 (Boort – Oakvale), 34/20 (Quambatook – Meatian) & 28/20 (Chinkapook – Annuello) replaced 138/11, 140/11, 142/11, 144/11, & 148/11 respectively as in service. The changes included the abolition of the following sidings: Llanelly (SW 87/16), Inglewood (SW 87/16), Oakvale (SW 202/14), Cannie (SW 202/14), Meatian

(SW 202/14), Chillingollah (SW 202/14), & Cocamba (SW 202/14), and the alterations at Manangatang (SW 102/17).

(26.06.2020) Murchison East (SW 79/20 & 80/20, WN 21)

Instructions have been issued for crossing trains in Nos 3 & 4 Roads (a portion of No 2 Road is booked out of service).

The standing room for crossing trains will be 480 metres. Post mounted foul point signs and sleeper fitted CP signs have been provided at the Up end (147.160 km) and Down end (147.640 km) of Nos 1 & 3 Roads. The points at the Up end of No 3 Road are normally secured reverse to lie for No 2 Road and the key for these points is held by the Signaller Murchison East.

The following points have been secured by Track and Civil: the points at each end of No 2 Road to lie for No 3 Road (Up end) and No 4 Road (Down end); the points at the Down end of No 3 Road; and the points leading from the Down end of No 2 Road towards No 4 Road.

The Up end dead extension of No 3 Road is available for use, and the points are now secured by a clip locked by the Signaller.

Loading Grain

A Signaller must be in attendance for the arrival and departure of a grain train at Murchison East, and also for any shunting operations in No 2 Road. The Signaller must remove the point clips from the points in No 4 Road to allow for the required loading and shunting movements.

When a locomotive is assisting with the loading of grain vehicles, it is not necessary for a Signaller to be in attendance. Prior to ceasing duty, the Signaller must secure the points at the Up end of No 3 Road and the Down end of No 4 Road for the dead end extensions. Shunting can then occur in Nos 3 & 4 Roads. The signals must be left at proceed and the Train Controller advised. Through Train Orders can be issued through Murchison East while shunting occurs.

Amend Diagram 80/14 (Nagambie – Toolamba). Operating Procedure 106 (Murchison East) was reissued. SW 62/19 and 69/19 are cancelled.

27.05.2020 Burwood – Ashburton (SW 334/20, WN 22)

On Wednesday, 27.4., circuit alterations took place to disable the Normal Speed Warning aspect on Automatic LA435. The signal will now only display Stop and Clear Normal Speed. Clear Normal Speed will be displayed when Home 4 at Ashburton is at proceed.

29.05.2020 Southern Cross Passenger Yard (SW 71/20, WN 19)

Between Monday, 25.5., and Friday, 29.5., the point machines in Nos 1 to 7 Roads at the Carriage Maintenance Depot will be renewed.

29.05.2020 Pakenham East (SW 337/20, WN 22)

On Friday, 29.5., Points 661 leading to the Wash Road were booked out of service and secured normal.

01.06.2020 Tottenham Yard (TON 191/20, WN 22)

On Monday, 1.6., No 5 East Road was booked out of service due to poor sleeper condition.

03.06.2020 Lal Lal (TON 194/20, WN 22)

On Wednesday, 3.6., the Up end of No 2 Road was booked back into service for stabling track machines after sleeper replacement works. The clear length of the restored track is approximately 500 metres and a baulk was provided at the Down end of this section. The Down end points remain secured normal. TON 17/17 is cancelled.

05.06.2020 Lalor (SW 357/20, WN 23)

On Friday, 5.6., eight electromagnetic latched emergency gates were provided at Paskchke Crescent.

06.06.2020 Ballarat (SW 87/20, WN 23)

On Saturday, 6.6, Lydiard St (118.930 km) was closed to road traffic until further notice. The Down side interlocked gates were removed from service and road barriers provided. The Up side interlocked gates were secured closed across the road. The gate stops were secured in the raised potion. The pedestrian gates were restored to service, as were the audible and visual warning devices.

Amend Diagram 98/12 (Ballarat).

08.06.2020 Carrum (SW 346/20, WN 22)

Between Sunday, 7.6., and Monday 8.6., Automatic F1158 was converted to an intermediate uncontrolled Home signal. The Frankston signaller is responsible for verbally authorising movements passed the signal at stop.

Amend Diagram 21/20 (Bonbeach – Frankston).

End£

THE ORIGINS OF THE AUTOMATIC BLOCK SYSTEM

Andrew Waugh

The previous part of this series examined the response of the State of Massachusetts and the railroads to the rear end collision at Revere in 1871 and the introduction of the Hall and Union automatic block signals in that state. In this section I will look more closely at Thomas S. Hall and his system of automatic block signals. It is possible to trace the development of Hall's system from contemporary descriptions of the system and Hall's practice of obtaining patents for his developments.

Thomas S. Hall

As is common for most ordinary people, not much is known of Thomas Hall's personal life.

Thomas was born on 1 April 1827 in Bartlett, Carroll County, New Hampshire, which even today is a very small village on the eastern side of New Hampshire about two thirds of the way between Boston and the Canadian border. He married Mary E. Page, probably around 1852. Mary was born around June 1827, probably in Vermont. They had at least two children; Alvah W. was born 1 January 1853 in Medford, Massachusetts (now a suburb of Boston), and Joel Elias was born on 24 June 1857. Sadly, Joel died ten days after his birth, and Mary followed him on 13 July 1857, almost certainly due to complications in childbirth. Mary and Joel are buried in Brooklyn, New York, which suggests where the family was living at the time. In later years it was reported that Hall had been a merchant in New York. Thomas married a second time to Sarah Catherine [Tabu?], probably around 1862. They had at least four children: William P. (born around 1863); Mary P. (born around 1865); Henry M. (born around 1866); and Melville P. (born in July 1869). Both Alvah and William were subsequently involved in the US railway signalling industry.

The 1870 census records Thomas' profession as 'RR Agent' and the family at the time was living in Stamford, Connecticut. Stamford is a town on the shores of Long Island Sound, about half way between New York and New Haven. The family's movements over the following two years are unclear. Most of Thomas' patents state that he was living in Stamford in this period, but some state that he was of New Haven or Boston. By 1872 the family had settled in Meriden, Connecticut, which is north of New Haven, about half way to Hartford. West Meriden became the headquarters of the Hall Signal Company. Thomas died on 1 December 1880 aged 53.

The development of Hall's signalling technology

The development of Hall's electric signalling can be traced by the patents issued to him between 1867 and 1875.

An 1874 newspaper report stated that Hall became interested in railway signalling when a train he was on derailed at an open switch. This is possible as Hall's first patent[1], dated[2] 26 February 1867, was for a railroad switch alarm. This was a point detector that caused a bell to ring in the station office if the points were not set for the main line. At this time the standard turnout on US railroads was the stub switch where the two rails were physically moved to align with the main line or the turnout, and no point blades were used[3]. While cheap and easy to fabricate, this style of turnout had a high risk of derailing trains. Trains were absolutely certain to derail if they approached the turnout from the trailing direction with the rails set wrong, and had a high risk of derailing if approaching from the facing direction if the rails were not properly aligned. Beyond the risk of derailment, accidents had certainly occurred (and continued to occur) in the US where the main line switch was left wrong and a main line train was directed at high speed into a siding causing a derailment or a collision with another train. Hall's 1867 detector, however, was not really practical as it consisted of a vertical cylinder buried in the subgrade beneath the toe of the head block.

