

Ref	NR/GN/SIG/19014
Issue	1
Date	March 1997

SIGTAN 014 Mechanical Handbook (formerly RT/E/C/19014)

This temporary front sheet facilitates change to the new Network Rail Standards referencing nomenclature.

The Ref above will be formally allocated to this standard when it is next changed in the meantime the contents, date and issue number of this Network Rail Standard are UNCHANGED and with immediate effect it should be referred to as “(new ref) formerly (old ref)”.

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of the Standard Owner.

© Copyright 2004 Network Rail

Uncontrolled copy once printed from its electronic source.

Published & Issued by: Network Rail; 40 Melton Street, London NW1 2EE



RAILTRACK LINE

CODE OF PRACTICE

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE (SIGTAN014) MECHANICAL HANDBOOK

Approval and Authorisation

Endorsed by:


.....
J F Wilson

Head of Control Systems Engineering, EE&CS

Authorised by:


.....
R I Muttram
Director, EE&CS

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of Railtrack PLC.

Published and issued by
Director EE&CS
RAILTRACK H.Q.,
40 Bernard St.
London WC1N 1BY
London SE1 8SR.

©1997 RAILTRACK PLC

SUMMARY

This SIGTAN contains a draft copy of the Mechanical Handbook and is intended as a guidance document only.

ISSUE/REVISION RECORD

This code of practice will be updated when necessary by the distribution of a complete document. Amendments will be marked with a vertical black line in the adjacent margin.

Issue	Date	Comments
Issue 1	Mar 97	First Issue

IMPLEMENTATION

The requirements of this code of practice are to be implemented from the date of publication unless express written permission is obtained for any deviation from the Director, Electrical Engineering and Control Systems. The following documents are superseded.

Superseded reference number	document	Issue	Date
NONE			

DISCLAIMER

Railtrack Plc has used its best endeavours to ensure that the content, layout and text of this document is accurate, complete and suitable for its stated purpose. It makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems of work or operation. Railtrack plc will not be liable to pay compensation in respect of the content or subsequent use of this document for any purpose other than its stated purpose or for any purpose other than that for which it was prepared except where it can be shown to have acted in bad faith or there has been wilful default.

SUPPLY

Persons requiring copies of this document shall obtain them from the Directorate's Document Control Point. should their Directorate or Department not have a Document Control Point, copies can be obtained from the Document Control Manager Production at Railtrack Headquarters.

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE
(SIGTAN014) MECHANICAL HANDBOOK

Section	Title	Page
0	PREFACE	4
1	SIGNALBOXES	5
2	LEVER FRAMES Fig. 2.1	7 12
3	LEVER FRAME CONNECTIONS Figs. 3.1 - 3.4	13 16
4	WIRE RUNS Figs. 4.1 - 4.12	18 22
5	SEMAPHORE SIGNALS Figs. 5.1 - 5.3	25 30
6	POINT DETECTION Figs. 6.1 - 6.3	33 35
7	POINT AND FACING POINT LOCK CONNECTIONS Figs. 7.1 - 7.3	38 41
8	COMPENSATION Figs. 8.1 - 8.3	44 47
9	FACING POINT LOCKS Fig. 9.1	50 52
10	BENCHES	53
11	CONTROLLED LEVEL CROSSING GATES	55
12	ELECTRIC LEVER LOCKS	59
13	CIRCUIT CONTROLLERS	62
14	MOUNTING OF LOCKS AND CIRCUIT CONTROLLERS	64
15	LOCK ADJUSTMENT AND FUNCTIONS	72
16	CIRCUIT CONTROLLER ADJUSTMENT AND FUNCTIONS	76
17	LEVER LOCK AND CIRCUIT CONTROLLER COMBINED CHECKLIST	81

0. PREFACE

This is a Draft Edition of the forthcoming Mechanical Signalling Handbook. In the absence of other material, it is offered for use, in the knowledge that certain sections require more work for completion. Many of the illustrations are temporary and many more illustrations are required.

It contains check lists for each of the sections, the purpose being to allow auditing of mechanical signalling installations to be carried out.

Many people have sent details of incidents which have occurred in recent times. It is intended that the final edition will incorporate all the shortcomings which have been highlighted as a result of those incidents.

There needs to be a rationalisation of Metric and Imperial Units as both are used at the moment. Temperatures are quoted in Fahrenheit.

Sources	Basic Mechanical Signalling Course Notes. York
Used	Training School.

	Railway Signalling and Communications. (Believed Published 1940).
--	--

I. SIGNALBOXES

In the course of railway development means were required to concentrate, within signal boxes, the control of points (switches), signals, level crossings and moveable bridges; furthermore to ensure the safety of rail traffic with steadily increasing weights and speeds interlocking between the various elements was devised.

Both the operation of the various functions and the interlocking between the levers initiating them was originally provided in mechanical form; only towards the end of the 19th century were tentative applications made of electrical operation and interlocking. It is to be noted however that relatively early on in railway operations communication between signal boxes, for the purpose of train (block) separation, was provided using telegraph principles of instrumentation and derivatives.

This handbook therefore gives guidelines to engineers involved in estimating, designing, installing, testing and maintaining signalling equipment which is of a fundamentally mechanical nature but can have grafted on to it electrical controls, interlocking and operating equipment.

