# SOMERSAULT

MARCH 2021
VOL 44, NO 2

SIGNALLING RECORD SOCIETY OF VICTORIA

# SOCIETY CONTACT INFORMATION

Published by the Signalling Record Society Victoria Inc (A0024029F)

EDITOR: Andrew Waugh, 28 Amelia St McKinnon, VIC, 3204
Phone (03) 9578 2867 (AH), (03) 9348 5724 (BH), email andrew.waugh@gmail.com
PRESIDENT: David Langley, P.O. Box 8, Avenel, VIC, 3664, Phone (03) 5796 2337
SECRETARY and MEMBERSHIP OFFICER: Glenn Cumming,
Unit 1/4-6 Keogh St, Burwood, VIC 3125. Phone (03) 9808 0649 (AH)
NSW CONTACT: Bob Taaffe, 63 Hillcrest Rd, Tolmans Hill, TAS, 7007, Phone: (03) 6223 1626
QUEENSLAND CONTACT: Phil Barker
PO Box 326, Samford, QLD, 4520, Phone: 0400 334403, email: signal01@bigpond.net.au


# MINUTES OF 2019 ANNUAL GENERAL MEETING HELD FRIDAY 20 MARCH, 2020, AT THE SURREY HILLS NEIGHBOURHOOD CENTRE, 1 BEDFORD AVENUE, SURREY HILLS, VICTORIA.

Present: – Glenn Cumming, Graeme Dunn, Michael Formaini, Chris Gordon, Judy Gordon, Andrew Gostling, Bill Johnston, David Jones, Keith Lambert, David Langley, Neil Lewis, Andrew McLean, Laurie Savage and Rod Smith.

Apologies: – Jon Churchward, Graeme Cleak, Steven Dunne, David Langberg, Steve Malpass, Phillip Miller, Roo Richards, Colin Rutledge, Brian Sherry, Peter Silva, James Sinclair, David Stosser, Andrew Waugh and Andrew Wheatland.

Visitor: – Floyd Bromley.

The President, Mr. David Langley, took the chair & opened the meeting at 20:06 hours.

Minutes of the March 2019 Annual General Meeting: – Accepted as published. Michael Formaini / Bill Johnston. Carried.

Minutes of the May 2019 Special General Meeting: – Accepted as published. Michael Formaini / Bill Johnston. Carried.

Business Arising: – Nil.

President's Report: – The President, David Langley, presented the President's Report to the meeting.

Some years ago I wrote that the society had achieved few positives but no negatives, meaning steady as she does. Unlike outside my window where nothing had run on the old BG line for over a year. So what has changed; nothing much. The society still progresses positively and the railway outside my window negatively with trains running on the former BG line but slowly. The attention accorded the railway by ARTC is vastly exceeded by the progress the society has made in the intervening time. Our archives room has been developed to the point where it isn't a pile of stuff in boxes anymore and our large format scanner is being progressed towards the time when it will be installed in the room.

"Somersault" continues to be published six times per year and as I wrote this, the March issue for 2020 which is Volume 43 No 2, is by my elbow. Forty-two years of our journal eh? Not a bad effort and largely due to our editor Andrew Waugh. Fortunately for us he has a happy knack of digging up stuff to publish because very little is coming in from the membership.

*(Front cover). One of the recent losses is Coburg signal box. Although closed in 1998, the box and its contents were preserved, only to fall victim to the level crossing removal project. Located immediately adjacent to Munro St, one of the level crossings to be abolished, the box was in the way of one of the viaduct piers and was unceremoniously demolished. The cover photo shows the interior of the box in happier times on the occasion of the SRS Showday tour on 23 August 1997. The brick box was provided on 30 September 1928 with a 51 lever A pattern frame. The frame always had a lot of spaces – at one time 24 – and it is likely that these were provision for a future island platform. In June 1995 the last goods siding had been removed to allow construction of the Up platform. The interlocking was not altered until April 1997 when provision was made for a new trailing crossover, mechanically worked. In this photo, the affected levers can be seen secured using wooden blocks to prevent operation of the catch handles. The crossover was not brought into service until June 1998. The signal box was closed on 18 October 1998. Photo Andrew Waugh*

The tour for 2019 was held on 21st of September, a day when the weather gave us a demonstration of what everyone thinks Melbourne's weather is like. Nonetheless an enjoyable day was had by the attendees including non-Victorians Ken Ashman and Bob Taaffe.

Six meetings were held during the year. The February meeting was at the Diamond Valley Railway where member Bruce McCurry along with Tony Kociuba and Chris King demonstrated the signalling equipment they have there. The remaining five meetings were held at Surrey Hills where the March meeting included the A.G.M., May was a further selection from the Stephen McLean slide collection, July was a screening of some of my black & white scanned images from 50 years ago, September was a presentation by David Langberg and Peter Silva on the scanner project so far, and the November meeting was to have been another screening of the late Stephen McLean's slides but owing to a projector failure it was postponed to a future date.

The society also had a Special General Meeting to discuss and make a decision on the ramifications of the new act of Parliament that required new rules for memberships of clubs and societies like ours.

And so it only remains for me to thank the committee for their tireless work; Bill Johnston Vice President & Syllabus organiser, Glenn Cumming Secretary, Tours Organiser and Membership Secretary, Peter Silva Treasurer, and Colin Rutledge and David Langberg committee persons. Special thanks to David for all his work in the scanner project; getting it to where we are now was no easy task and ably assisted by Peter and Glenn, and the committee when decisions were required but then that is what committees are for. Finally I thank the members for supporting the society and its aims, attending the tours and providing information from the field of signalling alterations that don't make official document or expanding on what is published.

I move the report. David Langley, President. David Langley / Rod Smith. Carried.

Treasurer's Report: – The Treasurer, Peter Silva, presented the Treasurer's Report for the year ended 31 December 2019.

Financially, 2019 was a significant year for the Society for two reasons. One reason is that we returned a loss of $68.02 – the first time the Society has incurred a loss in over 20 years.

The chief factors for the loss were: fees paid for changing the Society Rules; and declining Interest rates.

In response to the loss and ensure we cover the increased charges from Australia Post, the Committee decided to increase the increase the annual membership fee while holding the cost of the optional UK magazine unchanged.

The project to scan the documents is proceeding with the expenditure against the AREA Grant reported in the Equity section of the Balance Sheet. Despite the minor loss, the Society remains in a sound financial position.

The other significant event for the year is that we moved our banking from JB Were to Community Sector Banking. The move was triggered first by JB Were announcing that they were intending to close the product we were using without offering a suitable alternative and then by creating impediments to accessing our funds.

Community Sector Banking (CSB) is a partnership between Bendigo Bank and a number of large not-for-profit organisations. Bendigo Bank provides the platform for the CSB banking services using its business banking products. As a consequence we are able to use on-line banking transactions while still meeting the "2 to sign" requirements of the Society Rules.

Overall, the interactions with CSB have been excellent and the change is one we probably should have made years ago.

Peter provided a detailed explanation of the financial statements.

Neil Lewis / Michael Formaini. Carried.

There were no questions.

Tours Report: – The Tours Officer, Glenn Cumming, presented his report.

I am pleased to report that the SRSV conducted one signal box tour during 2019.

The tour for the year was held on Saturday 21 September 2019.

The locations visited this year were:

Box Hill – control panel, commissioned 1985

Ringwood – screen based equipment, commissioned 2016

Lilydale – control panel, commissioned 1985

Upper Ferntree Gully – control panel, commissioned 1964

The Signallers at each location were friendly and co-operative.

As expected, this tour was well attended and this justified the effort required to arrange this tour. A number of SRSV members travelled from interstate to attend this tour.

Thanks to all members & friends who participated & helped to ensure the success of the tour. A pleasant day out was enjoyed by all.

Special thanks must go to Wayne Bastin and Keith Lambert at Metro Trains Melbourne for allowing the SRSV to visit areas not normally open to the general public. Their assistance is very much appreciated.

The Tours Officer always welcomes suggestions & comments regarding the conduct of SRSV tours, especially ideas for future tours.

Glenn Cumming Tours Officer. Andrew McLean / Michael Formaini. Carried.

Membership Report: – The Membership Officer, Glenn Cumming, tabled the Membership Report.

| Type | 2019 | 2018 | Movement |
|---|---|---|---|
| V | 60 | 61 | – 1 |
| K | 24 | 26 | – 2 |
| N | 2 | 2 | – |
| KL | 2 | 2 | – |
| VH | 3 | 3 | – |
| Total | 91 | 94 | – 3 |

Analysis of Movement

Additions: – Frank Hinde (V), Roo Richards (V)

Non – Renewals: – Mark Bau (V), Brett Cox (V), Ray Gomerski (V)

Transfers: – Darren French (K – V)

Final Departures: – Wilfrid Brook (K), Graham Davis (V).

Glenn Cumming Membership Officer. Bill Johnston / Laurie Savage. Carried.

Editorial Report: – In the absence of the Editor, Andrew Waugh, the Secretary tabled the Editor's Report for 2019.

All six issues of "Somersault" for 2019 were produced during the year, although some ran a little late.

I would particularly like to thank those members who put pen to paper to produce content.

If you have some time at home during the coming year, you might like to use the time scanning, researching, or writing.

The Editor would heartily recommend hathitrust.org for entertaining reading, particularly if you like historical US railroad material.

I would particularly recommend the Railroad Gazette (https://catalog.hathitrust.org/Record/000677833?type%5B%5D=all&lookfor%5B%5D=railroad%20gazette&ft=ft) and its successors Railroad Age Gazette (https://catalog.hathitrust.org/Record/000676685?type%5B%5D=all&lookfor%5B%5D=railroad%20age%20gazette&ft=ft) and Railway Age Gazette (https://catalog.hathitrust.org/Record/000676684?type%5B%5D=all&lookfor%5B%5D=railway%20age%20gazette&ft=ft).

Another interesting site is the UK Railways Archive (http://www.railwaysarchive.co.uk/) which has an enormous collection of scanned accident reports.