Hall's patent only discusses providing an alarm in the station office, but the Scientific American of 4 May 1867 described Hall's switch detector and included an engraving[4] of its application, including a signal on the facing side of the switch. However, it was not until April 1869 that Hall patented an electric signal[5] that would be suitable to work with the switch detector. The signal was intended 'for use in connection with draw-bridges and the switches or points of railways, or to indicate the position of gates, doors, or other movable objects'. This signal was the ancestor of the Hall disc signal used for the automatic block system.

The signal itself (Figure 1) consisted of a disc of material mounted on an arm R with a counterweight 'a' at the far end. The counterweight was to reduce the force required to operate the signal and did not bias the signal to the 'on' position. The disc was to be large enough to be readily seen from a moving train, and Hall suggested that it be of glass or other transparent material. The motive power to operate the signal was provided by the solenoid coils D at the base

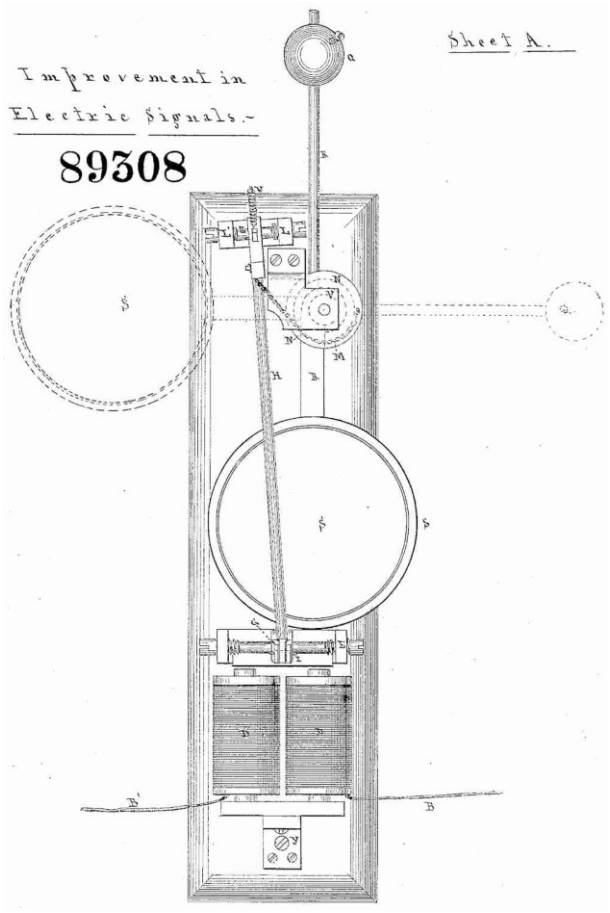
[1] Patent 62414 of 26 February 1867 'Railroad Switch Alarm'

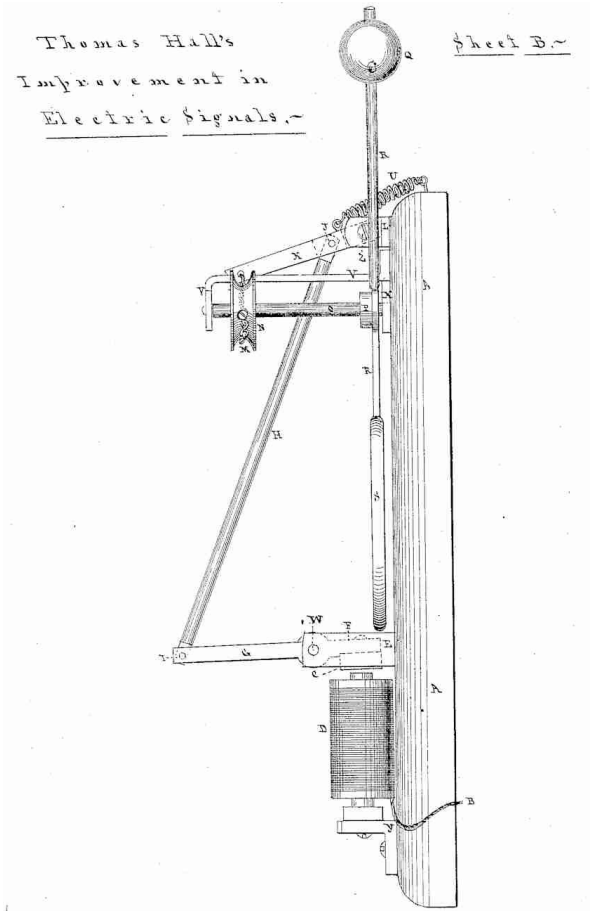
[2] The meaning of patent dates in this period in the US is not clear. Initially, only one date was quoted on the patent and this appears to be the date the inventor signed the patent.

[3] It is quite likely that the continued use of stub switches was the source of the US terminology of 'switch' for a turnout since the defining characteristic of a turnout – whether stub or using point blades – was that it switched trains between tracks.

[4] Reproduced on p146 in 'Trains and Technology, The American Railroad in the Nineteenth Century', Volume 4, Bridges and Tunnels, Signals, by Anthony J. Bianculli, University of Delaware Press, 2003.

[5] Patent 89308 of 27 April 1869, 'Improvement in Electric Signals for Railroads'



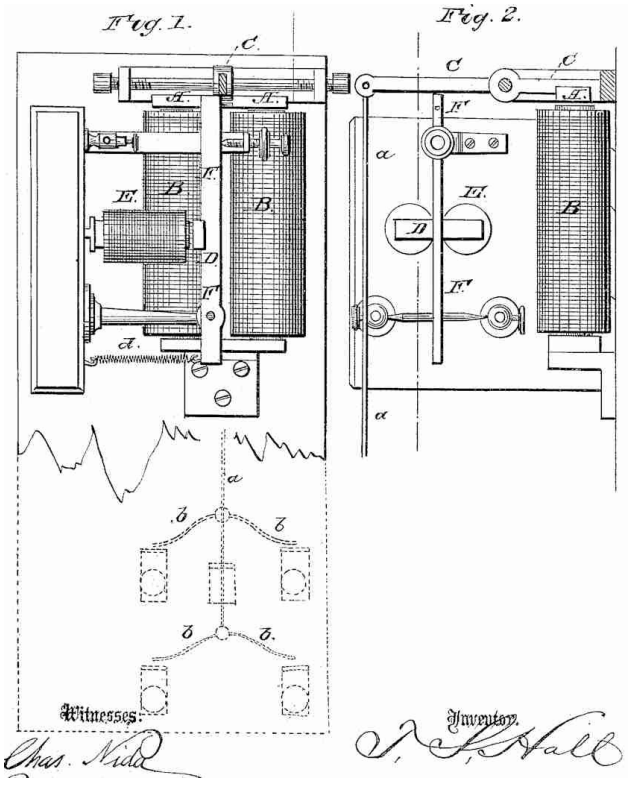


of the signal. The armature 'G' pivoted around W to form a lever, which was connected by rod H to a second lever X. The two levers converted the small movement of the armature to a large movement of the far end of lever X. Chain N was connected to the outer end of lever X, and the other end was wrapped around drum M. Lifting lever X pulled the chain off drum M, rotating the shaft on which it was mounted and lifting the signal. The spring U was provided to cushion the fall of the mechanism when the power was cut off. The patent specifically states that the mechanism was intended to be mounted in a case. The signal mechanism shown in the patent was not fail safe as the target – the red light – was lifted into view and fell clear by gravity.

