

Overhead Equipment : Erection

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1 Introduction

The adoption of 25 kV A.C. at 50 c/s as the standard voltage for all future Overhead Railway Electrification in Great Britain caused the Engineers responsible for erection of the equipment to review their methods, and speed up construction to meet the British Transport Commission's programme.

For foundation installation, whenever the ground is suitable, the rail-mounted earth auger, backed by a concrete mixing train, is the quickest, cleanest and most economic method. However, a 'hand-digging' gang is still needed, its size varying to suit the particular requirements of each section of route.

Less change has taken place in the methods of structure erection, and well tried techniques are still in use. In erecting the actual overhead system in this country, mechanical aids are used wherever possible, and it has been found that the A.C. overhead equipment which is much lighter than D.C. equipment can be erected and adjusted much more rapidly although the actual methods of running out remain substantially unchanged.

In all installation processes, therefore, mechanical equipment has been introduced on as wide a scale as possible. Such equipment has been developed by the BICC Group in conjunction with British Railways and is described in Paper 7. The use of costly equipment of course must be considered in relation to the Geographical location of the scheme; the cost of labour in some countries may not warrant such expenditure.

2 Survey

Prior to commencement of installation work, it is important to carry out a comprehensive survey of the route so that the

scheme may be designed as economically as possible and alterations during installation may be minimized.

The Survey should follow agreement with the technical and operating departments of British Railways on the basic requirements such as:

- Lines to be electrified.

- Positions of Sub-Stations and Track Sectioning Cabins.

- Electrical sectioning of the overhead equipment.

- Existing features which influence the positioning and/or design of structures or other overhead equipment.

They will have provided plans of station areas showing any modification schemes, small scale plans of open route, detailed drawings of overbridges, and tunnels showing any proposed alterations.

This information allows a survey team to check through the route and tentatively fix the positions of the overhead structures, including the positions of overlap spans, Neutral Sections, and other special structures. From this survey a preliminary layout plan can be developed which enables the departments of the Railway to walk the route and agree finally the positions of structures.

The final layout plans can then be produced. The Station and Junction layouts are usually drawn to a scale of 1 in. = 40 ft., and show the structure locations, spans between structures, type of structure, position of wire and other relevant information (fig.1).

For open route, the plans are normally to a smaller scale and show the structure locations and spans, the further details being shown on a data sheet which also gives foundation, steelwork, and assembly references and may form part of the layout plan (fig.2). Data sheets cover standard open route

equipment only and for the more complicated areas, a detailed cross-section of the track at each location is drawn out.

On approval of these details, the materials may be ordered so that they are delivered in good time for a satisfactory erection programme to be maintained.

3 Foundation Installation

British Railways readily agreed that the maximum use of a cylindrical foundation was desirable for speed, fewer track possessions, and economy. Specially adapted types of Earth Auger are therefore used wherever possible, but on an average scheme including large Terminal or Junction Stations and intermediate smaller stations it is optimistic to expect more than 60 per cent of foundations could be excavated in this way.

Ground conditions necessitate a wide range of foundation designs, many of which, particularly in Stations and Junctions, have to be considered individually to suit particular locations. Hand excavated foundations are normally required in such cases and a separate gang is employed in order to avoid interruption to the normal progress of the work. In this way the concreting train can work continuously throughout each section thus avoiding the necessity of additional possessions of the track at a later date.

The excavation of hand dug foundations follows normal practice with adequate timbering as required, and pumping when water is present.

Concrete is formed from a 1:2:4 mixture of Ordinary Portland Cement, sharp sand and $\frac{3}{4}$ in. ballast, the mix being fairly dry to allow for vibration by immersion type vibrators. If peat is present in the soil, a Sulphate Resistant Cement is used, when care is taken not to strike shuttering too early.