I would like to make the traditional request for articles, photographs, diagrams, etc. that can be published in "Somersault". Contributions do need to be related to signalling, though not necessarily just about Victoria.

Andrew Waugh Editor. Glenn Cumming / Andrew Gostling. Carried.

SRSV President David Langley urged all SRSV Members to support "Somersault" and assist the Editor wherever possible.

Archives Report: – The Secretary Glenn Cumming presented a brief report on activities in 2019.

David Langberg continues to work with the new scanner to get the best results and over 400 plans have been scanned so far.

Planning for an electronic catalogue has commenced with David Langberg, Peter Silva and Rob Weiss discussing possible designs.

A work day was held at Seymour in September 2019.

Graeme Dunn / Andrew Gostling. Carried.

Elections: – The Vice-President, Bill Johnston, chaired the meeting for the election of the new Committee.

No written nominations were received.

The following verbal nominations were received at the meeting: –

President: – David Langley, nominated by Laurie Savage and seconded by Michael Formaini.

Vice President: – Bill Johnston, nominated by Michael Formaini and seconded by Graeme Dunn.

Secretary: – Glenn Cumming, nominated by Michael Formaini and seconded by Graeme Dunn.

Treasurer: – Peter Silva, nominated by Michael Formaini and seconded by Graeme Dunn.

Committee member: – Colin Rutledge nominated by Michael Formaini and seconded by Graeme Dunn.

Committee member: – David Langberg nominated by Michael Formaini and seconded by Graeme Dunn.

There being no further nominations, all nominees were declared elected to the position.

General Business: – Michael Formaini thanked the SRSV Committee for their work during the previous year.

Bill Johnston thanked Andrew Waugh for his ongoing efforts with "Somersault".

Meeting closed @ 20:33 hours.

The March 2020 Annual General Meeting was followed by the March 2020 Ordinary Meeting.

## MINUTES OF MEETING HELD FRIDAY 19 FEBRUARY 2021.

The SRSV meeting scheduled for Friday 19 February 2021 was held as an online meeting on the internet using the 'ZOOM' application. This was due to the restrictions imposed on public gatherings announced by the Victorian Government in response to the COVID-19 (Coronavirus) pandemic.

Present: – Ken Ashman, Noel Bamford, Phil Barker, Robert Bremner, Brett Cleak, Graeme Cleak, Glenn Cumming, John Dennis, Michael Formaini, Peter Gerandt, Chris Gordon, Judy Gordon, Andrew Gostling, Graeme Henderson, Bill Johnston, Keith Lambert, David Langberg, Neil Lewis, Andrew McLean, Phillip Miller, Eddie Oliver, Andrew Pardy, Roo Richards, Laurie Savage, Peter Silva, Rod Smith, David Stosser, Bob Taaffe and Andrew Wheatland. (29)

Apologies: – Chris King and Michael Menzies.

Visitors: – Floyd Bromley and Jim Gordon.

The Vice-President Mr. Bill Johnston, took the chair & opened the meeting at 20:14 hours (8.14 pm).

Minutes of the November 2020 Meeting: – Accepted as read. Graeme Henderson / Michael Formaini. Carried.

Business Arising: – Nil.

Correspondence: – Letters to Surrey Hills Neighbourhood Centre with meeting dates for 2021 and then to cancel our booking for the meeting in February 2021.

Bob Taaffe / Michael Formaini. Carried.

Reports: – The 2021 Annual General Meeting is scheduled for Friday 19 March 2021.

General Business: – David Stosser noted an entry on page 28 of Weekly Notice 5 / 2021 that referred to access to the "Tissue Box" at Spencer Street Yard (Southern Cross) and asked what is the "Tissue Box"? Phillip Miller suggested that the "Tissue Box" is one of the modern style buildings at Spencer Street Yard.

Phillip Miller discussed an internet video that shows the working of electric key token instruments and signal boxes on the Gloucestershire and Warwickshire Railway.

Graeme Henderson described works at Chatswood NSW this weekend for the slew of tracks for the construction of the dive for the new Metro tracks.

Graeme Henderson outlined future track and signal alterations at Gosford NSW.

Graeme Henderson noted that ETCS Level 1 would be introduced between Emu Plains NSW – Mount Victoria NSW on Wednesday 3 March 2021.

An incident during the recent occupation at Werribee for level crossing removal works was discussed. It was reported that a level crossing did not operate for a Standard Gauge train. The occupation went one (1) week over time.

It was reported that the recent occupation on the Frankston Line for level crossing removal works went over time because of difficulties encountered during the relocation of the relay rooms at Bonbeach, Edithvale and Chelsea.

David Stosser reported on a recent derailment in Frankston yard where it is alleged that a set of points were moved under an electric train.

Keith Lambert reported that the Chelsea Signal Box and signal control panel had been abolished.

David Stosser shared a signal box pull diagram of Batman from 1959 and questioned the requirement to operate facing point lock levers for trailing moves.

Rod Smith asked about passenger trains using No.1 Platform at Brighton Beach. It was noted that the points are now booked out of service.

Andrew Wheatland reported that the lever frame from Moreland Signal Box was being overhauled in readiness for a future display.

Andrew Wheatland described the monitoring of protected level crossings on the Puffing Billy Railway.

Syllabus Item: – The Vice-President introduced the Syllabus Item.

In response to a late request for assistance, six (6) SRSV members presented a series of short Syllabus Items.

First up was David Stosser. David described a current project where he is entering information from the Weekly Notice Extract book by Alan Jungwirth and Keith Lambert onto a database hosted by the Vicsig website. This provides additional historical information for locations recorded on the Vicsig website. Additional diagrams are also being added to the Vicsig website.

Graeme Henderson shared images taken on a visit to Switzerland approximately 18 months ago. The emphasis was on signalling arrangements at crossing loops and yards plus a series of signal control panels in use and on display in a museum.

Brett Cleak shared six (6) random images from his collection – a signal and point indicator at Melba Siding on the Emu Bay Railway (TAS); a switch stand on double wire points at Meredith; Dwarf signal "D" on the Appleton Dock Line with a "T" indicator light at the Footscray Road level crossing; the light Down arrival home signals on bracket post at Sunbury (the first stage of power signalling); a South Australian Railways hand operated plunger lock and switchstand at a crossing loop on the Mount Gambier Line; No.21 switch and point indicator at Finucane Island at Port Hedland on the BHP Iron system; a QR DTC screen and laptop in a train; and a "train staff" for the section No.8 Loop – No.9 Loop on the SEC system.

Rod Smith shared some black and white images from the collection of Maryborough signal man John Blakeborough. Views of Maryborough, Wedderburn Junction and Mysia were seen plus an "S" class loco B end leading at the APM Siding at Fairfield.

Phil Barker shared a brief signalling of Cloncurry QLD which featured images of the lever frames in use at this remote location over the years and images of the QR staff transfer system used at Cloncurry.

Andrew Wheatland completed the Syllabus Item by sharing images from 2004 taken at Gunning NSW, Harden NSW, Cootamundra NSW, Wodonga, Wangaratta and Whitfield.

At the completion of the Syllabus Item, the Vice-President thanked each of the presenters for their assistance and the entertainment.

Meeting closed at 21:55 hours.

The next meeting will be on Friday 19 March, 2021, commencing at 20:00 hours (8.00pm).

## Signalling Alterations

*The following alterations were published in WN 1/21 to WN 8/21, 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.*

**11.01.2021 Katunga (TON 19/21, WN 2)**

On Monday, 11.1., the main line turnouts have been booked out of use due to the condition of the turnouts. The turnouts have been secured normal

**14.01.2021 Waitchie (TON 33/21, WN 3)**

On Tuesday, 14.1., the siding, extending from 413.469 km to 413.899 km, was booked out of service due to sleeper condition.

**14.01.2021 Borung (TON 32/21, WN 3)**

On Tuesday, 14.1., the siding, extending from 289.017 km to 289.383 km, was booked out of service due to sleeper condition.

**16.01.2021 Glenroy (SW 116/21, WN 2)**

On Saturday, 16.1., the Glenroy Rd level crossing was closed. The level crossing protection equipment on the Up side and the boom barrier and mast on the Down side was removed. The pedestrian crossing on the north side of Glenroy Rd was closed.

The Up platform was reduced by 30 metres at the Up end and extended by 33 metres at the Down end.

A banner indicator E532BI was provided at 14.735 km to repeat Automatic E532.

Amend Diagram 53/20 (Glenbervie – Somerton).

**(19.01.2021) Deer Park West – Ararat (SW 4/21 & 5/21, WN 3)**

The following Operating Procedures were reissued:

- 67 (Deer Park West – Wendouree Defective Signals). SW 202/19 was cancelled
- 68 (Ballarat – Warrenheip, Banking Locos) was cancelled. Banking will be conducted in accordance with Rules and Operating Procedures. SW 261/05 was cancelled.
- New Procedure 68 (Ballarat Corridor, Deer Park West – Ballarat East) was issued in SW 4/21 and reissued in SW 5/21.

- 69 (Ballarat – Signalling and issue of Train Orders). SW 141/20 was cancelled.
- 70 (Ballarat – Ararat Train Staff working). SW 210/20 was cancelled
- 71 (North Ballarat Workshops). SW 4/13 was cancelled.
- 72 (Ballarat West Line Siding, Bunge Siding). SW 87/11 was cancelled.
- 73 (Ballarat East Locomotive Depot). SW 82/12 was cancelled.
- 74 (Maddingley Stabling Sidings). SW 51/19 was cancelled.

**22.01.2021 Bacchus Marsh (SW 8/21, WN 4)**

On Friday, 22.1., a notice board lettered "BMH730 Clear Medium Speed 65 for No 2 Road Rowsley" was provided at Down Home Departure BMH730.

Amend Diagram 2/21 (Bacchus Marsh – Rowsley)

**23.01.2021 Werribee (SW 121/21, WN 3)**

On Saturday, 23.1., the ARTC standard gauge line was taken out of use to slew the track over the new viaduct over Werribee St.