In June 1869, Hall received two consecutively numbered patents for applications that could drive this signal. The first[1] was for a detector for the lock of a drawbridge, and the second[2] was an improved switch detector. Hall had, presumably, either tried the first switch detector or had had some advice as he noted that the first mechanism was 'below ground, and was therefore difficult of access and subject to injury by water or otherwise'. Neither of the applications were failsafe as in both the current flowed when the signal should show danger.

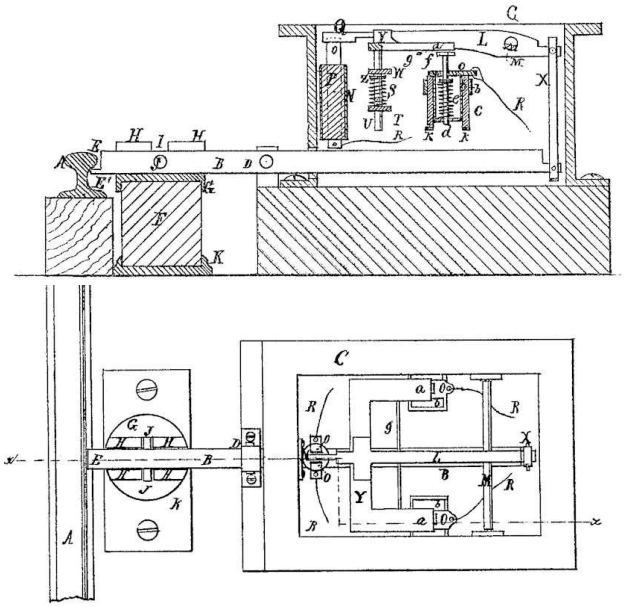
By this time, Hall had set up a company to market his patents as these two patents were assigned to 'Hall's Electric Railway Switch and Drawbridge Signal Company.'

Figure 1 (above). Hall's electric signal of 1869 from Patent 89308. Figure 2 (below). The 1869 mechanically latched relay from Patent 97505.



[1] Patent 90743 of 1 June 1869, 'Connection for Drawbridge Signals'

[2] Patent 90744 of 1 June 1869, 'Connection for Railroad Switch Alarms'



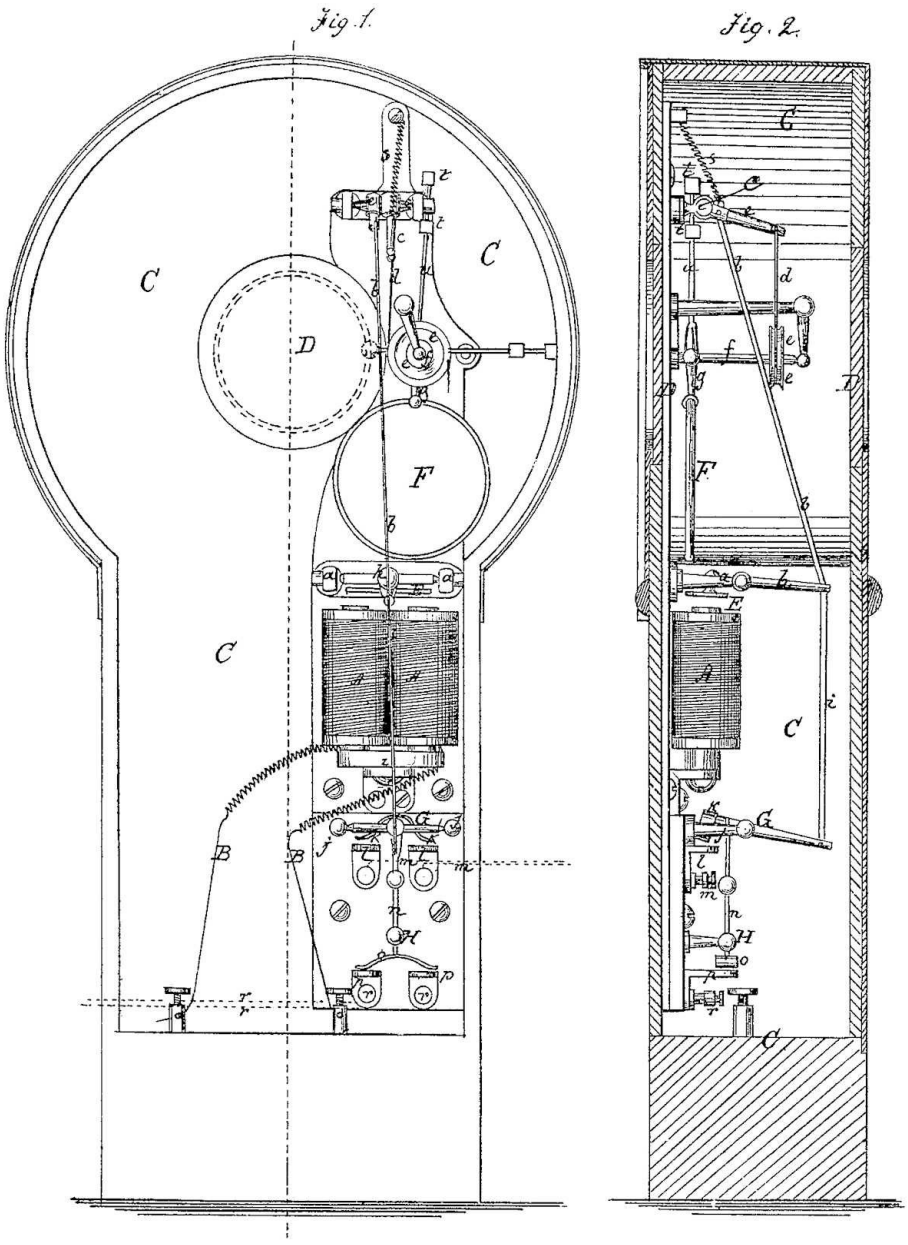


Figure 3 (left). The 1870 treadle from Patent 103174. Figure 4 (below left). The 1870 signal from Patent 103875.

The company had been organised in New Haven, Connecticut.

In December 1869 Hall made another step towards a block signal system, although Hall's goal was apparently a level crossing warning device. The 1869 signal required a continuous current, but a treadle to detect the passage of a train only gave momentary indications when the train was actually passing over it. This patent[1] (Figure 2) described a mechanically latched relay. The relay had two sets of coils. When one coil was energised the relay armature would latch up, and it would stay up until a second coil was energised to withdraw the latch. In Figure 2 the relay is shown latched up with both coils de-energised. If Coils E were now energised, Armature D and lever F would be attracted. The top of lever F would be removed from underneath lever C which would then fall. If Coils B are then energised, lever C is raised and Lever F is then pulled underneath Lever C by Spring d. The two contacts b-b were provided to operate subsidiary circuits. According to the patent, this relay was intended to operate a signal for a 'railroad crossing' (highway crossing) 'to provide a means by which an electric visible or audible signal, operated by a passing train, can be held displayed for a suitable length of time, until the train acts on a different magnet than at first set in motion.'