I.1 Responsibility

The signal engineering discipline is responsible for the design, construction, testing and maintenance of signalling equipment within and leading from mechanical signal boxes. This generally includes the block instrument and indicator shelf together with its associated signalling diagram, the mechanical interlocking lever frame, electric lever locking, circuit controllers and relay or solid state interlocking.

This handbook will, however, only provide information with respect to the mechanical interfaces between the lever frame, its mechanical locking, electric lever locks, circuit controllers and the mechanical equipment on the ground. The electrical circuit principles involved within the block shelf equipment, signalling diagram, electric lever locks, controllers and ground equipment are dealt with elsewhere.

I.2 Safety

The underportions of signalboxes, bed timbers and leadaway timbers must be kept clean and free of obstructions. If a walkway is provided over the leadaway, precautions must be taken to prevent injury to persons during the time that it is lifted.

The underportions of signalboxes are designated as hard hat areas as are also those areas on the operating floor where there is restricted clearance to the rear of lever frames.

1.3 Structure

Railtrack Property are responsible for the provision of new works, maintenance and repair of all portions of signalboxes that are not part of the signalling system.

1.4 Signalbox Check List

1. Lever Frame (See separate list).
2. Signal Wire Adjusters operational.
3. Block Instruments intact and locked.
5. Closing Switch. Covered and locked.
6. Blockshelf labelling intact and correct description.
7. Signalbox Diagram. Legible and correct depiction.
8. TC Indicators. Intact and operation.
9. Signal Indicators. Intact and operation.
10. Lamp Indicators. Intact and alarm operative.
11. Level Crossing Indicators. AHB or Other. Operation.
12. Level Crossing Controls. Operation (Pedestal or CCTV).
13. CCTV Picture. Quality and operation.
14. CCTV Supplementary Systems (ie Wipers). Operation.
15. CCTV Diverse Systems. Operation.
16. Power Supply Indicators operation.
17. Approach Locking Elapsed Indicator. Operation.
18. Emergency Releases sealed.
19. Hand Timers sealed.
20. Operational phones working.
21. Emergency (AHB) phones working.
22. Single Line Instruments. Operation and Locked.
23. Tokens in System. Agrees with Record.
24. Train Staffs. Legible and Keys intact.
25. Plungers. Intact and secure.
26. Blockshelf Wiring. Sound.

2. LEVER FRAMES

2.1 Purpose

Lever Frames are provided to enable the concentration of control of all points, facing point locks, releases, derailleurs and associated signals allocated to a particular operating area. The levers are grouped and mechanically interlocked to ensure that the equipment can only be operated in a logical and safe order according to a pre-designed relationship.

2.2 Lever Positions

General arrangement drawing on page 12 illustrates the cross section and front view of a typical lever frame fitted in a mechanical signal box.

The lever is shown in its **normal** position away from the signalman and when operated is pulled towards the **reverse** position; it is retained in either position, but sometimes in others, by a spring-loaded down rod fitted to the lever engaging in the floor plate which separates the levers. The rod is connected to, and operated from, a catch handle towards the top of the lever; generally this catch handle is fitted as shown to the rear of the lever but sometimes is mounted to the front often in the form of a horizontal loop. On certain frames the operation of the catch handle energises or de-energises electrical circuits through the medium of a catch handle circuit closer, also known as an economiser, mounted adjacent to the down rod.

If the catch arrangement is loose or worn to the extent that it will not adequately hold the lever in place, then the frame is unsafe.

2.3 Types

There are approximately forty different types of lever frame still in use on Railtrack and other railway administrations in the British Isles. The great majority have direct locking between the levers, a few have indirect locking between the catch handles related to the lever position. There are a small number of other types which have special mechanisms.

2.4 Frame Underside

At the point where the lever bottom is pivoted a tail set at 90 degrees to the lever extends to the rear to operate signal wires, point rodding, level crossing gate mechanisms and sometimes vertically mounted electric lever locks. A similar tail to the front of the lever generally will be fitted to accommodate vertical locks and counterbalance weights.

Horizontally mounted lever locks and economiser contacts driven by tappets connected directly to the lever are usually mounted beneath the operating floor but sometimes to the rear of the frame on the operating floor. Electric circuit closers can be mounted to the rear or front of the frame and driven through reduction linkage from the lever

2.5 Lever Tails

The lever at the tail is designed to apply a movement of a wire or rod of between 17.5 inches for a signal and as little as 6.5 inches for a set of points. In some types of frames this is directly transmitted from the lever tail, or transmitted through a separate, horizontally pivoted counterbalance lever. In such circumstances the connection between the Counterbalance and the lever tail is of a fixed length, which if more than 9ft.4.3/8ths must be supported at an intermediate position to prevent buckling.

2.6 Counterbalance

Counterbalance weights, also known as back weights, are provided for levers controlling signals at approximately 400 yards or more from the signalbox, and/or where multiple point detection is required, to balance the weight of slack wire and to counter the effects of friction.