Werribee St level crossing was permanently closed. All level crossing protection equipment and signage was removed.

**24.01.2021 Southern Cross (SW 122/21, WN 3)**

Between Friday, 22.1., and Sunday, 24.1., the following signals were equipped with TPWS: Homes 508, 518, 519, 529, 535, 536, 548, & 555. All these signals are on Nos 8 & 8A tracks.

**25.01.2021 Werribee (SW 121/21, WN 3)**

On Monday, 25.1., the ARTC standard gauge line was restored to use over the new viaduct at Werribee St. The control panel at Werribee was updated to reflect the removal of the level crossing.

**25.01.2021 Toorak – Malvern (SW 123/21, WN 4)**

Between Friday, 22.1., and Monday, 25.1., Automatic D262 was replaced by a new mast located on a cantilever mast located 1 metre in the Down direction. Automatics D271 and F271 were similarly replaced by new masts located on a cantilever mast located at the same position as the former mast for D271, and 3 metres in the Up direction of the former mast for F271.

Diagram 89/20 (South Yarra – Malvern) replaced 55/19.

**(26.01.2021) Aircraft – Werribee – Little River (SW 131/21, WN 4)**

Diagrams 91/20 (Aircraft – Werribee) and 87/20 (Werribee Racecourse – Little River) replaced 47/20 & 20/20 respectively due to the removal of Werribee St level crossing. The broad gauge lines between Werribee & the MTM lease boundary remain out of use.

**(26.01.2021) Bacchus Marsh – Rowsley (SW 7/21, WN 4)**

Diagram 7/21 (Bacchus Marsh – Rowsley) replaced 112/19 due to the alterations at Maddingley Sidings (SW 2/21).

**(26.01.2021) Frankston (SW 127/21, WN 4)**

Whenever a move is to be made between Siding A and No 4 Track (in either direction), the Signaller must reverse and sleeve Pilot lever 17 before reversing signal levers 11 or 32. Pilot lever 17 must remain sleeved until the indication for track circuit 25T on the illuminated diagram shows the track is clear. If the movement involves a track machine or road/rail vehicle, the Signaller must not remove the sleeve until the person in charge of the movement that it has cleared No 25 points.

This is in response to a derailment of an EMU being moved from No 4 Track to Siding A.

**30.01.2021 Berwick (SW 126/21, WN 4)**

On Saturday, 30.1., the road was narrowed to one lane in each direction with the lefthand lane in each case being closed. The left hand boom barrier mechanism in each direction was removed and the associated flashing lights were relocated to temporary masts.

Amend Diagram 71/18 (Narre Warren – Cardinia Rd).

**30.01.2021 Pakenham East (SW 140/21 & 146/21, WN 5)**

On Saturday, 30.1., the axle counter reset configuration for sections PKE710T & PKE711T was altered to remove the 'Direct Reset' function and provide a 'Next Train Without Condition' reset function.

Following this alteration, Points 661 at Pakenham East were restored to service. SW 337/20 is cancelled.

**31.01.2021 Hampton (SW 122/21, WN 3)**

On Sunday, 31.1., automatic pedestrian gates were provided at the Grenville St/Hastings St pedestrian crossing. An axle counter overlay was provided across the crossing on the Down line.

Diagram 55/20 (Prahran – Sandringham) replaced 33/19.

**(02.02.2021) Southern Cross (SW 132/21, WN 5)**

After the recent installation of TPWS in No 8 Track (SW 121/21), there have been instances where a locomotive has received a TPWS intervention at Home 508 when setting back along No 8 Track after running around.

Until alterations are made the following procedure must be followed.

After running around, the V/Line Shunter must request a low speed aspect on Home 508. The Signaller, Northern Signal Control panel, must set the route from Home 508 to Home 536 and clear the low speed aspect on Home 508.

**(02.02.2021) Geelong (SW 10/21, WN 5)**

When train preparation is to be carried out in No 10 Road, rail movements must not be carried out in No 9 Road.

The Geelong Yard Shunter must inform the Geelong Corridor Signaller when it is necessary to prepare a train in No 10 Road (the Driver will perform this duty if the Shunter is not on duty). The Signaller will apply blocking commands to the appropriate points and endorse the train graph. The blocking commands can only be removed when the Shunter (or Driver, if the Shunter is not on duty) informs the Signaller that the train preparation has been completed.

Operating Procedure 61 (Geelong) was reissued. SW 151/17 was cancelled.

**07.02.2021 Southern Cross – Franklin St (SW 144/21, WN 5)**

On Sunday, 7.2., the following Homes were provided with TPWS: 114, 115, 116, 507, 509, 520, 539, & 541.

**07.02.2021 Chelsea (SW 861/20, WN 50)**

On Sunday, 7.2., the pedestrian crossing at Wellwood was expected to be returned to service. Amend SW 796/20.

**End£**

*An exterior view of the neat and sturdy Coburg signal box on 21 August 1994. It was, of course, a Sunday as no trains ran on Sundays and the whole line was deserted.*

# WILLIAM ROBINSON & THE TRACK CIRCUIT

Andrew Waugh

The previous part of this article looked at Robinson's early interest in railway signalling, culminating in the experimental automatic signal installation at Kinzua, PA, in 1871. This used treadles for train detection. While Robinson claimed subsequently that this installation was successful, it was unlikely to have been reliable or safe in service due to the use of treadles. This part takes up the story with the development of the track circuit and its development over a number of trial installations.

**The development of the track circuit**

Robinson described the development of the track circuit as follows:

> As soon as [the trial installation] was found to be working perfectly and accomplishing all claimed for it, Mr. Robinson, who aims to be his own most severe critic of his own work entered systematically into a deeper study of the system, from the standpoint of a railroad man, with a view of finding the weak points in it, if any existed.
>
> He soon discovered the following serious defects, which are inherent in all normally open circuit or wire [treadle] systems of automatic signaling, without exception.
>
> Such systems are extremely limited in their functions, and may, under certain circumstances, show a safety signal when the danger actually exists which they are designed to avert, as in the following cases [1) the train breaks in two with the leading portion leaving the section; 2) a train enters the section from the exit, or from a siding; and 3) if a line wire breaks or the battery fails.]
>
> Mr Robinson at this early date recognized the above serious objections as inseparable from the open circuit system, of signalling, apparently before these defects were recognized by any one else […]
>
> He reasons that to accomplish this result [safe detection of trains] every car and every pair of wheels in the train must have controlling power over the signal throughout every inch of the block section, and secondly, the signal should go to danger by gravity, the electric current being used to hold it at safety.
>
> […] Could the rails be used in any way to carry the primary current in a reliable manner? Manifestly not by any open circuit means, for the reason that sections of rails of even moderate length, on open circuit, would form a good ground, especially in damp or wet weather, thus keeping the circuit closed continuously and preventing any operation of any kind.
>
> He at once cast aside this open rail circuit idea as fruitless and having previously, in 1869-70, used the short circuit principle in his model […] he concluded that this principle presented the only possible solution of the problem.

There are tantalising hints here about how Robinson came up with the track circuit. Given the technology he was used, it is reasonably certain that the risk of an unsafe situation during a failure actually occurred. However, Robinson extended this to operational failures such as trains breaking in two. This led him to conclude that operation of the system must be 1) failsafe, and 2) have continuous detection over the entire section. This suggested using the rails to carry current.

He rejected the idea of a 'rail circuit' where the wheels and axles completed a circuit between the two rails as Robinson discovered that the ballast leakage in any reasonable length rail circuit would result in the circuit being continuously closed. At some point, Robinson conducted "a dozen experiments on rail sections [circuits] ranging in length from one thousand feet to two miles, in weather snowy, rainy, damp and dry, on sections partly in contact with the earth, and on others wholly free from contact with anything by the ties, and with batteries arranged to secure the best results. In every case, without exception, the rails formed a perfect ground, keeping the circuit closed and the magnet magnetized.[1]"

Sometime in 1871, Robinson applied the idea of shunting an energised relay with current flowing through the track and the track circuit was born. In 1871 Robinson applied for a patent on this idea (Patent 130,661) and it was granted 20 August 1872[2].

Figure 5 is the drawing from the patent and it is notable that the signal and battery are connected to both tracks. Apart from this issue, the drawing is of a recognisable DC track circuit. In a modern track circuit, the battery and relay connections would be applied at the extreme ends of the circuit (as, indeed, it would be by Robinson in practice). No track resistance is necessary as the internal resistance of the gravity cell (copper/zinc in a copper sulphate solution) was high enough not to require one. No track relay was provided and the track circuit consequently had to provide sufficient power to operate the signal mechanism. The signal in the drawing bears a marked resemblance to Hall's disk signal, patented around a decade earlier and in operational use by 1872. The mechanism is much simpler than Hall's, however, as

[1] This story is a good example of the problems with interpreting Robinson's history of the track circuit. He recounts these experiments in the section discussing his dispute with Pope (see later) but is vague about when they were conducted. The logical time for the experiments to occur would be in the lead up to the invention of the track circuit – a rail circuit was the obvious and simple solution to the problem of detecting trains, although not to the problem of failsafe operation. But conducting these experiments required access to a railroad line and the solution to the problem of bonding which suggests they occurred after the second trial. It is possible that Robinson specifically conducted the experiments as a counter to Pope's patent.

[2] The patent was reissued (RE5958) on 7 July 1874, application filed 19 May 1874.