Although this relay was specifically intended to operate a crossing via some form of treadle, Hall did not patent a treadle until May 1870[2]. Interestingly, although Hall specifically linked this patent to the mechanically latched relay, he did not link it specifically to crossings. Instead, he simply referred to "a passing train will operate the mechanism, and close the electro-magnetic circuits, one or more, by the

[1] Patent 97505 of 7 December 1869 'Improvements in electro-magnetic railroad-signals'

[2] Patent 103174 of 17 May 1870 'Electro-magnetic railway signal'

closing of which the signals are brought into action, and also reversed."

The treadle was mounted outside the rail and operated by the tread of passing wheels which pushed down on lever B, which pivoted on spindle D. This raised rod X which rotated lever L around spindle M – the two levers made the small movement at E into a much larger movement at Q. Sleeve P surrounded two insulated contact fingers which were connected by a wedge driven downwards by lever L to made the circuit. After the wheel passed, the levers were restored to normal and the contact broken, by means of spring F (between the rail and the treadle) and springs S inside the treadle. Spring F was strong and stiff to provide the primary returning force, as well as to prevent the treadle's operation by persons passing along the track. Considerable thought went into the design – the frame for spring F, for example, contained supports to prevent the treadle lever from being moved laterally or traversely by the train. Treadle lever B was prevented from rising too far by the stop E that engaged with the underside of the head of the rail, and further stops were provided with springs S to control the movement of the contact wedge.

Neither this patent, nor any of his subsequent patents, were assigned to the Electric Signal Co.

In June 1870, Hall patented a further improvement to his disc signal (Figure 4)[1]. The actual improvement was minor, but the patent drawings give a good indication of how the rather abstract signal of a year earlier had evolved. An examination of the drawing reveals that the signal and operating mechanism is identical to that of Patent 89308, but more neatly arranged. The drawing also shows the case and the single central window through which the signal is viewed. In operation, the circular portion of the case C provided a visual contrast to the hole D. With the Disc F in the down position, the engineer of the approaching train would see a white circle of daylight through the hole D, contrasting with the darker consistent colour of the case. When operated, the disc F would be raised in front of the hole to colour the daylight – probably red, but this is not stated. The improvement patented was the provision of the two contacts below the operating coils and operated by an extension of the operating rod.

It appears that this technology was actually used. Around 1870 the Hall system was applied to the Harlem drawbridge over the Hudson River used by the Harlem & New York and New Haven railroads.[2] Approach bells were provided to ring a bell in the bridge-tenders' cabin. Distant signals were provided 3000 feet from the drawbridge and mechanical drop signal[3] 1500 feet from the drawbridge. These were interlocked with the bridge bolt to ensure the signals were at danger before the bridge bolt could be withdrawn. It appears that this system was still in use in 1880.

Automatic signalling

Hall's key patent applying to automatic signalling was dated 29 August 1871[4] - just three days after the Revere accident. This patent combined Hall's existing technology – treadles, the mechanically latched relay, and disc signal – to implement an automatic block system which could be used on both single lines and double lines. The patent also described how the same technology could be used to protect trains standing at stations and to provide a warning signal for road crossings.

Hall apparently primarily envisaged the system would be applied to single lines. The line would be divided into blocks with a signal at each end of the block. Two treadles would be provided at each end of the block. At each end the first treadle on entering the block cleared the signal, and the second placed it at danger (this meant that the last treadle operated by a train entering the block placed the signals at danger, and the last treadle leaving the block placed them at clear). The impulses generated by these treadles were fed by line wires back to the signal at one end of the block which acted as a controlling signal. The signal at the other end of the block simply repeated the aspect displayed by the controlling signal.

The arrangement for a double track line was almost identical to that proposed for a single line, even down to the repeating signal provided at the exit of the section. The main difference was that only two treadles were provided; one to put the signals 'on' at the entrance to the section and a second to restore them to 'off' at the exit. The patent is silent about the purpose of the repeating signal at the exit of the block on a double line, but, as we shall see the actual installations used this repeating signal for a different purpose.

Figure 5 is a drawing of the controlling signal. The signal drive itself was unchanged from that shown in June 1870, and a mechanical latching relay was provided in the middle of the case to operate the signal drive. Wires 11, 12, & 13 led to the treadles; and wires 14 & 15 to the repeating signal. It will be noted that the repeating signal was driven off a second contact of the mechanical latching relay, not directly from a contact of the signal mechanism. A trembling bell was provided in the signal case and was driven from a contact worked by the signal mechanism when the signal was at danger.

The mechanism of the repeating signal was much simpler than that of the controlling signal as it was continuously driven from the latching relay in the controlling signal.

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[1] Patent 103875 of 7 June 1870, 'Electromagnetic signal apparatus for railroads'

[2] Letter from Thomas Hall to the Railroad Gazette 16 January 1880 p27. It appears that this drawbridge was the lift bridge over the Harlem River on the approach to Grand Central station. The bridge was constructed in 1841 with four 90 foot box truss spans; three being iron and one wooden swing span. In 1867 the wood drawbridge was replaced by an iron one. This bridge was replaced by a new drawbridge at a higher level in the early 1890s.

[3] This was a large wooden barrier that dropped foul of the loading gauge when at danger. If the engineer ignored the distant, the drop signal would hit the locomotive chimney. Hall patented this signal - Patent 113425 of 4 April 1871, 'Improvement in railway-bridge signal apparatus'

[4] Patent 118606 of 29 August 1871, 'Improvement in electro-magnetic signal apparatus for railroads'

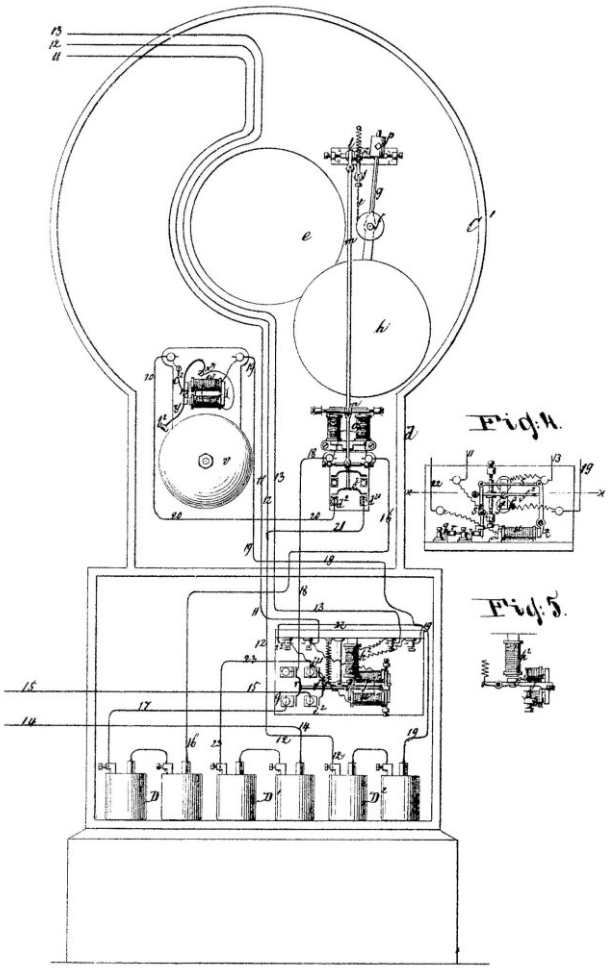


Figure 5 (above). The 1871 signal from Patent 118606.