2.7 Direct Lever Interlocking

For Tappet - Direct Lever Interlocking, tappets are directly connected to the lever and drive into locking boxes. The locking boxes are normally mounted to the front of the frame and usually contain two locking channels which contain the locking dogs and have room for five bars. The locking boxes are accessed by lifting hatches in the operating floor. On such frames the lever catch handles can be operated, even if the lever is locked, because of this the interlocking has to be robust and able to withstand the force of a signalman pulling the lever against a lock.

2.8 Catch Handle Interlocking

For Tappet - Catch Handle Interlocking, the tappets are connected to a rocker. When the catch handle is operated with the lever normal, the rocker moves the tappet forward. During the travel of the lever the rocker remains static. When the catch handle is released with the lever reverse, the rocker drops to the reverse position - because the catch has passed the rocker fulcrum, the tappet is moved further forward. On such frames the catch handle can only be lifted if the lever is free, because of this the interlocking may be of lighter construction, but must still be capable of withstanding a signalman attempting to operate a catch handle.

2.9 Duplex Tappet Interlocking

For Duplex - Tappet Interlocking, there are two tappets, one connected directly to the lever and one connected through an escapement to the catch handle. Both tappets drive into the same aperture, that for the catch handle sliding on top of that for the lever. On such frames the catch handle can only be lifted if the lever is free.

2.10 Other Frames

There are a number of other types of mechanism. However the majority of frames use tappet locking, or a derivation of such.

2.11 Lever Forces

Calculations are necessary to provide the correct balance lever weighting to ensure wire return, minimal lever return push forces consistent with this requirement and in the event of inter-linking breakage minimal risk of injury to the Signalman.

2.12 Lever Frame Checklist

Operating Floor

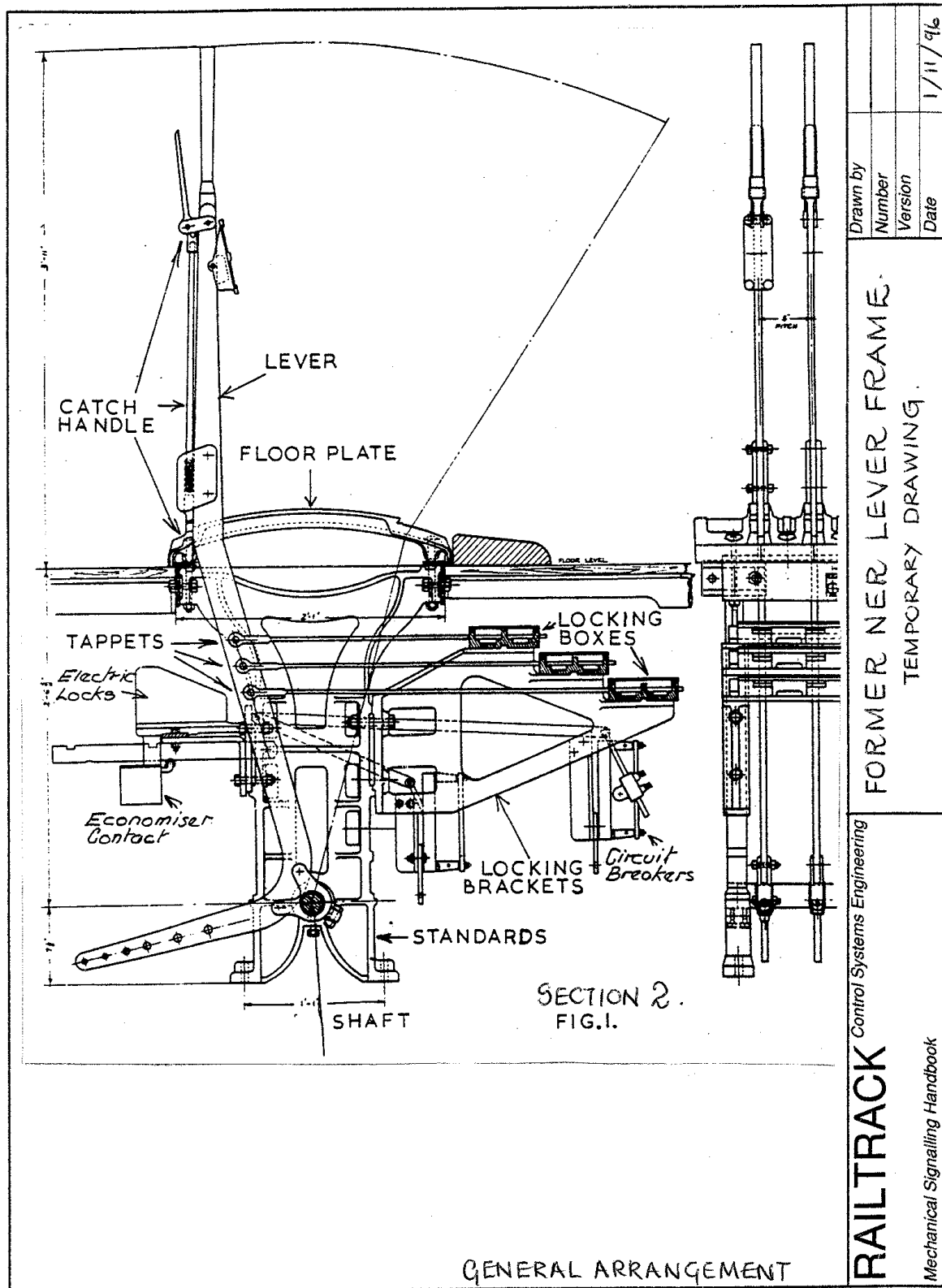
1. Lever Painting. Correct Colours.
2. Pull Plates. Intact and Correct.
3. Description Plates. Intact and Correct Descriptions.
4. Quadrant Plates. (If on LMS Frame) - Unbroken.
5. Catch Handles. Securely pinned.
6. Catch Blocks. Operation and wear.
7. Catch Springs. Intact and operation.
8. Footboard. Sound.
9. Foot Plungers. Intact and operation.
10. Gravity Locks. Mountings and Locks secure.
11. Gravity Locks. Lids present, intact and locked.
12. Gravity Lock Tappets. Securely pinned and guarded.
13. Lever Operated Economisers. Secure.
14. Wiring to Locks and Economisers. Sound.