The concrete may be mixed in several ways to suit various conditions. Labour costs here rarely permit hand mixing and three types of mechanical mixing are used:

- (a) Where large quantities of concrete must be placed in a short time a rail mounted unit consisting of continuous mixers, material hopper wagons and bulk cement containers can be used to advantage and with great economy. See Paper 7 for details of this arrangement.
- (b) For smaller foundations and for use as a secondary unit, a rail mounted conventional mixer with material wagons, cement vans, and water carriers is used. This unit may consist of two mixers mounted on the same wagon with a central placer unit for transporting the concrete from mixers to excavation (fig.3).
- (c) In the case of foundations in Station areas or yards it may be convenient to set up a central fixed mixing plant, arrange a road supply of materials to it, and deliver the concrete to the excavation by dumper.

4 Steelwork Erection

Single masts for cantilever construction are normally installed by directly planting them into the augered excavation and concreting the foundation immediately thereby completing the operation in one possession. A complete unit consisting of three trains, a mechanical auger, a steelwork erection train, and a concreting train is used in this case and on an open route section approximately one mile of masts can be erected and concreted in a four hour possession.

Bolted base masts are erected by direct lifting on to the foundation bolts, plumbing the masts carefully and bolting down. Either steam or diesel cranes of $2\frac{1}{2}$ tons, $6\frac{1}{2}$ tons, or 10 tons capacity are used according to the weights to be lifted, and reach required. Structure booms are normally fabricated on the ground prior to erection, and if weight permits, are lifted in one piece for bolting to the mast. In the case of heavy booms it may be necessary to erect in two or more pieces, providing temporary support to ends of pieces as necessary.

All masts not forming part of a portal structure are erected with an initial rake away from the normal load so that under maximum loading conditions the masts are approximately plumb. It is particularly important to allow for balance weight anchor masts to be as near to plumb as possible so that ultimately the balance weights can move freely up and down the guide tube.

5 Small-Part Steelwork and Cantilevers

Small-part steelwork is normally laid out at each location from a materials train, the weight of some items making the use of a train essential. All items are then erected in their final positions, calculated from the positions of track and mast. A common datum rail is used for the erection of equipment wherever possible, so that equipment on each track is based on identical dimensions. At low bridges and other places where heights above individual tracks become critical, it may not be possible to adhere to a common datum.

In the case of simple open route masts, cantilevers are prefabricated in the stores to dimensions obtained from the 'as fitted' steel erection drawing, and the appropriate stagger. These cantilevers are then taken out by works train and erected by means of a Hydraulic Elevating Platform which enables each cantilever to be positioned accurately for attaching to the mast. Each cantilever is then locked in an across track position to facilitate running out of catenaries. Special Hydraulic Elevators have also been developed for use when attaching small steelwork to masonry and to rock.

6 Running out Conductors

Having erected the steelwork and the registration fittings and insulators as far as possible, the catenary is run out from the pre-assembled balance weight anchor locations at one end of the tension length through rollers at each supporting structure, is tensioned correctly and is then finally made off at balance weight anchor at the other end. The contact wire is

then run out on droppers from the main catenary and is tensioned so that it just begins to take the load of the balance weights. The catenary can be cut at the mid-point anchor, check-tensioned, and finally made off through appropriate insulators.

Generally the conductors are run out from a wiring train of six or seven flat-topped coaches and drum wagons. A running-out jib (fig.4) has been developed to facilitate the positioning of the conductor in the roller. It is also useful in running out Contact Wires particularly where the wire transfers to an adjacent track for part of its run. Thus there is a minimum handling of the wire and as a result there is less tendency for kinks to be formed.

External lighting of the trains (fig.5) is provided so that work can proceed at night under tolerable conditions and thereby difficult daytime possessions on heavily trafficked routes may be avoided. Work can in fact proceed under these conditions almost as quickly as in the daytime and taking into account the better track possessions that can often be obtained at night, the job can then be completed more quickly.

In certain areas such as complicated junction, sidings, and four-track main line where there is a preponderance of over-the-boom construction, it is often convenient and more economic to run out catenaries by hand instead of making use of a train.