The patent proposed using the signals to protect trains at stations. An electric signal would be placed around half a mile on each side of the station. An arriving train would place the signal it passed at danger, and the signal would be cleared as the train departed from the station. In this case the trembling bells would be placed on the station buildings to give a warning to passengers and employees that the train was approaching. This would, of course, have protected the accommodation train at Revere even the line as a whole was not equipped with automatic block signalling. Manual control of the signals was also provided by means of a contact box that provided impulses to place the signals on or off.

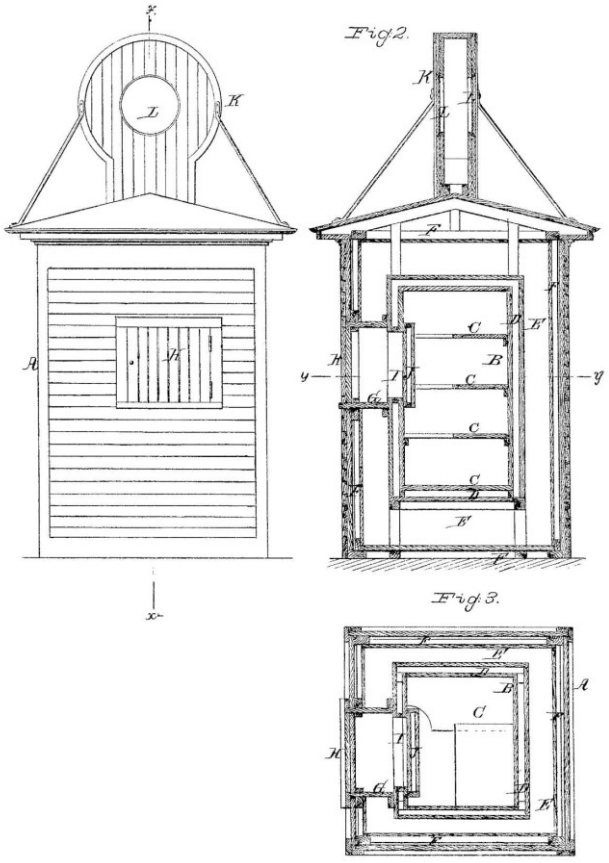
The final application proposed in the patent was the control of warning bells at level crossings. This had no railway signals, instead a single electric signal was provided at the crossing facing road traffic. The disc that appeared when the signal was on had the word 'STOP' on it. At a level crossing on a single track line the electric signal at the crossing was identical to that proposed for the automatic block signalling system, including the alarm bell. Two treadles (an 'on' and an 'off' treadle) were provided on each approach to the crossing, and a fifth ('off' treadle) was provided at the crossing. As the train approached the crossing it depressed the 'on' treadle to start the bell ringing at the crossing and display the signal, and the 'off' treadle at the crossing to stop it. As the train moved away from the crossing it would encounter the approach treadles for the opposing direction. These would not cause the crossing to operate as the train would pass over the 'off' treadle shortly after passing over the 'on' treadle.

Double track level crossings were both simpler and more complex. They had only a single pair of treadles on each line – the 'on' treadle at the approach distance, and the 'off' treadle opposite the signal at the crossing (no attempt was made to ensure that the 'off' treadle was on the departure side of the crossing). On the other hand, Hall recognised that two trains could be approaching the crossing at one time, and the alarm must not stop until the second train entered the crossing. The solution was a separate mechanically latched relay for each direction with the signal and the alarm operating if either of the relays was 'on'.

Trials and tribulations

By December 1871 Hall's mind was turning to the practicalities of installing an automatic signalling system. At that time he patented a small 'electro-magnetic signal-house' (Figure 6)[1]. The two problems Hall was trying to solve with this small building were the freezing of the batteries in winter, and the protection of the signal

Figure 6 (below). The 1871 'electromagnetic signal house' from Patent 121870.



[1] Patent 121,870 of 12 December 1871 "Improvement in electro-magnetic signal-houses'

mechanism. The batteries used were gravity batteries (zinc and copper electrodes in a copper sulphate solution), which would cease working if the electrolyte froze[1]. Hall's solution was a small building with a sealed chamber (air gap) around the battery chamber. The signal head was mounted at the peak of the roof, and the patent specifically mentioned the provision of glass in the front and rear openings L to protect the signal mechanism.

This patent shows that Hall was attempting to solve the practical problems of installing automatic signals in the New England winter. The date of the patent would suggest this was the result of practical experience with the operation of the system, implying a trial installation.

The contract to install automatic block signals on the Eastern Railroad was probably granted around mid 1872. By late December 1872 it appears that it was clear to Hall that the signal houses, if tried, were not sufficient to stop the batteries freezing. Around 21 December 1872[2], Hall came to the conclusion that it would be possible to concentrate the batteries in the station buildings (where they would be kept warm) and distribute the power to the signal locations by a transmission line. Alvah returned to Meriden from Boston and he and other employees made a working model of the proposed centralised battery system. At this time the Hall company was actively installing the automatic signals on the Eastern Railroad using batteries at each signal location.

Early in January 1873[3] Hall described the new plan to the manager of the Eastern Railroad, who agreed that it might be placed on the road in lieu of the original proposal, but that it would be at Hall's expense if the central battery idea did not work. About 20 January 1873, Hall telegraphed to George H. Snow, his assistant, to stop work on the Eastern Railroad installation and return to Meriden. Snow then worked on the signals and instruments (treadles) the new plan required until the autumn of 1873.

In the later part of April, 1873, a new design of treadle was placed on the Down track of the Hartford & New Haven Railroad at Meriden, and a line of telegraph poles extended to the shop about 10 chains away. The new system was successfully tried. In December 1873, after the new treadles were finished, Snow returned to the Eastern Railroad to put the new system in operation.

Unfortunately, a new problem then arose with the central battery system. The relays were designed for operation from local batteries. The solenoids were electrically inefficient, having only a few turns of 'coarse' wire, and required a relatively large current to operate. If the battery voltage was increased to drive the furthest relays through the resistance of the power transmission wire, the nearer relays received a high voltage and resulting current. The high current caused arcing across the relay contact points. Hall and Snow solved this problem in an ingenious way[4]. As originally installed, the central battery system used a metallic return. This return was disconnected from the battery at the station and grounded at the far end. The battery terminal was also grounded to form an earth return. The result was that the power for all the relays, near or far, passed through the entire length of the line wire and the earth return. The resistance was consequently the same for all the relays and the current at each was reduced to a safe value. The circuits were adjusted to operate in this way on 14 February 1874.