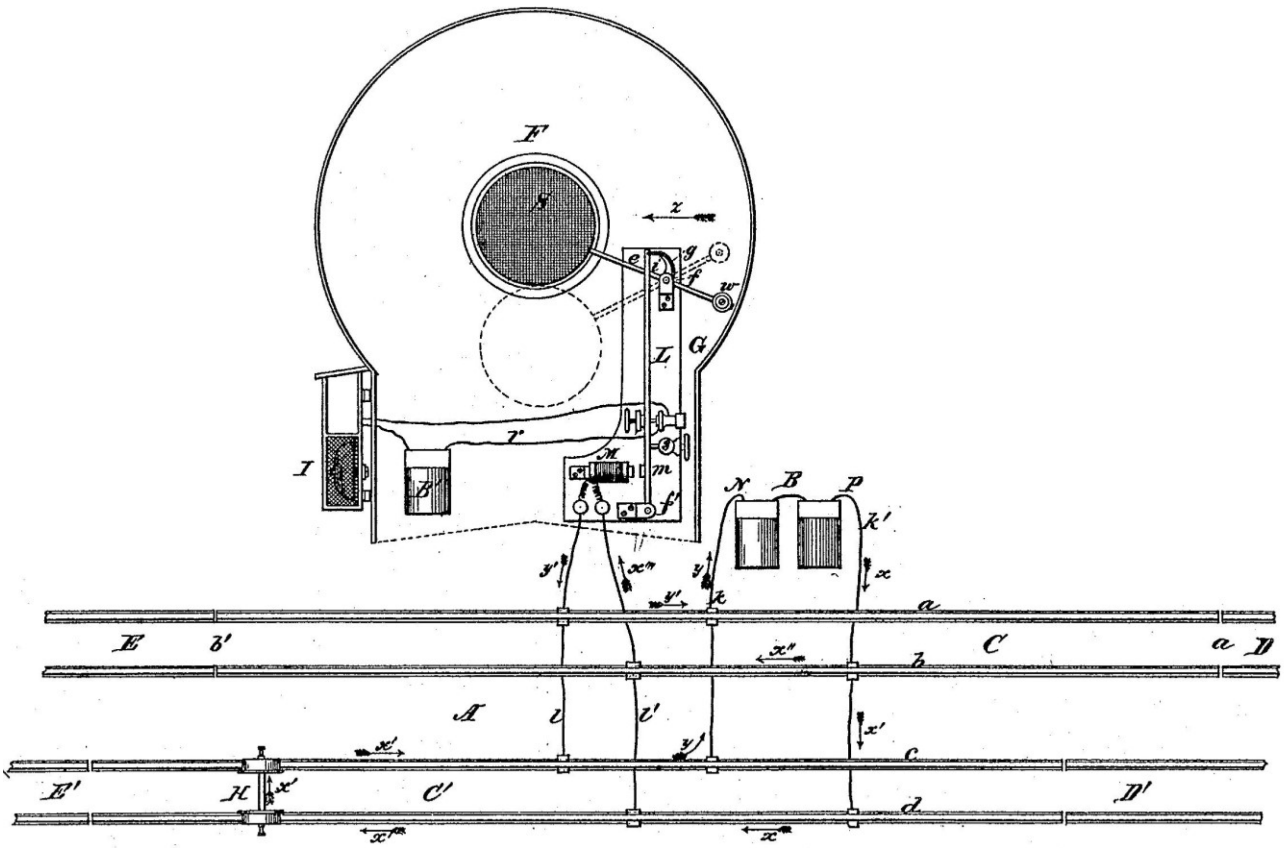
the continuous control provided by the track circuit avoided the need to provide a latch to hold the signal in one of the two positions. Robinson's arrangement of the signal is also superior to Hall's as gravity is used to display the 'danger' signal – the signal is consequently failsafe.

In 1872 Robinson exhibited a model of a track circuit at the State Fair, held in Erie, PA. This had a portion of track, submerged in water, on which a 'car' ran. The back contact of the relay operated a loud bell mounted on one end of the building. The bell sounded when the car occupied the track circuit, and ceased sounding when it left. The loud sounding bell apparently attracted considerable attention at the fair.

Robinson had the advantage of knowing railroaders, and discussed his new invention with Baldwin, who agreed that he could trial it at Kinzua. All the signal apparatus, relays, batteries, office switches, and overlapping[3] devices used in in 1870 were reused for the new trial.

The major challenge in getting this first track circuit to work was bonding the rails. The light rails in use were connected by a 4 foot wooden bar on the outside of the rails and a 12 inch iron fish plate on the inside. The wooden bar was secured to the rails by two bolts in each rail. The inner bolts in each rail also went through the iron fish plate. By careful attention to each joint – filing off rust and tightening the bolts – Robinson finally managed to get a current working through the entire length of the first section – about a mile and a quarter. It was obvious that this would not work as a general approach. Robinson proposed to bond the rails together using wires – preferably by driving the ends tightly into holes drilled in the rails ("making the connection so close that there would be no room for moisture to penetrate or rust to form"), but alternatively by soldering the wires to the rails. The railroad company was reluctant to allow holes to be drilled in the rails, and this would have been too time consuming and expensive anyway. Soldering was considered impracticable due to the difficulty in heating up the rail quickly enough to solder the wire. Robinson succeed in using the flexibility of the joint itself to ensure electrical contact. A short wire bridged each joint with a piece of spring steel at each end. The pieces of spring steel were held in place against the rail flange by wooden blocks. The movement of the rails as a train passed over the joint caused the spring to scratch the rail, ensuring a bright

*Figure 5. The patent drawing from US Patent 130,661 granted to Robinson in 1872 for the track circuit. The train H is on the lower track section C′, shunting the relay and allowing the screen S to rise in front of the signal aperture by means of the counterweight w. Unlike modern practice, there is no track relay with the track circuit directly operating the signal relay. The box I on the side of the signal houses a bell, which is controlled by contacts on the signal armature. The similarity of the signal to Hall's patented enclosed disc signal is to be noted. For some reason, not explained in the patent, the battery and the signal relay are connected to both tracks.*




[3] A signal repeater. An 'overlapping tell-tale signal' was placed in the agent's station a mile from the signal 'showing to the agent when the main signal was actually exposed at danger'. A switch was also provided so that the agent could manually place the signal at danger.

electrical contact at all times. This was described as 'very successful.'

The battery used was an early form of the gravity battery (bluestone cell – zinc and copper in copper sulphate), and initially used four cells on the track circuit.

The insulated rail joints were two massive baulks of timber laid on each side of the rail forming the fishplates (Figure 6). The foot of the rail was let into each baulk. One baulk was taller than the other and was bolted to the web of the rail. Additional bolts joined the two baulks together below the rail. It is not clear how the space between the two rails was insulated. This joint continued to be used until about 1876.

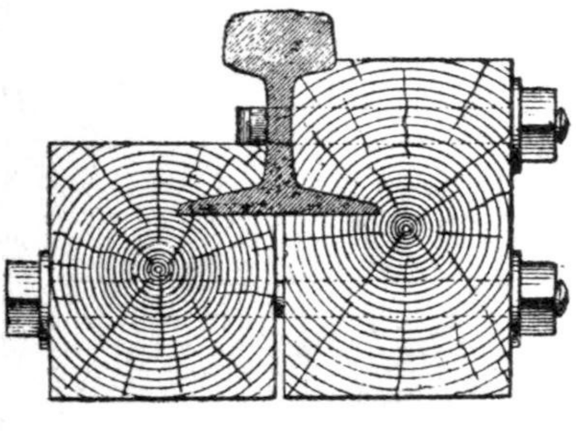


*Figure 6. The insulated joint used at the first installation of the track circuit.*

The relays were adapted from telegraph sounders and were wound to a resistance of a little over one ohm, but some were as low as an ohm.

The signal mechanism was similar or identical to the mechanism illustrated in Robinson's 1872 patent, which we have already noted was very similar to Hall's disk signal in conception and appearance. By the second trial installation this was mounted on a small wooden building – almost certainly an insulated house to house the batteries, just as Hall had already patented. The installation included the bell described in the patent and it was noted that this could be heard for a distance of half a mile.

According to information supplied by an old PRR employee around 1921, the installation at Kinzua was in operation for about a year and was then discontinued due to the battery expense.

In comparing Robinson's progress with Hall, at this time Hall was well ahead. During 1872 Hall was installing his automatic block system (using treadles) on 18 miles of the Eastern Railroad. This was in service in January 1873. By mid 1874 this installation had overcome its teething troubles and was in reliable, continuous, operation.

**Further trial installations**

In September 1872 Robinson published a circular publicising the 'Robinson's improved systems of electric railway signals'. At this point, Robinson considered the key improvements of the new system to be the elimination of track instruments (treadles) and the line wires between the two ends of the section. The overall applications envisaged continued to be 'for switches, draw-bridges, crossings, curves, cuts, and tunnels; also, to indicate the location direction, rapidity and length of trains'. However, block signalling was mentioned as an application and it was noted that "the new system… with closed circuit, is the best ever devised for 'block-signaling,' since the failure of the battery through neglect or otherwise, cannot possibly be productive of disastrous results to the train, however implicitly the signals may be relied on."