After running out the conductors, and tensioning them correctly, they are clipped into their registration fittings and the swinging cantilevers positioned to give their correct offset according to the temperature of the day and their distance from the mid-point anchor.

When compound equipment is used, the auxiliary catenary is run out at correct tension on the droppers from the main catenary before the contact wire.

contractors and the user is to ensure that the survey and programming are such that everything works according to plan during the installation period. When such pre-planning is associated with good designs and skilled erectors little need for adjustment will arise under service conditions, and such a line should require the minimum of maintenance.

7 Completion and Testing

The overhead contact line is completed by bonding, earthing and running of feeders, including attachment to the rails, earth plates or switches as required, as described in Paper 6. When booster transformers and/or return conductors are involved, this is necessarily part of this work but, where possible it should be completed before any conductors are run out. It then remains to check the whole catenary system for compliance with the specification and adjustment as necessary before checking its performance by trial runs with the pantograph trains, described in Paper 7.

8 Conclusion

In the course of erecting nearly 650 single track miles for British Railways electrification schemes, practically every conceivable circumstance that can arise in electrification practice has almost certainly been met. It is clear that the best way of ensuring that the work is done to the satisfaction of the

SUMMARY

This Paper deals with the work to be carried out on site after designs have been finalised and an order has been given for construction to proceed.

A survey of the route is necessary so that special designs can be made and materials ordered to suit a detailed construction programme. Then possessions can be arranged and tools and plant, staff and labour can be organised in advance of any actual construction work starting.

Foundation installation and the erection of masts proceed simultaneously and only when this is well advanced should work begin on the erection of cantilevers and booms and smallpart steel-work prior to the running out of conductors. The erection of switches and other auxiliary items follows closely so that the equipment can be finally adjusted and tested as soon as possible after erection.

Only by the closest co-ordination of the work of Railway Departments and the work of the Overhead Line Contractor can a smooth installation programme be achieved.

RÉSUMÉ

Cet exposé traite du travail à exécuter sur place après que les projets ont été terminés et l'ordre a été donné de commencer la construction.

Une étude de la ligne est nécessaire pour qu'on puisse faire un projet spécial et commander des matériaux appropriés à un programme détaillé de construction. Alors des mesures peuvent être prises pour disposer de la ligne, et les outils, les équipements, le personnel et la main d'oeuvre peuvent être organisés avant le commencement de tout travail de construction.

L'exécution des fondations et l'érection des poteaux s'effectuent simultanément, et seulement quand c'est bien avancé qu'on commence le montage des consoles et des haubans, des poutres, des ferrures avant la disposition des conducteurs. Le montage des sectionneurs et d'autres équipements auxiliaires les suivent de près de sorte que l'équipement complet peut être réglé définitivement et essayé immédiatement après l'installation.

Seule la coordination la plus étroite du travail des départements des Chemins de fer et de celui des entreprises chargées des caténaires peut réaliser sans incidents un programme d'installation.

ZUSAMMENFASSUNG

Dieser Bericht behandelt die Arbeiten, die nach Fertigstellung der Pläne und Erteilung des Bauauftrages auf der Strecke auszuführen sind.

Zunächst ist eine Streckenaufnahme erforderlich, so dass Spezialpläne ausgearbeitet und Baustoffe, entsprechend dem ausführlichen Bauprogramm, bestellt werden können. Dann kann die Freigabe der Strecke vereinbart und die Bereitstellung von Werkzeugen, Maschinen und Arbeitskräften organisiert werden, bevor mit den eigentlichen Bauarbeiten begonnen wird.

Herrichtung der Fundamente und Aufstellung der Maste erfolgen gleichzeitig. Erst wenn diese Arbeiten weit genug fortgeschritten sind, sollte mit der Anbringung der Ausleger, Gurte und des Kleiseisenwerks begonnen werden, vor dem Auslegen der Fahrleitungen. Darauf folgt unmittelbar die Aufstellung von

Schaltern und sonstigem Zubehör, so dass die Gesamtanlage möglichst bald nach der Aufstellung endgültig justiert und geprüft werden kann.