At least one other improvement was necessary before successful operation was achieved – a better treadle than Hall's 1870 design. The new treadle was developed by May 1873 and patented by Hall's assistant – George H. Snow – in October 1873[5]. The key feature of this new treadle was a pneumatic dashpot to slow the operation and reduce the force. This treadle was so good that it was still offered, almost unchanged, in the 1901 Hall catalogue. Like the previous treadle this was operated by a lever L depressed by the outside of the wheel tread. There were two springs to control the lever, one above the lever R to prevent inadvertent operation, and the second below the lever (r) to provide a cushion when it fell back. The vertical column contained a piston P in a cylinder K with a rod p that extended downwards to rest on the operating lever and upwards to the contact chamber. The piston rod was not coupled to the lever and when the lever was operated it propelled the loose rod and piston upwards. The cylinder walls contained an air passageway. This led from a hole q in the upper portion of the cylinder (near to, but not at, the top of the cylinder), through the valve s at the top of the cylinder, and down the passage o to an exit at the bottom of the cylinder. When the piston was impelled upwards, air passed freely from the upper side of the piston through the

[1] The copper sulphate would lower the freezing point of the water, but would not stop it freezing. As ice is denser than the solution, it would sink as it formed and would insulate the zinc.

[2] Most of the detail in this section comes from the judgements in a patent case brought by the Electric Railroad Signal Co (Union Switch & Signal) against the Hall Railroad Signal Co for infringing Frank L. Pope's patent No 140,536 of 1 July 1873. This patent covered the use of a central battery to work multiple signals along the line. In 1872 Pope and Hendrickson were attempting to introduce electric signals on various roads, and in the summer and fall were employed on the PRR. Pope had the idea of operating all the signals by means of a single battery just prior to 6 November 1872, but did nothing until 25 April 1873 when he prepared the patent application which was filed on 15 May 1873. The system described in the patent, however, was never used. The first judgement, in the Circuit Court of Connecticut (6 F 603), and given on 5 April 1881, dismissed the case as, while both inventors had had the idea at roughly the same time, and Pope had patented first, Pope had not attempted to produce a workable system while Hall had succeeded in doing so. The case was appealed to the Supreme Court (114 US 87) and in a judgement on 30 March 1885 it was decided that Hall had not infringed Pope's patent. This time it was decided that Hall's scheme, while it used a central battery, was sufficiently different to Pope's scheme so as not be covered by Pope's patent.

[3] The Board of Commissioners noted in its report of January 1873 that a system of electric signals had been installed on the Eastern Railroad, presumably a trial.

[4] Patent 165,570 signed 15 June 1875, filed 23 June 1875, and granted 13 July 1875. "Improvements in circuit for electric signal"

[5] Patent 143,935 filed 24 May 1873, granted 21 October 1873, "Improvement in circuit-closers for railroad signals". It is an interesting commentary on Thomas Hall that he allowed his employee, Snow, to patent his own invention. It was common for employers to claim the inventions of their employees – Edison being a well known example.

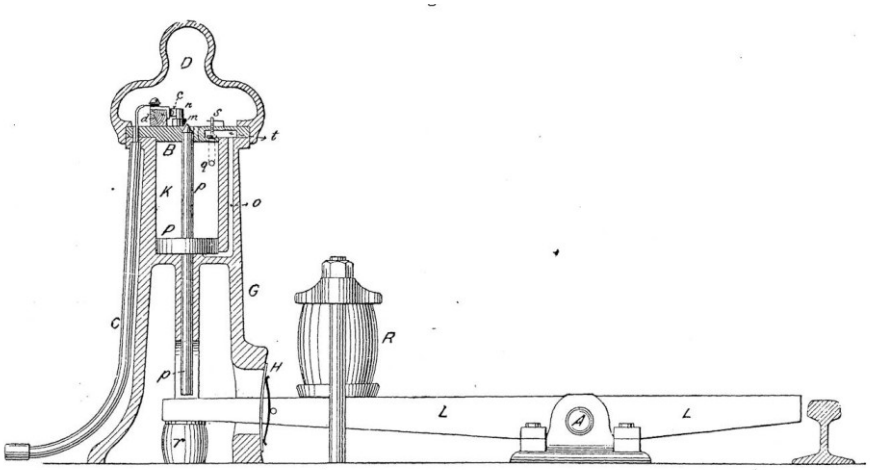


Fig. 4.

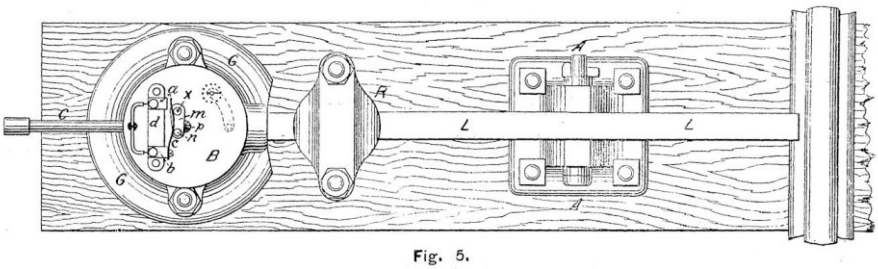


Fig. 5.

Figure 7 (above) Snow's 1873 treadle (Patent 143935). This illustration is from the Railroad Gazette of 31 October 1879, but is essentially identical to the patent drawing. Figure 8 (below) Arrangement of apparatus and circuits in Patent 150,030 of December 1873.

passageway to the lower side of the piston until the piston passed the hole q. The remaining air in the cylinder was then compressed and formed a buffer to prevent the piston from striking the top of the cylinder. When the piston began to fall, return of the air back to the top of the piston was restricted by valve s, causing the piston fell slowly. A mark of the sophistication of the design was that this valve could be adjusted to control the speed of descent. The electrical contact was in the chamber at the top. The top of the piston rod was pointed and, immediately the rod began to rise, it pushed aside lever m which closed the contact spring. The contact would remain closed until the rod had fallen back to its lowest position. The decorative cap on top of the treadle pillar unscrewed and provided access to the contact and the air return valve.