Once the first installation had proved itself, the Philadelphia & Erie installed a second at Irvineton, PA (now Irvine) about 18 miles west of Kinzua. This installation was completed early in 1873. The locomotive engineers supposedly named this signal 'The Old Reliable'. Only one signal was provided at Irvineton, 2,500 feet east of the agent's office and this was provided to protect the main line between the signal and a point 900 feet beyond the station office. In this distance there was a sharp curve, in the middle of which was a bridge over the Brokenstraw Creek, and a trailing junction with a line to Oil City. Like Kinzua, a repeating bell and manual switch was provided in the agent's office. Figure 7 is a very early (and indistinct) photograph of the signal

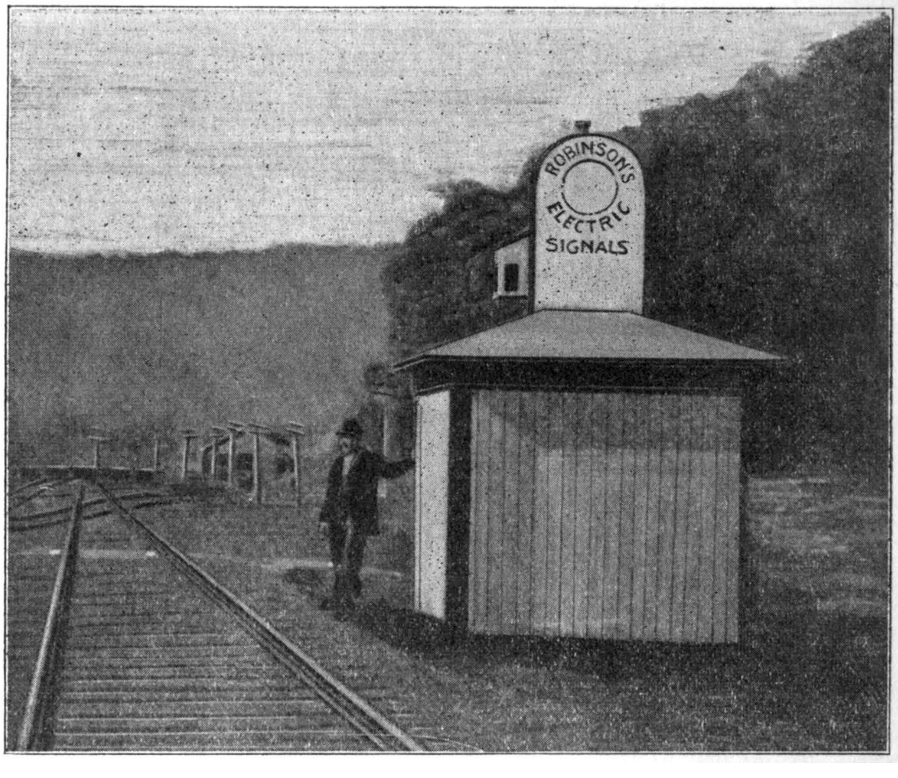



*Figure 7. A photograph of the signal and signal at the second track circuit installation at Irvineton PA. The box on the side of the signal housed the bell.*

at Irvineton, showing the small house that supported the enclosed disk signal. This house was almost identical to that patented by Hall, and probably had the same purpose: to prevent cold weather freezing the batteries and mechanism.

A May 1873 postal card produced by Robinson highlighted the fact that these are 'wireless' signals (i.e. they did not need a line wire between the two ends of the section). The second feature highlighted was that they were the 'only absolutely SAFE electric signals in existence.' The card stated that the system was in successful operation on the Baltimore and Ohio, the Philadelphia, Wilmington & Baltimore, and the Philadelphia & Erie, and had worked "uninterruptedly through last winter regardless of rain, snow, slush or sunshine." The applications were described as "automatic blocks with tell-tale alarms, office, station, road crossing and switch signals, and broken rail detectors".

By 24 October 1873 the signals were in use at two places on the Philadelphia & Erie: at Ridgway on the Middle Division and at Irvineton on the Western Division (note the original installation at Kinzua appears to have been out of use by this time). These signals were inspected on that date by A.J. Cassatt (General Manager, Pennsylvania Railroad) and other senior officers of the PRR, including Mr Gardner (General Superintendent), Mr Lewis (Controller), Mr Robert Pitcairn (Superintendent, Western Division), and Mr Frank Thompson (Superintendent Motive Power). William Baldwin was also present. Robinson considered that Baldwin "could not say enough in favor of the signals". Cassatt, Pitcairn & Thompson participated in a lively discussion with Robinson and Baldwin in which Pitcairn described his ideal of signal system, and Baldwin explained how the Robinson system met this ideal. The next day, Robinson wrote that the PRR officers were 'very much pleased' with the signals, but were so surprised by their operation that it would take some days for them to understand it. Robinson seemed to be under the impression that the system would be installed on the PRR main line; he subsequently called on the officials several times, was courteously received, but the PRR did not install the system.

During 1873, Robinson organized the 'Robinson Electric Railway Signal Company', of which he was President and General Manager. Little is known about this company.

**Robinson vs Pope**

Robinson was not the only inventor working on electric railroad signals and he, like Hall, came up against Frank L. Pope.

By the early 1870s, Pope was an established and highly influential American telegraph engineer. He had started his career as early as 1857, when he was only 17, as a telegraph operator. He quickly became a telegraph engineer. In 1868 he wrote a highly influential textbook on telegraphy (it went through 15 editions to 1895). The following year he formed a short lived electrical engineering partnership with a young Thomas Edison. In the same period, he was in business as a manufacturer of telegraph instruments and supplies. By 1875, Pope had become a lawyer and patent expert with the Gold & Stock Telegraph Co and later had a similar position with the Western Union[4].

In the early 1870s Pope had become interested in the application of electricity to railway signalling.

On 16 July 1872, Frank L. Pope received a patent[5] for an automatic block system. Train detection was by rail circuits in which the axles of a train complete a circuit between the two rails. His proposed system was very simple. The track was divided into insulated sections. One terminal of the battery was connected to one rail of the section, and the other rail was connected to the other battery terminal via the coils of a relay that operated a signal. When a train was in the section current would flow from the battery to one rail, through the axles to the other rail, and back to the battery via the signal. The flowing current would display a stop signal at the entrance to the section. Apart from being completely not failsafe, the idea would not work for any reasonable length sections as ballast leakage between the two rails over a circuit of any serious length in wet weather would mean that the signal would always be 'on'.

However, irrespective of whether his proposed technology worked, Pope's patent claimed as an invention the application of train detection by sending electrical current through rails for three applications: block signalling, switch detection, and highway crossing protection. Note that Pope's patent slightly predated Robinson's track circuit patent.

Pope apparently subsequently realised that rail circuits could only be made to work over relatively short distances and, around 1872/3, Pope experimented with short (42 foot long) rail circuits at Charleston, MA[6]. In a Patent filed 15 May 1873[7] he showed a block signalling system which used short rail circuits to restore a signal to danger when a train entered a section, and clear it when it left. In this system the rail circuits simply replaced the treadles of earlier systems.

A third patent, filed in June 1873 by Pope[8], showed a bizarrely complex system apparently designed to duplicate the functionality of Robinson's track circuit – in particular the length of the track circuit and its failsafe nature. It required a short rail circuit at each entrance to the section, in addition to a long 'track circuit'. Occupancy of both the entrance rail circuit and the 'track circuit' cleared the entrance signal, and occupancy of the 'track circuit' alone restored it to danger. The track circuit had a battery and a relay in series at each end of the section. The

[4] The details of Frank L. Pope's career have been taken from the 'Telegraph-History' website http://www.telegraph-history.org/pope/

[5] Patent 129,425, "Improvement in Electric Signaling Apparatus for Railroads", patented 16 July 1872.

[6] Described in a paper read to the New York Society of Practical Engineers

[7] Patent 140,536 "Improvement in circuits for electric railroad signal', filed 15.5.73, granted 1.7.73.

[8] Patent 143,529 "Improvement in electric circuits and devices for railway-signals', filed 11.6.1873 and granted 7.10.73

positive pole of the two batteries were connected to the same rail, so that (theoretically) the two batteries opposed each other and no current flowed when the line was clear. When a train occupied the section, the rails would be short circuited and current would flow in both batteries and the associated track relays would close. Nowhere in his patent does Pope reference the Robinson track circuit, but he was clearly aware of it as his claims to the novelty in the patent commence "I do not claim, by itself, the method of operating a signal by means of a constant circuit, which is shunted out of the operating magnet by means of a connection formed by the wheels and axles of a locomotive or car […] except when combined with the devices and arrangements herein shown and described."

It appears that trial installations were made by Pope on the PRR and at least one other railroad. Robinson notes that in 1873 he asked a General Superintendent (almost certainly Gardiner on his inspection of Robinson's track circuit in October 1873) whose road had installed several of Pope's signals how they went. The response from the General Superintendent was that "They did not work at all." A Divisional Superintendent (probably Pitcairn) at the same interview stated that "Pope's signal is not worth fighting for; it is not worth a baubee." The superintendent of another road said "Their signal is not giving us satisfaction."

The periodical 'Iron Age' published a description of Robinson's system in January 1874[9]. This resulted in a letter to the periodical from Pope in which he stated that he had invented the track circuit and that "Mr Robinson also applied for a patent on the rail circuit differing from mine only in the arrangement of connections, so that the magnet would be unmade instead of made by the passage of the train." In other words, Pope was claiming the key invention of using the rails to detect trains. Unfortunately for Pope, Robinson was aware of two prior UK patents that had already proposed rail circuits.

On 31 October 1860, William Bull had been granted an English patent for a rail circuit used to operate an indicator in a station. Bull apparently realised that rail circuits were limited in length as he specified that the insulated rails were to be short 'twenty feet, more or less'. The rails were to be insulated from each other, and the fishplates, by leather, mill-board, gutta percha, or some similar substance.

Another patent was filed on 10 February 1868 by Banes & Hancock. The main advance in this patent was that the rail circuit would work a signal protecting a train. Like Pope, Barnes & Hancock thought that the rail circuit could be of any length.

Robinson responded in a letter to Iron Age published on 29 February 1874, stating that Pope "by stating too little falsifies truth, belies science, and is generally calculated to deceive your readers, scientific and general." Strong words, bearing in mind Pope's eminence as an electrical engineer and knowledge of patent law. Robinson went on to point out that Pope specifically disclaimed the invention of the closed track circuit and only claimed improvements to Robinson's invention. To rub salt into the wound, Robinson stated that these improvements were useless to Pope as Robinson would not him a grant a license to use the principle of the closed track circuit.

On 28 July 1874 Robinson served an infringement notice on Pope and his associates claiming that they were infringing at least seven claims of Robinson's patent and at possibly six more, and threatening a legal suit. He sent copies of the notice to various railway companies. Pope apparently then ceased work in this field, but he eventually sold his signalling patents to Union Switch & Signal and became a director of that firm.

While the train detection approach in Pope's patent would not have worked, one of the subsidiary ideas in his Patent 129,425 was more important – this was the conventional insulated rail joint that is still used today (Figure 8) The two rails (R & R') were to be insulated from each other by an end post r of 'vulcanite or other suitable insulating material'. The fishplates were to be insulated from the rails by channels t of insulating material, and the fishbolts were provided with sheaths q of insulating material to insulate them from the rails.