Ein flüssiger Ablauf des Bauprogramms kann nur durch engste Zusammenarbeit zwischen den Bahndienststellen und dem Unternehmer für die Fahrleitungsanlage erzielt werden.

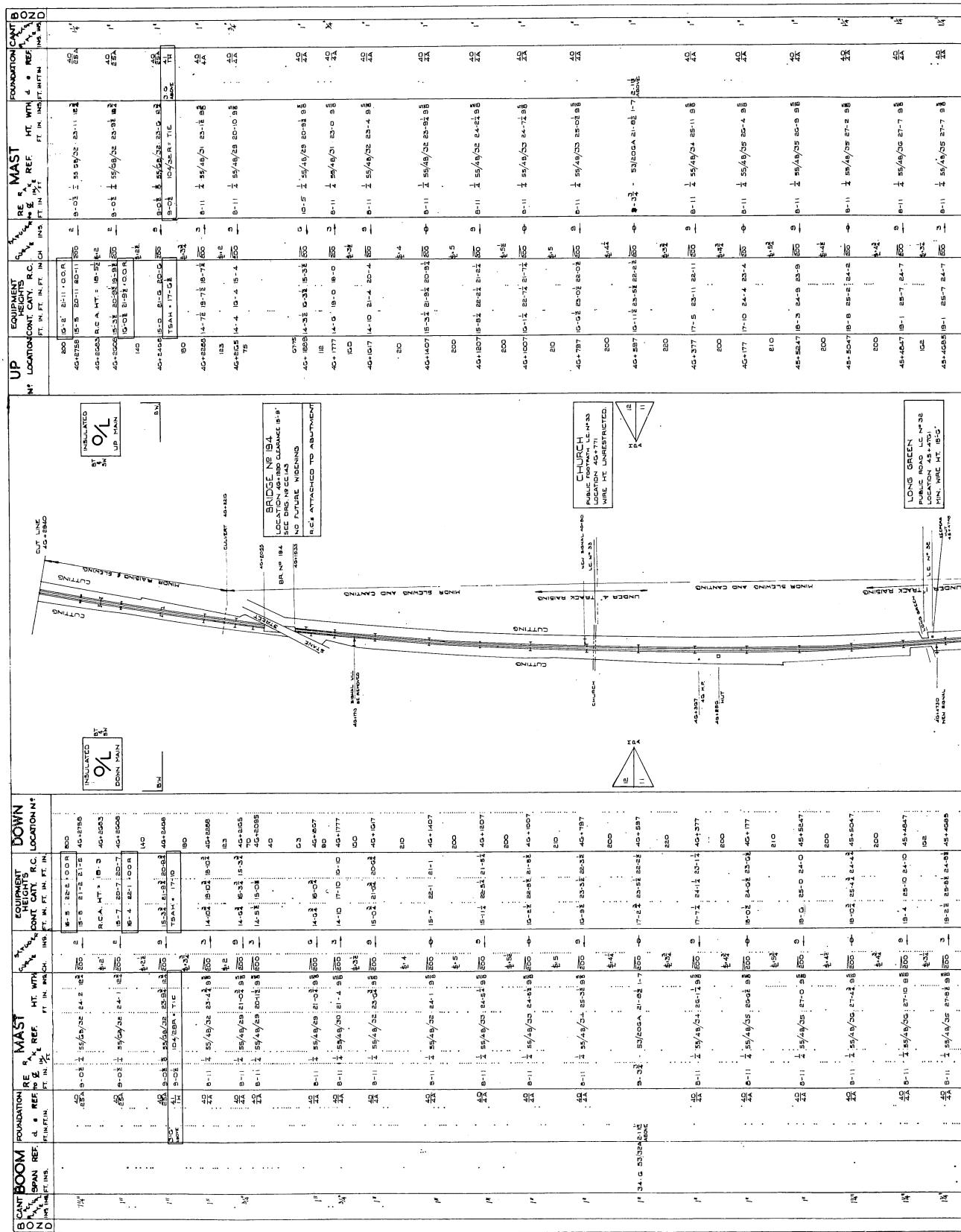
RESÚMEN

Este informe se refiere a los trabajos de efectuarse en el sitio mismo, apenas finalizados los diseños y planes, y después de darse el mando que la construcción se comience.