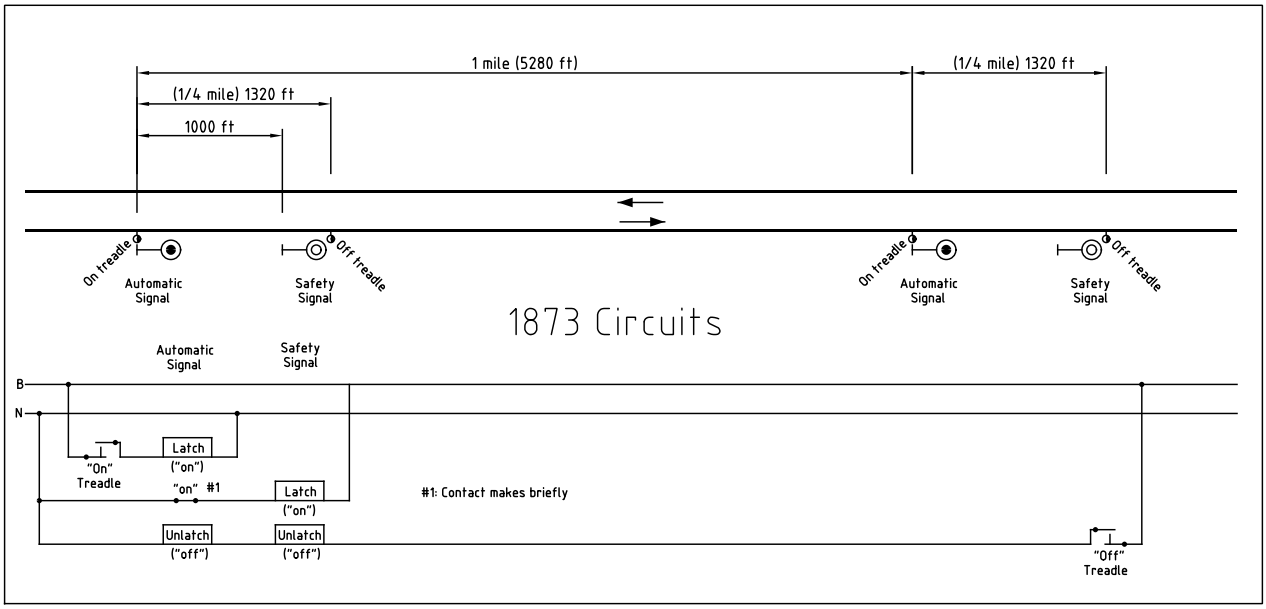
Sometime in 1873 Hall's 'Electric Railway Signal Co' was reorganised as the 'Hall Railway Signal Co' under a Connecticut charter. This was reportedly to distinguish the company from the 'Electric Railroad Signal Co' of New York[1].

The installed system

Hall obtained a new patent on electric signalling in December 1873[2]. Comparing the patent with an August 1874 newspaper report[3] of the installation on the Eastern Railroad suggests that the patent describes the system as actually installed.

Figure 8 shows the arrangement of the signals, treadles, and circuits on one line of a double track railway. Modern circuit symbols have been used to aid comprehension.

The basic arrangement was as a modern reader would expect. The block sections were one mile long with an automatic signal (referred to as the 'danger signal' in the



[1] Railroad Gazette 22 April 1881 p219

[2] Patent 150,030, filed 31 December 1873, granted 21 April 1874 "Improvements in Electric Railway-Signal Apparatus"

[3] Boston Advertiser 10.8.1874, reprinted in the Railroad Gazette, 29.8.1874 p340

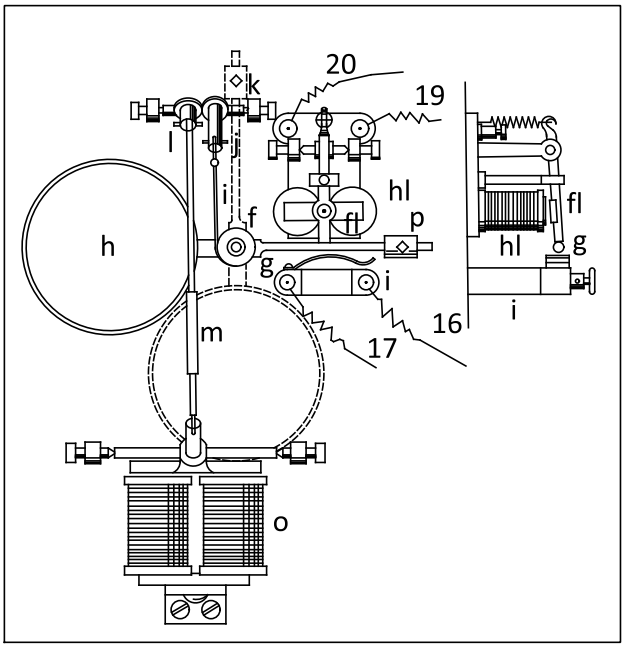


Figure 9. The mechanism of the 1873 patent signal applied to an automatic signal.

patent) at the entrance to each block. The automatic signal showed red when the signal was on and white when it was off. The treadle to place the automatic signal 'on' was adjacent to the signal. The 'off' treadle (or 'letting down machine' in the patent) for a section was located about a quarter of a mile (1320 feet) beyond the next automatic signal. Since the treadles were operated by the first wheel of the train, this quarter of a mile distance ensured that the train was well past the protecting automatic signal before the signal in the rear was cleared.

The most unusual feature to modern eyes was the second 'safety' signal provided 1000 feet in advance of each automatic signal and situated where it could be seen from the automatic signal. The safety signal normally showed a red light[1]. As an approaching train passed the automatic signal and that signal went to danger, the automatic signal would change from red to white. The purpose of the safety signal was to manage the risk of the signalling system failing to operate; in particular the risk of the automatic signal failing to go to danger to protect the train. The technology was primitive and not as reliable as modern signalling, and, of course, the system was not failsafe. It should also be remembered that the engineer of a train could not see the automatic signal go to danger due to the construction of the Hall disk signal – there was no visibility of the aspect from the side or from the rear. If the engineer saw the safety signal change aspect he would know that the automatic signal had correctly gone to danger to protect his train. Further, if the safety signal was showing white when the train approached, the engineer would know that the system had not correctly responded when the previous train had left the section.

No distant signals were provided; trains were expected to be able to stop within the sighting distance of the automatic signal. Distant signals, at the time, were most uncommon in the US[2].

The major new feature of the December 1873 patent was a redesign of the signals. The signal drive mechanism was unchanged – a set of coils attracted an armature which moved a counterweighted disk. One innovation was the provision of a shock absorber in the drive rod between the armature and signal disk. Experience had shown that the rapid movement of the armature when it was attracted by the coils caused the mechanism to rebound which 'disturbed its correct operation', and the sudden motion cause the mechanism to wear rapidly.

A second change to the design was to eliminate the mechanical latching relay. Instead, the mechanical latch and coils were combined with signal drive.

In the automatic signal (Figure 9), the signal disc continued to be raised to the on position and it was now latched in that position. The mechanical latch directly operated on the counterweight tail of the signal disc. A contact was provided that was made briefly as the signal disc was raised to the 'on' position before falling back slightly to be held by the latch. By 1873 the disc was definitely made of cloth.

The basic mechanism of the safety signal was similar to an automatic signal, however, it was arranged differently as the signal disc was normally displayed. Operation of the signal raised and latched the disk clear of the opening. Unlatching caused the signal disk to drop back in front of the opening. In the case of the safety signal the mechanical latch was directly applied to the operating armature. It is not clear why two different latch mechanisms were used in the two types of signal.

The circuits that the controlled the signals were quite simple (figure 8). Operation of the 'on' treadle energised the operating coils of the automatic signal and raised the disk to show 'danger' where it was mechanically latched. As it was raised, the contact operated by the lever tail was briefly made, and this energised the operating coils of the safety signal. This raised the safety signal disc clear of the opening and latched it. When the train passed over the 'off' treadle after it left the block, this operated the unlatching coils of both the safety and automatic signal controlling the entrance to the section. Gravity then caused the signal discs to fall back – in the case of the automatic signal the signal disc fell clear of the opening to show clear, and in the case of the safety signal, the signal disc fell in front of the opening to show a coloured light. Four line wires were required: two power wires, and a line wire for each direction connecting the 'off' treadle with the signals at the entrance to the block.