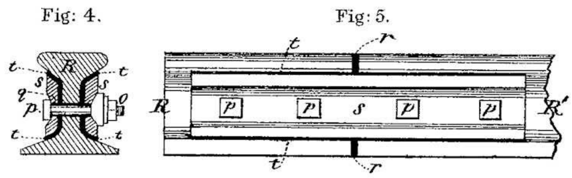



*Figure 8. One of the inventions in Pope's 1872 patent was this insulated joint – which ultimately became the standard approach to insulating the ends of track circuits. This was a subsidiary invention in the patent. Pope intended the insulated joint to be entirely separated rails, the ends of which were supported on independent chairs.*

**Consolidation and improvements**

Robinson published a circular on his system in January 1874 – this circular was almost certainly linked to the Iron Age article published on 8 January 1874. A woodcut in the circular shows the system as it was installed at that time (Figure 9).

The track battery consisted of three cells at the exit of the section. This fed a track relay at the entrance of the section which drove a secondary circuit operating the signal. Four further cells powered the sign. A contact on the signal mechanism could operate an optional 'distant' signal which could be placed either in advance or on the rear of the main signal. In the woodcut this optional signal was shown as a bell placed at the exit of the block. This was intended to provide an 'overlap'. As before the signal, track relay, and signal batteries were housed in a small cabin with the signal mounted in a cupola on the roof.

The text associated with this January 1874 circular indicates that manual control of the signal could be

[9] Iron Age, 8 January 1874. Unfortunately, Iron Age is not easily available in Australia and this article, and the two subsequent letters have not been sighted. The description of their contents and battle with Pope is taken from Robinson's book, and hence should be taken a little cautiously.

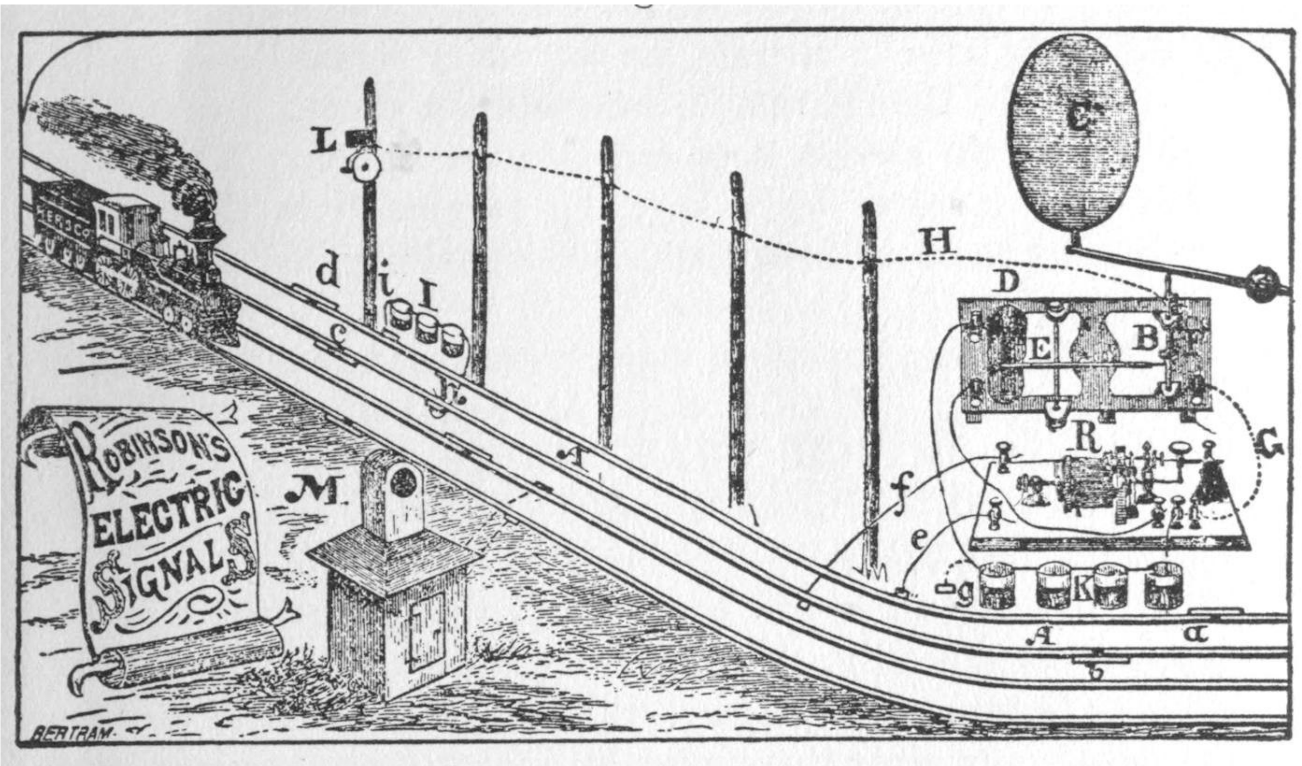



*Figure 9. A January 1874 woodcut illustrating Robinson's electric signal system as it was at that date. 'a' to 'd' are the insulated rail joints for the track circuit A – note that these are not placed opposite each other, probably because the rail joints were staggered. The track battery, I, is at the exit of the track circuit and consists of three gravity cells. R is the track relay which appears to be similar to contemporary telegraph relays. F, above it, is the signal mechanism. The coloured disc C is mounted on a horizontal arm, with a counterweight at the other end, that rotates in a horizontal plane on shaft B. This is driven by coils D and armature E. Not surprisingly, four battery cells are provided to operate the signal. The optional dotted wires G and H operate the bell L at the exit of the section which was described as the 'overlap'. The track relay, signal mechanism, and batteries were housed in small cabins, M.*

provided by providing a switch in the station that, when operated, short circuited the two rails. The applications of the system were stated to be block signalling (both automatic and manipulated – i.e. manual block), switch, draw-bridge, road-crossing, and station-approach signalling, and broken rail detection. The failsafe nature of the system was also highlighted: "In this system it will be observed that, since the signal is exposed mechanically, any tampering with the rails or connections, or failure of the battery, will invariably result in exposing the signal; any error therefore which may occur from any cause will be in behalf of safety. *It is impossible to show safety when the danger exists which the signal is designed to avert*." (emphasis in the original).

Robinson received three patents in mid 1874 – the applications were filed in July 1873 – and represent improvements made as a result of experience with the installations.

Robinson received a patent[10] in July 1874 for the electric signal shown in the January 1874 woodcut (Figure 10). This had a cumbersome mechanism – perhaps to get around Hall's patent. The coloured discs that displayed the signal were mounted vertically on an arm that was free to swing 90 degrees in the horizontal plane. The arm was worked via a crank and lever from a relay. Energising the

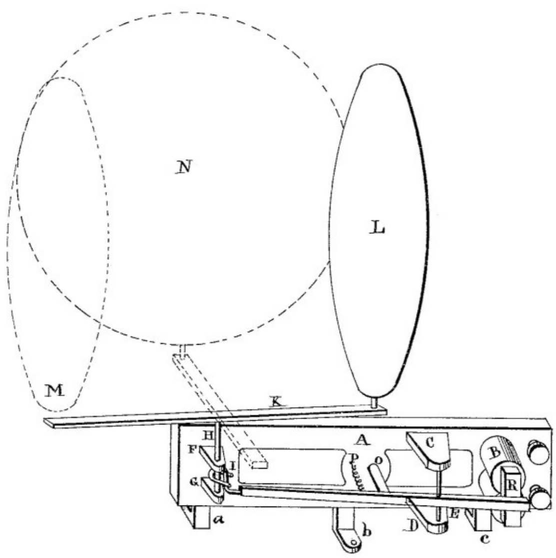



*Figure 10. The signal mechanism Robinson patented in 1874. The disc L was mounted on bar K that was free to pivot in the horizontal plane around pin H. The operating force came from the coils B which attracted armature R and rotated pin H by crank I. The signal is returned to danger by spring P.*

[10] Patent 153,613 'Electric Railway Signals', filed 18.7.73 and granted 28.7.74

relay rotated the arm 90 degrees and withdrew the coloured disc from the opening. The only advantage of this design was that up to four discs could be provided to give different colours for the on and off aspects, and to display aspects in both directions. The claimed novelty was in having two (or more) banners and the drive mechanism. The drawing indicates that gravity had been abandoned to return the signal to danger, instead a spring was used.

A second patent[11] covered the power supply for the track circuit. In use the track circuit battery was continuously discharging and polarisation caused failures. Robinson developed a scheme where two batteries were provided which were automatically swapped in and out of circuit after the passage of a each train. This allowed each battery to rest in turn and gave 35 to 40 days service out of each cell. The mechanism was simple and involved a commutator worked by the signal mechanism (or equivalent) at the battery (exit) end of the track circuit. The track circuit battery was divided into two sections (in the patent of four cells each) connected in series. One rail was connected to the centre of the two batteries. The outside ends of the batteries were connected to the other rail through a commutator driven by the signal mechanism via a ratchet. The ratchet would step when the signal mechanism returned to danger, reversing the commutator, and connecting the track circuit to the other end of the battery. The mechanism, of course, had to be provided at the exit of the track circuit where the battery was situated and it appears that it was intended to be operated by the signal for the next section. Where there was no next section, a separate mechanism was provided that was driven by a short track circuit in advance of the normal track circuit.

The final patent[12] covered an improved – or at least a simpler and probably cheaper - method of bonding the rails. This was an extremely simple mechanism consisting of a small arched section of spring steel. This was placed between the rail and the fishplate at a joint. When the fishplate bolts were tightened up the ends of the spring plate were pressed against the rails, and, as the joint moved under the passage of a train, the spring plate scratched clean contacts. One interesting thing about this patent is that it is includes the first use of the term 'track circuit'.

By October 1874, Robinson's signal apparatus was being manufactured by J.H.C. Watts, of Watts & Co, Baltimore. Robinson was still considering soldering the bond wire to the rail as Watts wrote to him saying "Am afraid your idea of soldering a strip of copper to the rails will prove very troublesome in carrying out, as it is a most difficult matter to heat so large a body of iron sufficiently to make a sure joint such as you require, or that will stand the jarring of passing trains &c., to say nothing of sneak thieves who abound wherever copper is lying around loose. I know however you scoff at theory so will 'dry up'".