Underfloor

1. Levers. Secure in shoes.
2. Lever Axle. Check for excessive movement.
3. Lever Tails. Secure in shoes / Fixed to Lever / Front and Back.
4. Electric Lock Tail (Boomerang). Where provided, secure.
5. Electric Lock or Circuit Controller Mountings. Secure.
6. Electric Lock or Circuit Controller Drive. Securely pinned.
7. Electric Lock or Circuit Controller Covers. Intact and labelled.
8. Electric Lock or Circuit Controller Wiring. Sound and secure.
9. Electric Lock Travel Limit Pins / Screws / Blocks. Intact.
10. Counterbalance Weights. Secure and pinned where appropriate
11. Counterbalance Swinger. Secure and pinned.
12. Counterbalance Wheel. Secure to underfloor ceiling.
13. Lever Tail to Counterbalance Lever. Secure and supported.

Locking

1. Tappets. Lever fixings secure and pinned.
2. Swung Tappets. Swing pins secure.
3. Locking Boxes. Secure.
4. Locking Lids. Fastened down.
5. Rockers. Secure and pinned where appropriate.
6. Lubrication. Sufficient.



3. LEVER FRAME CONNECTIONS

3.1 Down Rod

For points and facing point locks, if the rod between the lever tail and the vertical crank is longer than 9 feet, 4.75 inches then it must have some intermediate support to prevent buckling. If the line is electrified the bottom joint on the down rod must be insulated.

3.2 Points & FPLs

Points and facing locks (FPLs) are driven by channel rodding carried on rollers and directional changes are carried out using cranks. The connection at the lever tail, which can be at variable fulcrum distances to suit the throw, and at each intermediate crank is by means of a forged pin joint bolted to the channel section.

The maximum practical distance at which points can be operated, due to the forces required of the signaller, is recommended as 200 yards to satisfy the Health and Safety Executive - HM Railway Inspectorate 'Guidance on signalling' which states under paragraph 90:

"The design of signal-boxes should provide a working environment which minimises distraction, fatigue and stress, to avoid risk of error by the signaller." (Railway Safety Principles and Guidance part 2 section D; HSE Books - HS(G)153/5 - ISBN 0 7176 0953 7)"

3.3 Signals

Mechanical signals are operated by stranded wire carried on staked pulleys and directional changes are carried out using 10 inch or larger pulleys, or cranks where there is no risk of over-centring and locking up. To prevent a set in the wire developing at the directional pulley, which would otherwise lead to wire fracture, a short length of chain or sometimes a wire sling, which is of sufficient length for maximum travel, displaces the wire over the pulley. The connection at the lever tail, which can be at variable fulcrum distances to suit throw, and at any cranks is generally by thimble shackles.

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE
(SIGTAN014) MECHANICAL HANDBOOK

The maximum recommended distance at which signals can be mechanically operated is 1000 yards which minimises the effects of temperature change on the wire route, consequent risks of signal arm displacement and the necessity for the signaller to make frequent wire adjustments.

On electrified lines, where a signal wire leaves the signalbox there should be a wire insulator.

3.3.1 Signals to 75 yds.

The necessary mechanical advantage to operate signals up to this distance can be obtained by securing the wire directly, or indirectly using a miniature draft wheel, to the lever tail. In the former minor trimming adjustments to the wire are made using a turnbuckle, whilst in the latter the wire chain is taken over the wheel and reconnected to an individual link to suit using a 'S' hook.