The central battery stations were at Chelsea (working the line between Boston and Lynn), and Salem (working the line between Lynn and Beverly). Another improvement

[1] In subsequent installations this was changed to a blue light when on.

[2] There was nothing unusual about this, distant signals were virtually unknown in US practice at this time. For example, the PRR had no distant signals whatsoever on its lines at this time, including at its manual block posts.

was the provision of lightning arresters as it was found that lightning would sometimes burn out the electric coils.

In addition to the automatic block signals, the system as provided could be controlled by the station staff. Approach bells were provided at stations to signal the approach of trains. The staff could restore signals using local controls to control the arrival of trains. At Salem, for example, the station staff could use the manual controls to control the working of trains through the single line tunnel and junction to the north of the tunnel. At Revere, a train arriving on the main line automatically set the arrival signal for the branch at stop (and vice versa) until the train passed the next signal a mile in advance. In addition, if the junction switch was set incorrectly it was protected by danger signals a mile away on either side. At Everett a highway crossing was provided with a bell to warn the flagman to close the gates.

(To be continued)

More on Chelsea

Ray Layton

Down Home Post 4 The photo on the left dates from January 2006 and shows how living by the sea has caused corrosion. By the time replacement became necessary this post was in quite a badly corroded condition. The replacement post, on the right, was installed on the weekend of 4th to 6th July 2015. The rusty original Post has been fully replaced by a new galvanized one, complete with occ health and safety approved ladder and platforms for maintenance. The replacement post is fully kitted out with LED A, B, and C heads plus a LED letter A. This seems an expensive way to replace the original given the crossover had long gone and the Panel switched out. Probably an easy way out by not having to alter the existing circuitry in the relay cabin. While that will become irrelevant with the works upcoming, one has to ask with Post 18 likely to need replacing also why this option was chosen rather than do the rewire and remove the panel and home signals at each end replacing them with autos as was proposed at some stage.

When the Mechanical signalling at Chelsea was replaced by power signalling, there was still a trailing crossover at the Down end and also a goods siding that serviced the local firewood and briquette merchant.

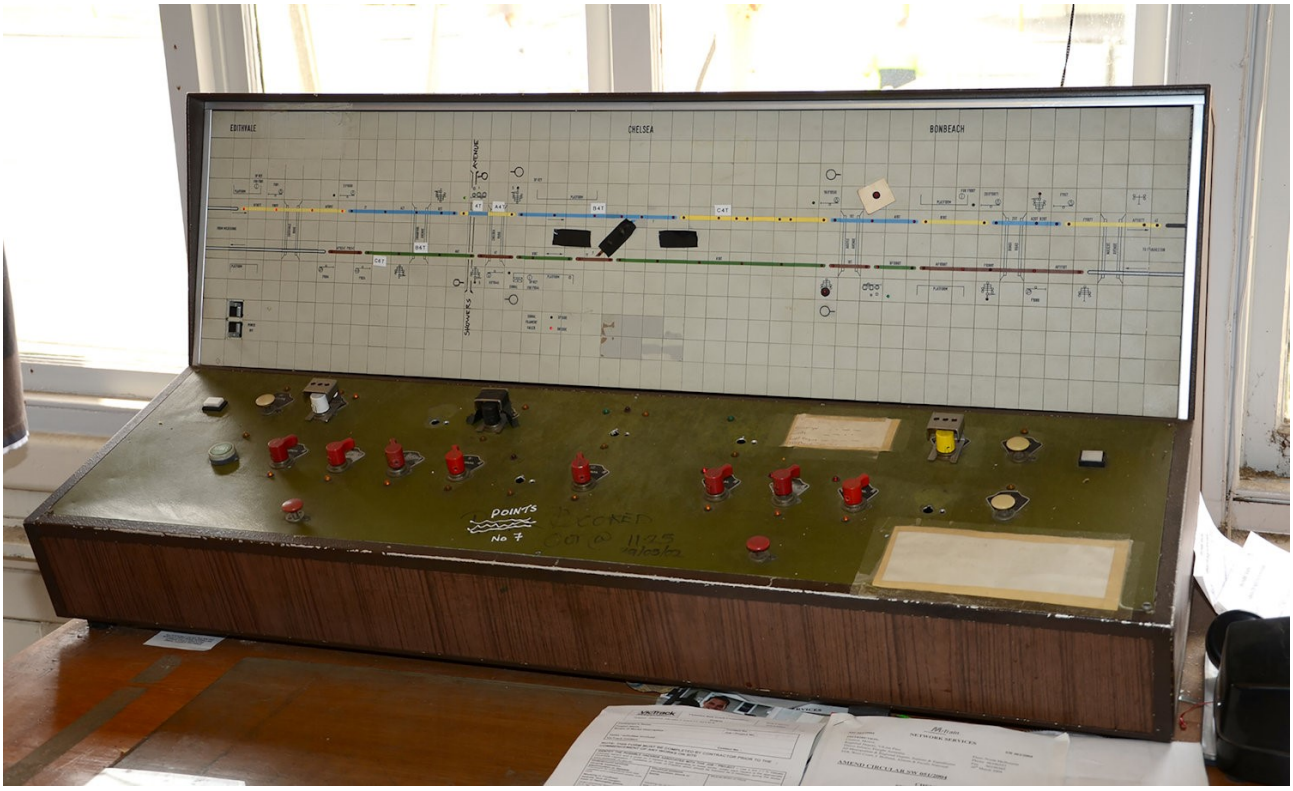
The goods siding, including the switch locked connection at the Down end of the siding to the Down line, was subsequently removed. At the Up end of the siding no changes to the main line connections was done initially. Sometime later, the single compound was changed to a simple turnout to form a trailing main line crossover.

The upper view, from January 2006, shows the crossover spiked out of use using fishplates, together with the two aspect Dwarf signals.

Note the Clearance Notch in the Platform coping. This notch is in the Post electrification section of the platform face - later on during the 1970's the platform was extended further in the Down direction as part of the suburban platform extensions project for 8 car trains.

The lower view, taken 30 April 2007, shows the crossover has been removed along with Dwarfs 8 and 12. The overhead remained intact in place until fairly recently when major renewals of structures took place.

The notch for clearance is still there and remains to this day.



(Above) The Chelsea Panel had long since been permanently switched out on the occasion of the SRSV box tour on 17 September 2011. A few bits of black gaffer tape have been used to amend the panel, although note the siding has been properly removed. Mosaic panels were only provided in Victoria during the resignalling of the Frankston line beyond Mordialloc. Chelsea panel was provided on 19 December 1976, and initially worked in conjunction with the interlocked gates which remained worked by a portion of the former mechanical frame. The interlocked gates were not replaced by boom barriers until 9 April 1978. At first the boom barriers were manually controlled from the panel; the manual control was not removed until 24 October 1982. (Below) The signal bay at Chelsea was provided on 21 May 1924 in conjunction with the provision of interlocked gates at the level crossing. The large number of windows provided to give the signalman a good view of the crossing will be noted. The signal bay still contains the panel today. (All photos by Ray Layton, except the photo below which is by Andrew Waugh)