**Boston installations**

In December 1875 Robinson moved to Boston. By this date there were

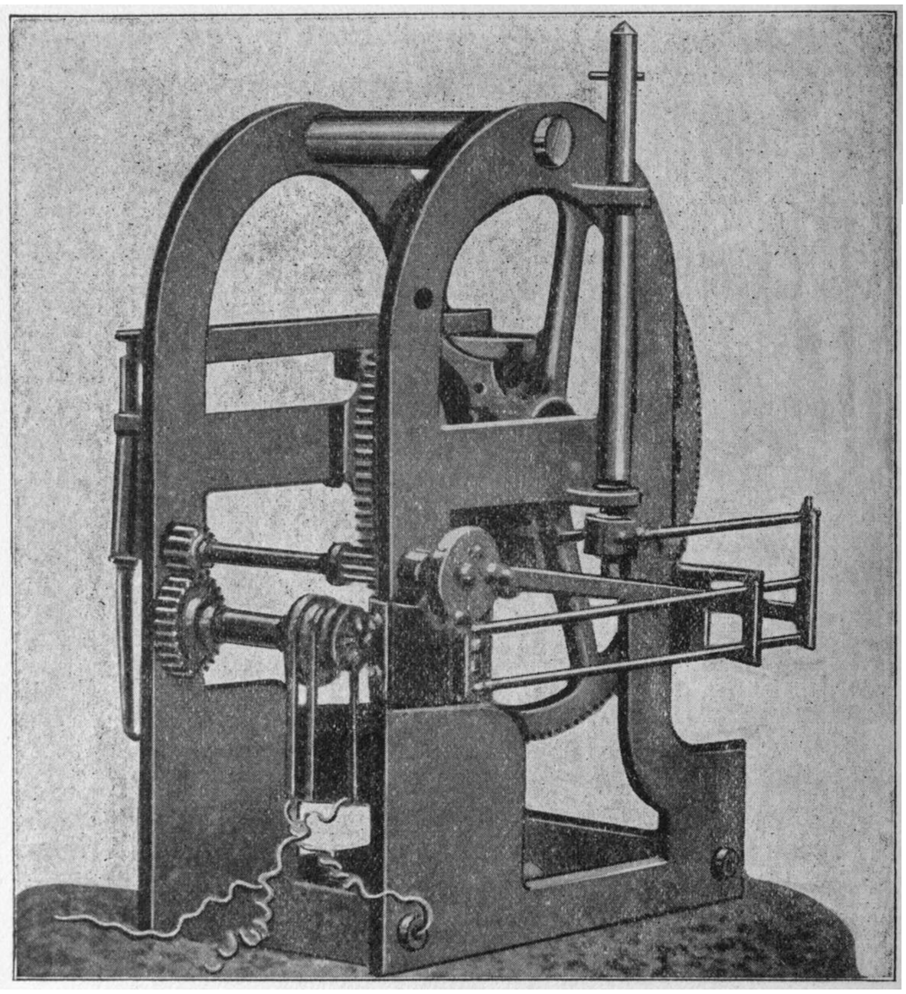


*Figure 10. This illustration is of Robinson's signal mechanism used in 1876 at West Somerville. The mechanism appears to be broadly that of his 1874 patents, but it has been refined considerably. The signal discs are mounted on the vertical spindle at the front of the mechanism. This appears to be operated by a crank at the foot of the spindle and the rod extending off to the right. The other two horizontal rods appear to be some form of slide, and the mechanism is driven by the inclined bar and the disc crank mounted on the front plate at the centre of the picture. This disc crank is mounted on a shaft extending to the rear plate and is driven by a small spur gear and large gear wheel mounted immediately behind the front plate. How this gear wheel was driven is not immediately apparent. The mechanism at the left with the wires appears to be the commutator for the battery saving.*

[11] Patent 154,520 "Improvement in automatic electric commutators", filed 18.7.73 and granted 25.8.74.

[12] Patent 155,259 "Improvement in splices for electric track-circuits", filed 18.7.73 and granted 22.9.74.

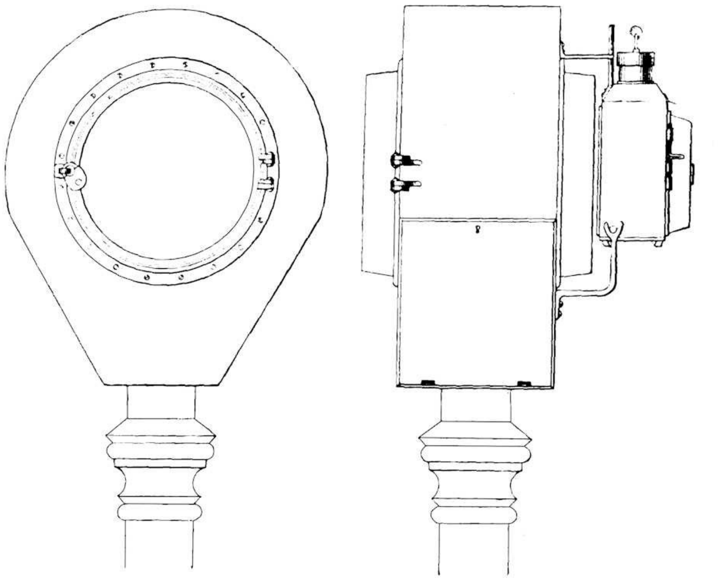


*Figure 11. Although from 1880, after the formation of the Union Electric Company, this drawing is almost certainly of the signal casing that enclosed Robinson's electric signal mechanism. The width of the case necessary to fit the horizontally rotating discs is obvious.*

four installations of Hall's automatic block system in use or under construction: 18 miles of the Eastern Railroad between Boston and Salem; 10 miles of the Boston & Lowell Railroad between Boston and Stoneham Branch Junction; 21 miles of the Boston & Albany between Boston and South Framingham; and four miles on the Old Colony Railroad. It is likely that Robinson felt that installations of his system were more likely in an area where electric signals were already a known quantity.

In January 1876 Robinson made a track circuit installation at West Somerville on a branch of the Boston & Lowell Railroad. The signal was placed at Elm Street with the batteries at North Avenue[13]. On 14 June 1876 the system was inspected by His Majesty, Dom Pedro II, Emperor of Brazil. The demonstration included removing one of the rails! It was reported that the battery had been in operation exactly 180 days without any attention, except for topping up the water on two occasions. A year later the station agent at Elm Street reported that the signal had been continuously work and was 'entirely reliable'. This installation worked 'perfectly for a number of years until the signal post, which was of wood, rotted down.'

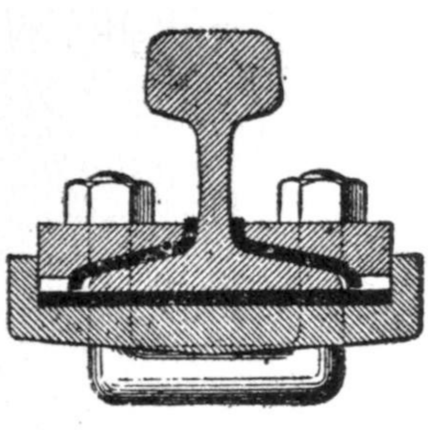


*Figure 12. The improved insulated joint showing the U shaped casting that supported the base of the two rails, and the U bolt with clips that held the casting to the rails with clips. The black portions are the fibre insulation.*

One technical innovation at this installation was the use of bond wires to connect the rails. Holes were drilled in each rail and the wire, closely fitting the hole, was forced in. A semi-circular punch was then "carefully" used to set the metal up close around the wires. A diagram of the bond wire used at this time shows that the wire was formed into a complete loop about halfway along; Robinson appreciated that the wire had to be sufficiently flexible to allow for movement of the rails without stressing the bond to the rails.

Around this time a new insulated rail joint was developed using vulcanised fibre (Figure 12). This joint was based on the Fisher & Norris Trussed joint. This joint did not use fishplates. Instead a continuous casting supported both rails underneath the base of the rails. Clips on top of the rail base were bolted to the casting. In the insulated version of this joint, fibre was placed, between the clips and the base of the rail and between the base of the rail and the support casting. Further fibre "the shape of the rail section" was placed between the ends of the adjacent rails. Robinson stated that "this makes an excellent insulated joint, both mechanically and electrically."

The equipment for this installation, and the subsequent Boston ones, was manufactured by Gassett & Fisher, who will have an important role to play in the third part of this article.

Further installations were made in 1876 on the Boston & Providence Railroad, the Old Colony Railroad, and the Boston, Lowell & Nasua Railroad, all in the vicinity of Boston.

Little is known of the Boston & Providence installation, except that it was installed in 1876 and introduced plugs for the bond wires. A plug was provided at each end of the bond. A slightly tapering hole was drilled through the top of the plug and the bond wire forced through the hole and soldered with hard solder. The plugs, being much larger than the wire, could be readily driven home through the holes in the rails with "a good deal of force," ensuring "an excellent electrical connection without endangering the

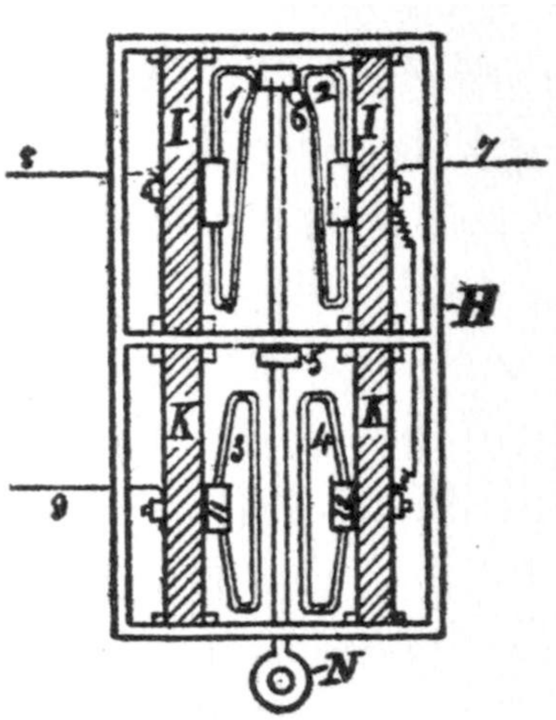
[13] Elm Street was a station on the Lexington, Arlington and Middlesex Division (the line between Boston, Arlington, Lexington, and Concord). It would appear that this is the modern location known as Davis Square where Elm Street crossed the line. The station was closed for passenger traffic in 1927 when passenger service into Boston was rerouted over the former Fitchburg Railway, and for freight around 1980. The modern Davis station of the Red Line is located in this vicinity.

wire". A slightly different approach, also used in 1876, added wrapping the wire twice around the head of the pin which would have reduced stress on the joint between the wire and the pin.