3.3.2 Signals 75 to 250 yds.

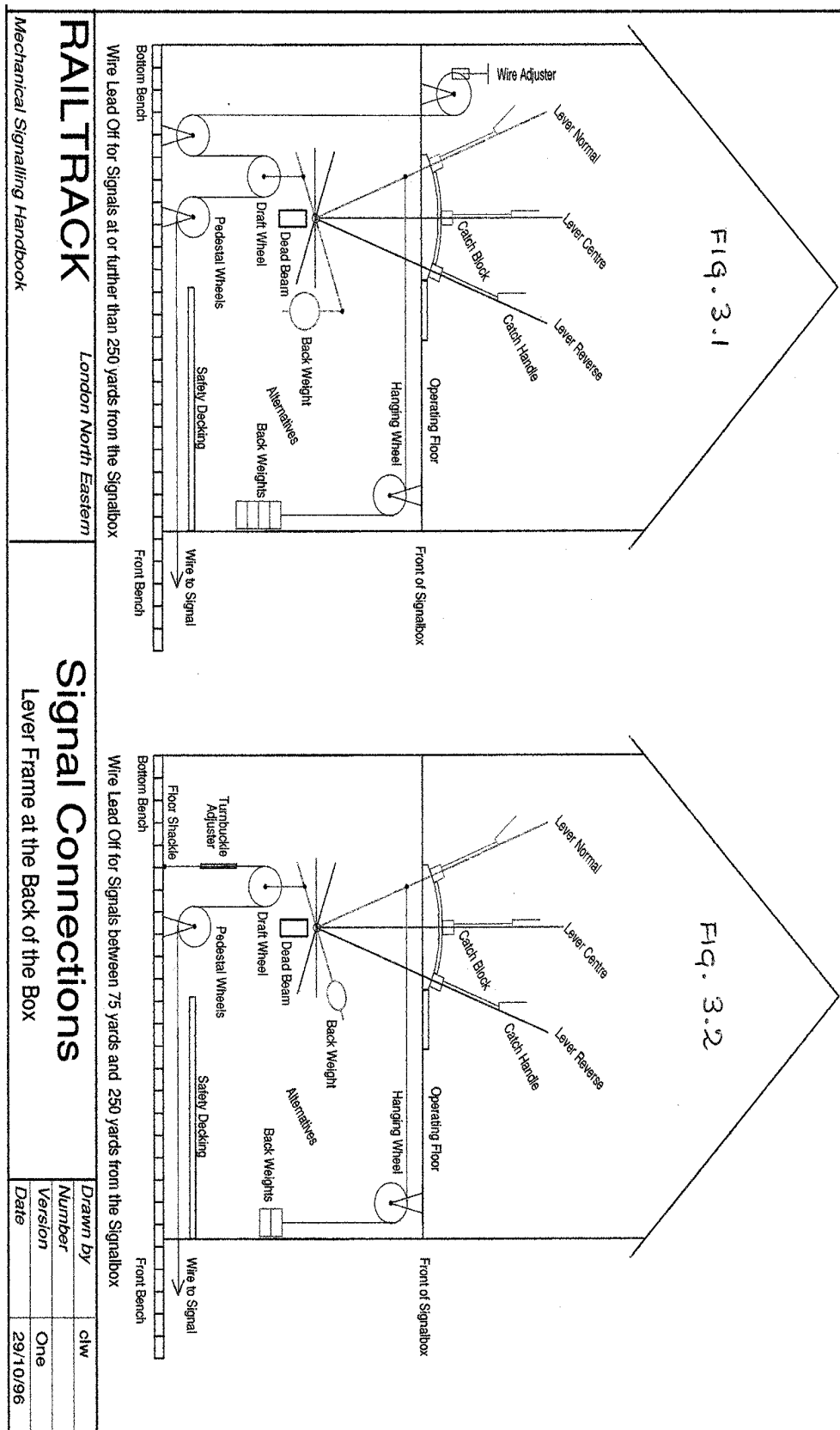
The necessary mechanical advantage to operate signals further than 75 yards from the signal box is obtained by using a gainstroke wheel. Up to 250 yards the effects of temperature on the wire run can be ignored and the wire end will be secured through a turnbuckle on to a floor bench mounted shackle after passing over a gainstroke draught wheel attached to the lever tail. One gainstroke wheel will impart double the lever train movement.

3.3.3 Signals 250 to 1000 yds.

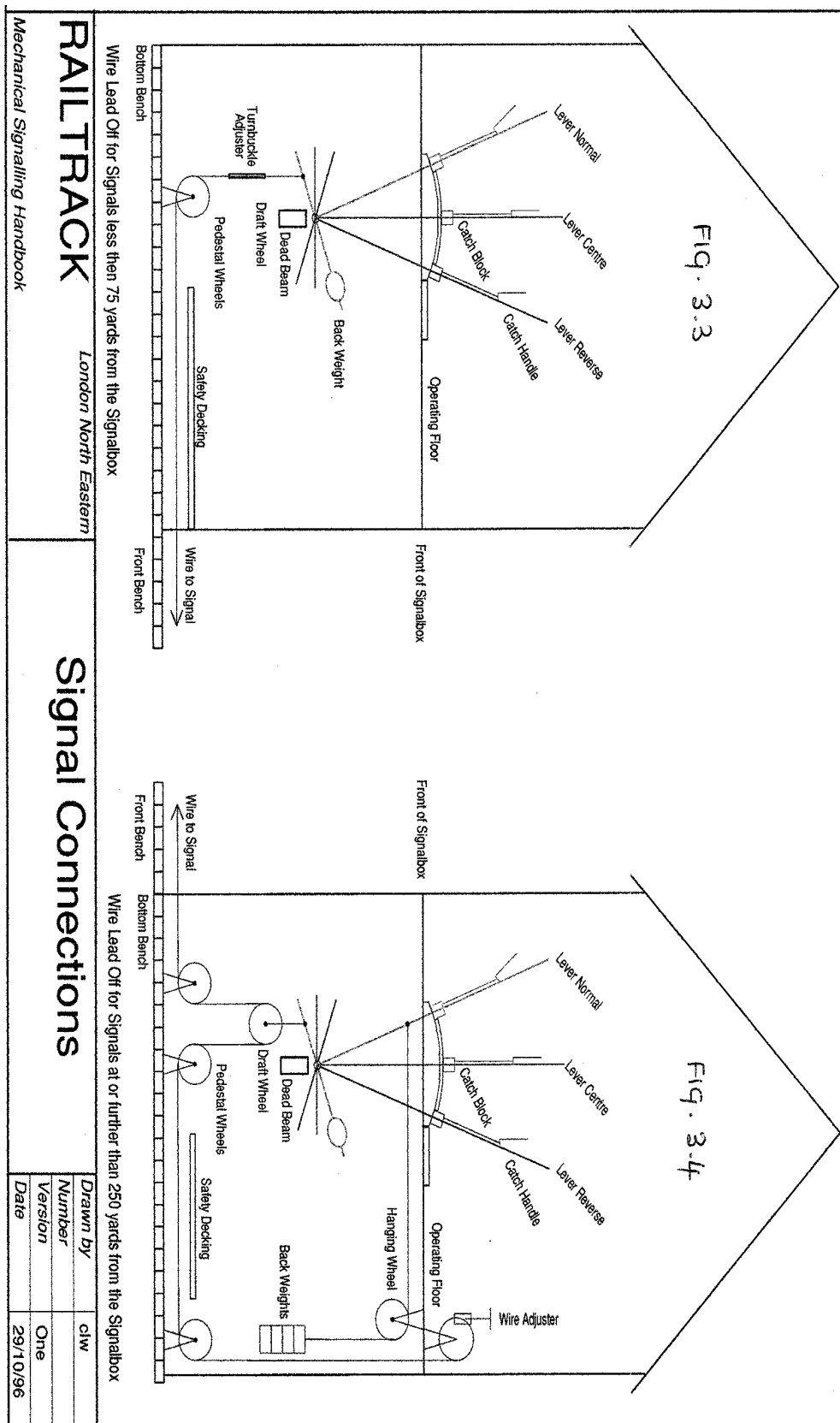
For signals which are more than 250 yards from the signalbox it will be necessary for the signaller to be able to adjust the wire to compensate for extremes of temperature. The same method of connection to the lever tail as in the previous example is used, with the exception that instead of the wire being terminated at the bench, the sling or chain passes over another vertical wheel and then onto a wire adjuster which is located on the operating floor. A statement that mechanical detectors cannot be used on compensated wire runs should come in the point detection section.

3.4 Connections Check List

1. Point Drive Rods. Pinned and supported where appropriate.
2. Down Rod. Secure and supported.
3. Insulations. Presence and condition.
4. Signal Draft Wheels. Secure and pinned.
5. Direct Wire Connections. Secure and pinned.
6. Wire S Hooks or Split Links. Secure and closed.
7. Wire Barrel Adjuster. Sufficient adjustment remaining.
8. Chains or Slings. Sufficient length for all adjustment.
9. All Cranks and Wheels. Fitted by two bolts and two screws.
10. Pedestal Cranks and Wheels. Secure and pinned.
11. Pedestal Cranks. On action.
12. Crank and Wheel Spindles. Cranks and Wheels firm.
13. All connections. Correctly pinned and T bolts secure.
14. Cranks. Fitted with grease nipple where appropriate.
15. Lubrication, where required, in moderation.
16. Cleanliness and freedom from foreign objects.
17. Evidence of wear and corrosion or wire at shackles.
18. Security of split pins and wear in spacers, spindles and bushes.

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE
(SIGTAN014) MECHANICAL HANDBOOK

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE (SIGTAN014) MECHANICAL HANDBOOK



4. WIRE RUNS

4.1 Arrangement

Wire runs should be designed so that the wires with the longest run are running in the top pulleys with the shortest run in the bottom pulleys, this avoids wires crossing each other. Wire runs should be as straight as possible. Any leads dropping from the main run down to other connections should be gradual and adequately supported. Any such leads should leave the main run <In Line>, or if this is not possible a swivel pulley should be used. Wires must not obstruct or be obstructed by rodding or other fixed obstacles and must be supported so as to avoid snagging. A considerable amount of stroke is lost in wire runs due to sag caused by the weight of the wire and by contraction and expansion due to extremes of temperature.

4.2 Crossing the Track

Repeated crossing of the track should be avoided. Such wires should be routed so as to avoid contacting the bottom of the rails (or in electrified areas, the conductor rail). The bay should be cleared of ballast to a sufficient depth to accommodate the wires and precautions taken to ensure that this bay cannot fill with water, which may then freeze the wires into a wrongside position. If necessary it may be necessary to mount <in line> wire pulleys at sleeper level across the bay, to ensure the correct positioning of the wires.

4.3 Trunking and Pipes

If wires are run through trunking or pipes, these must be kept clear of waste and water and precautions taken to ensure that wires do not snag each other.

4.4 Route Dimensions

Wire pulley posts must be placed at a maximum interval of 9 yards, they must be kept square and firm in the ground. The pulleys attached must be secure with no broken parts. If the wire run is round a curve then swivel pulleys must be used. (The wire will snag in a fixed pulley).