The Boston, Lowell & Nashua installation was also installed in 1876 at Wilmington Junction. In this double track installation two track circuits were installed, one on each track. Six sets of switches were detected in the two blocks – one track had five sets and the other had only one. The protecting signals would not clear unless the switches were set and locked for the main line. The detector and bonding (Figures 12 and 13) were interesting as it was arranged for stub switches, with the actual switch 'rails' not being bonded in the circuit. One rail was continuously bonded around the switch rail. The second rail was bonded through the detector. When the switch was in the normal position, it was connected to the rail beyond the switch. When the switch was reversed the track circuit was short circuited; as Robinson realised that positively shorting the track circuit was more reliable and faster than opening the bonding. The detector itself had two sliding contacts. The diverging rails were included in the track circuit to detect vehicles foul of the main line. The bonding arrangement for this would be entirely recognisable to a modern signal engineer – the crossing and one rail of the turnout were bonded together; the other rail of the turnout was bonded to the other main line rail; and insulated rail joints were provided in the two closure rails. This switch detection circuit had been installed on the Philadelphia & Erie in 1873.

Around 1876, Robinson installed the system at Somerset, MA, on the Old Colony Railroad. The novelty in this system was that one track circuit included a drawbridge. The track rails of the drawbridge were included in the circuit, and withdrawing any of the bridge lockbolts would drop the track relay and cause the signal to display danger.

The system must have been getting some attention for in 1876/7 it was installed through the Tehuantepec Tunnel[14] on the Southern Pacific in California. This installation was notable for several reasons. The first was that Robinson did not actually install the system. The



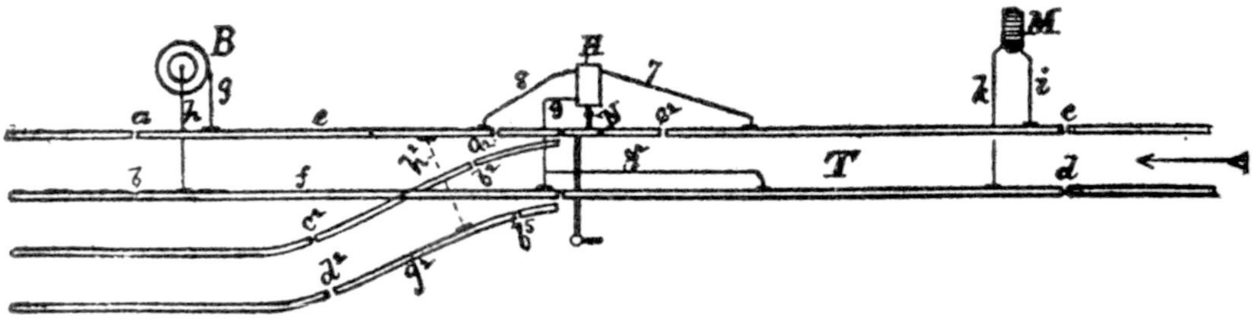




*Figure 13 showing the bonding at a switch (below) and the switch detector (right). In the bonding diagram, B is the battery and M is the track relay. H is the switch detector. The switch is a stub switch in which short pieces of rail are slid horizontally to align with either the main line or siding. Note that the switch rails themselves are not included in the track circuit; being bridged around by wires 7/8 and g2. Other than this, the bonding would be familiar to a modern signal engineer – notice the insulated joint in the curved closure rail to insulate the crossing from the upper rail, and the bonding wire h' connecting the two stock rails. The switch detector (right) uses sliding contacts operated from the switch stand. The upper contacts are closed when the switch is set for the main line. The lower contacts are closed when the stub rails are moved from the normal position. In this position the two rails are shorted together via wire 9.*

[14] There is no Tehuantepec in California. It has not been possible to definitely identify this location, and it is notable that the Signal Section did not attempt to do so in 1923. However, in the 1870s the Southern Pacific was legally distinct from the Central Pacific and was only involved in constructing one line – the line between Lathrop near San Francisco and Los Angeles through the Tehachapi pass. The tunnels through the Tehachapi pass itself are all relatively short, but Tunnel 20 on the line is the San Fernando tunnel near Los Angeles which is over a mile long (6,966 feet). The line was completed through the single track tunnel and opened on 5 September 1876. The tunnel was notoriously wet, but the surrounding countryside is very dry. Upon opening it was reputedly the longest tunnel in the world, and being single track, would be an obvious candidate for some form of protection. However, Signor's history of the line ('Southern Pacific – Sante Fe Tehachapi', Golden West Books, 1983) does not mention this signalling system.

equipment was forwarded by Robinson to Stephen D. Field, secretary of the Electrical Construction and Maintenance Company of San Francisco. It appears that Field successfully installed the track circuit. Technically the installation (Figure 14) was notable as it was the first instance of a cut section track circuit, where the track relay of one section energised or de-energised a second section. The cut section was necessary due to the length of the tunnel (Robinson stated it was one mile long) and poor ballast conditions with the rails in the tunnel buried in wet mud. It is not clear who came up with the idea of the cut-section track circuit. It might have occurred independently to both Robinson and Field as, on 21 March 1877, Field wrote to Robinson stating that he had just received Robinson's letter, but had already connected the signals as shown in Robinson's diagram.

**Status as at 1876**

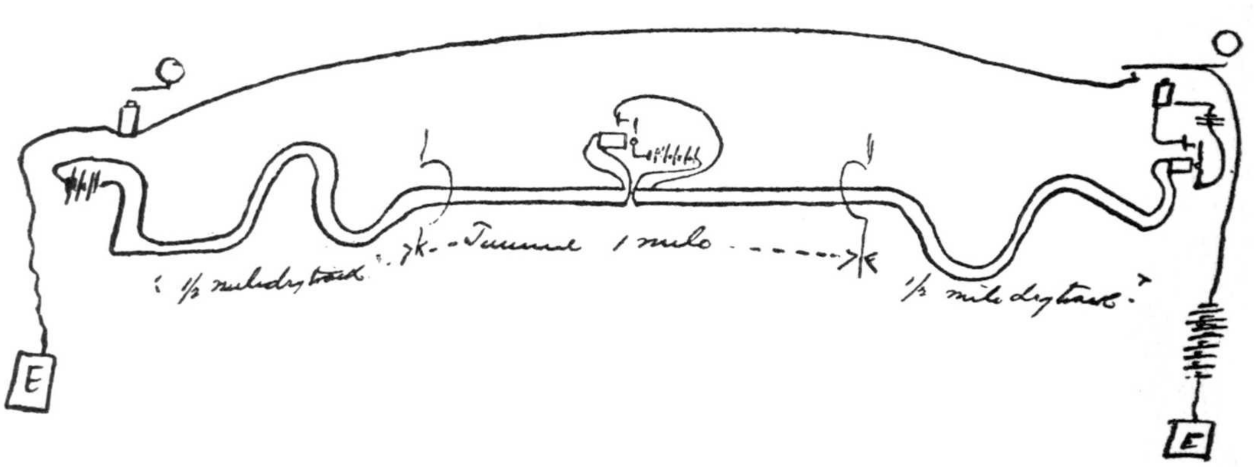
The trial installations up to the end of 1876 showed that Robinson's track circuit based signalling system worked. However, while Robinson could get railroads to install trial installations, and they appeared to work well enough to be used for a while, railroads did not appear to maintain them, or extend their use. Robinson's writings are not clear as to the problem.

About eighty years later, Farnsworth in his internal history of the US&S Co, stated that this lack of success was due to "the supply of energy to the signal mechanism through the track rails. The high potential currents necessary to establish the current flow from the battery through the track rails to the signal operating mechanism resulted in very large leakage losses across the ties and ballast and operation of the signal was erratic and inefficient."[15] In Farnsworth's view, the key to successful operation was the track relay which allowed the signal mechanism to be driven by a local battery.

However, it is clear from the descriptions given in this section that Robinson had been using a track relay since about 1874.

The next installation of the track circuit was a success and did result in further permanent installations. There were two key differences with this successful installation: Robinson had little involvement, and the electric signal was replaced by a clockwork one.

*Figure 14. Stephen Field's sketch of the 1876/7 track circuit installation at 'Tehuantepec' tunnel on the Southern Pacific in southern California. This was included in Robinson's book because it was the first cut-section track circuit, but the sketch is of greater interest for the detail that it gives on what was probably Robinson's practice at this time. The double lines are the two rails forming the track circuits, with the battery at the left hand end, the cut section in the middle of the tunnel, and the track relay at the right. The track relay controls the circuit for the entrance signal at the right hand end. A repeating circuit, with earth return, is used to control the entrance signal at the left hand end. This was probably the method used by Robinson when protecting other short sections with signals at each end. An interesting feature is the number of battery cells shown in each circuit – about half a dozen in each section of the track circuit, two for the directly controlled signal, and about a dozen for the indirectly controlled signal.*




---

[15] The Union Switch and Signal Company, A review of its predecessors, formation, developments, growth, activities, acquisitions and affiliates, M.M. Farnsworth, 1948, p29-30