4.5 Changing Direction

Wheels and frames must be kept secure and clear of obstructions. Care must be taken to ensure that wires, slings, chains and joints do not foul each other. Consideration must be taken of the effects of the wire going very slack if as a result the wire may leave a wheel and become entangled in the frame, consideration must be given to fitting additional wire guides.

4.6 Slings and Chains

Where the wire passes round wheels, a sufficiently long sling or chain must be used to ensure that in the event of expansion, contraction or adjustment, the sling or chain remains on the wheel (not the wire).

4.7 Splicing

Where wires are spliced, care must be taken to ensure that the splice is well clear of any other chain, sling or splice upon which it may snag.

4.8 Gainstrokes

In very long wire runs to a distant signal, a gainstroke lever is sometimes used. This is a weightbar mounted on a lineside post, which when pulled, pulls the next section of wire at a longer stroke setting. The weight tending to return the wire (and the signal) to the restrictive position. Care must be taken with gainstroke levers, because as the wire contracts in the cold, the lever will tend to pull the distant. Where gainstrokes are used the system must be fitted with a wire adjuster.

4.9 Wire Wheels

Wheels are for changing the direction of the wire, they consist of a 12 or 16 inch pulley with deep flanges that will keep the chain or sling in the correct position. They are available in three basic types.

4.9.1 Flat Wheels

Flat Wheels are contained within a horizontal frame which are mounted on a bench and turns the wire run through 90 degrees, the frame may be fitted with two wheels mounted above each other. If the wheels are not fully enclosed, then a wire guide should be fitted.

4.9.2 Pedestal Wheels

Pedestal Wheels are contained within a vertical frame and are used for turning the wire run from the horizontal to the vertical plane. They are always used on the bottom bench for turning the wire from the lever tail to the leadoff. Pedestal wheels may also be used at the bottom of a signal to turn the motion from the horizontal wire run to the vertical wire fixed to the weight bar.

4.9.3 Draft Wheels

Draft Wheels are also contained within a vertical frame which is attached by a pin to the lever tail and moves with it. Signals which are a long distance from the signalbox and are fitted with a wire adjuster are pulled by a draft wheel because of the mechanical advantage which this offers.

4.10 Wire Cranks

Wire Cranks are an alternative way of turning a wire through 90 degrees. However they are only suitable for use at the very end of a run where the stroke of the wire is at a minimum. They are most often used at the signal to turn the direction of the travel from the horizontal to vertical, or to turn direction on a gantry.

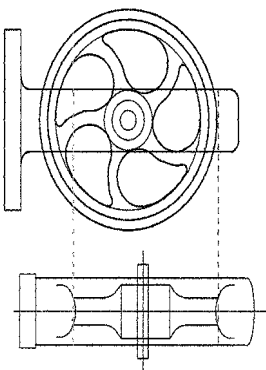
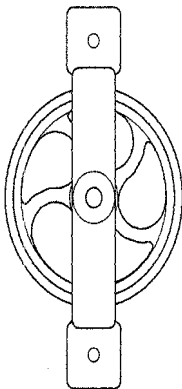
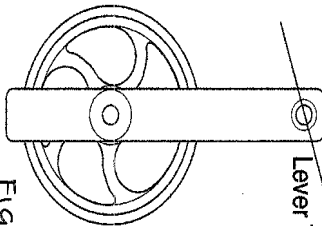
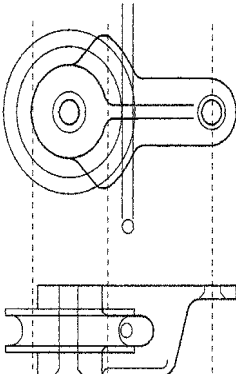
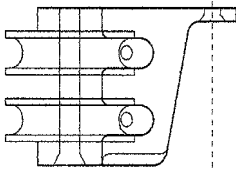
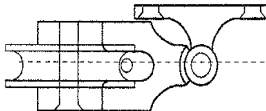
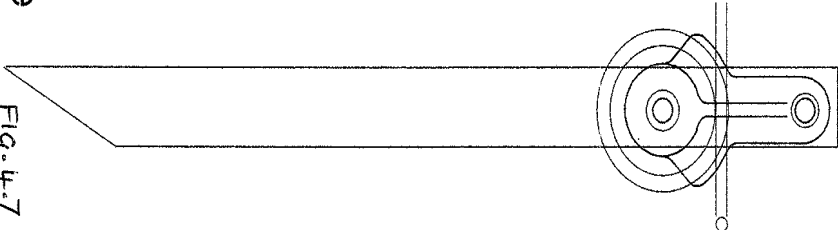
4.11 Health and Safety

Due consideration must be made with respect to causing obstruction to walkways.

4.12 Wire Run Check List

1. Pulley Wheel Stakes. Secure in the ground.
2. Pulleys. Secure on Stakes.
3. Swinging Pulleys. Free to swing.
4. Cross Track. Bays clear of debris, Wires clear of rails.
5. Trunking. Clear of debris.
6. Pulley Stakes. Correctly spaced.
7. Pulley to wheel or crank connections not too short.
8. Wheels and Wirecranks. Secure on benches.
9. Slings and Chains. Sufficient length.
10. Open Wheels fitted with wire guard.
11. S Hooks at the end of a chain fully closed.
12. S Hooks placed so that they cannot obstruct each other.
13. Wire splices placed so that they do not obstruct each other.

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE
(SIGTAN014) MECHANICAL HANDBOOK

Pedestal Wheel  FIG. 4.1		Flat Wheel  FIG. 4.2		Draft Wheel  Lever Tail FIG. 4.3									
Single Wire Pulley  FIG. 4.4		Double Wire Pulley  FIG. 4.5		Swivel Pulley  FIG. 4.6									
Channel Stake  FIG. 4.7													
RAILTRACK London North Eastern Mechanical Signalling Handbook			Signal Connections Wheels <table><tr><td>Drawn by</td><td>clw</td></tr><tr><td>Number</td><td></td></tr><tr><td>Version</td><td>One</td></tr><tr><td>Date</td><td>25/12/95</td></tr></table>			Drawn by	clw	Number		Version	One	Date	25/12/95
Drawn by	clw												
Number													
Version	One												
Date	25/12/95												

SIGNALLING EQUIPMENT TECHNICAL ADVICE NOTICE
(SIGTAN014) MECHANICAL HANDBOOK

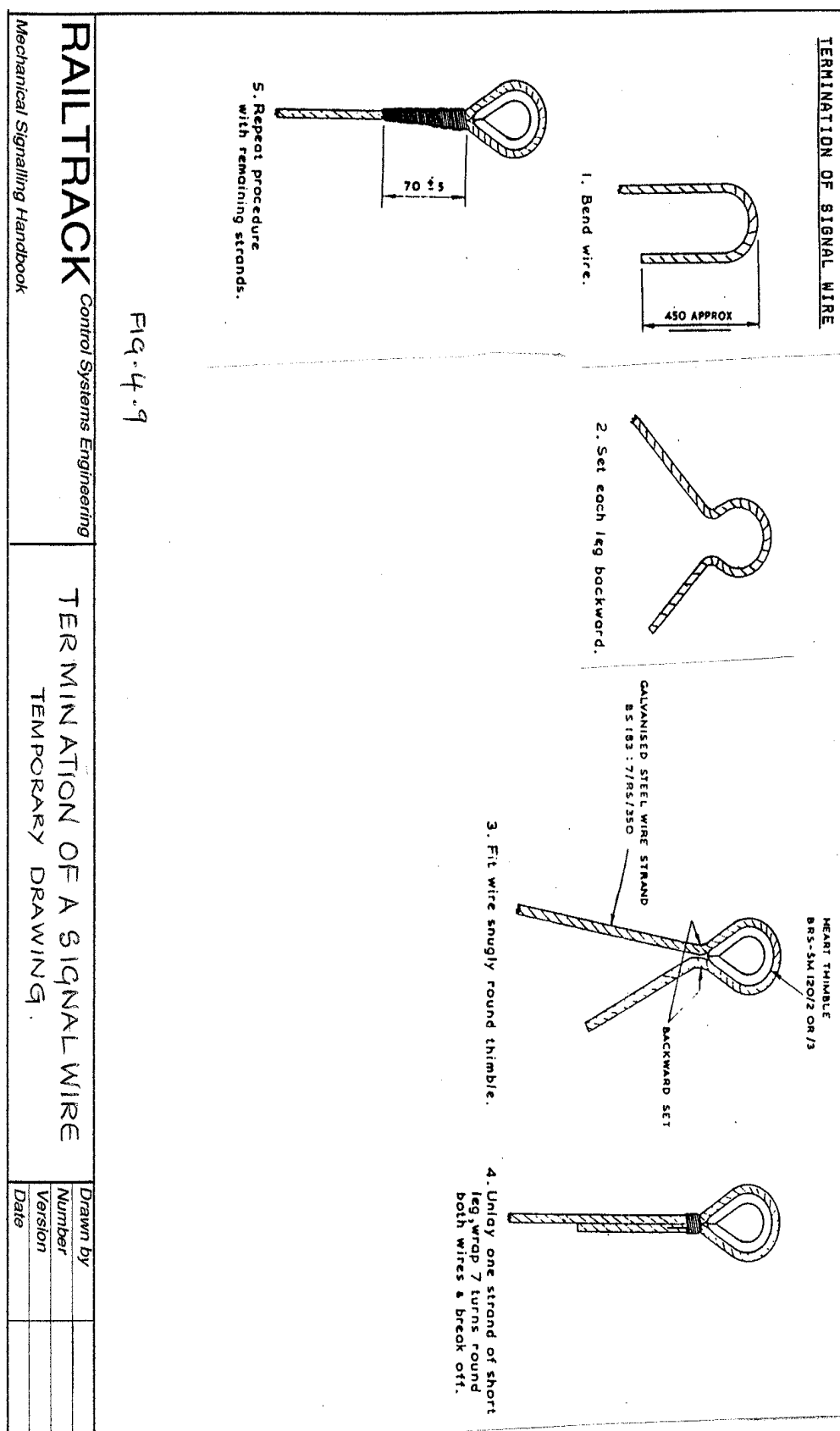


FIG. 4.9