Es preciso que se inspeccione y se mida el trazado para que se puedan hacer planos especiales y mandar materiales en conformidad con un programa detallado de construcción. Entonces sera posible de apoderarse de los terrenos, obtener herramientas y material, y además organizar los empleados y obreros antes de empezar el trabajo mismo de construcción.

La colocación de los cimientos y la elevación de postes y torres se efectuan simultaneamente, y sólo cuando estas obras ya se hallan bien avanzadas debería empezarse el trabajo de instalar brazos y traviesas de pórticos de soporte, piezas y miembros de acero pequeños, antes de la suspensión de los conductores aéreos. La instalación de agujas aéreas y otros componentes auxiliares se hace en seguida para que el equipamiento pudiera finalmente someterse a ajustes y ensayos tan pronto como posible, después de su acabamiento.

Sólo por una coordinación muy íntima de las actividades de las oficinas de los Ferrocarriles con el trabajo del contratista de las líneas de contacto, será posible asegurar que se hallará una operación facil del programa de instalación.



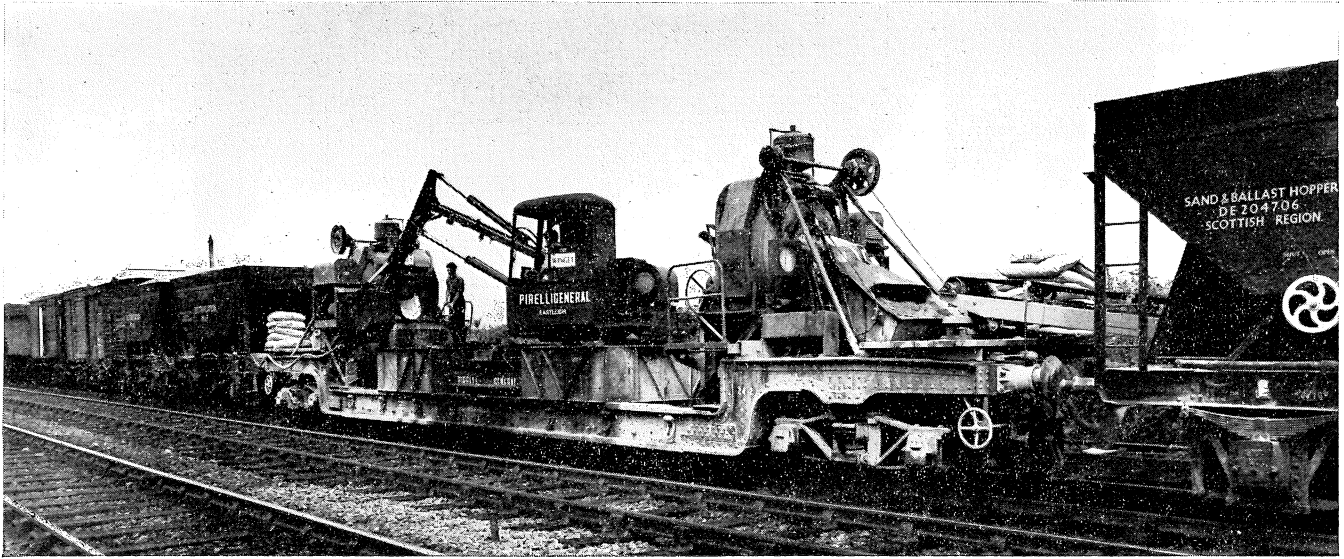


Fig.3 Concrete mixing and placing unit

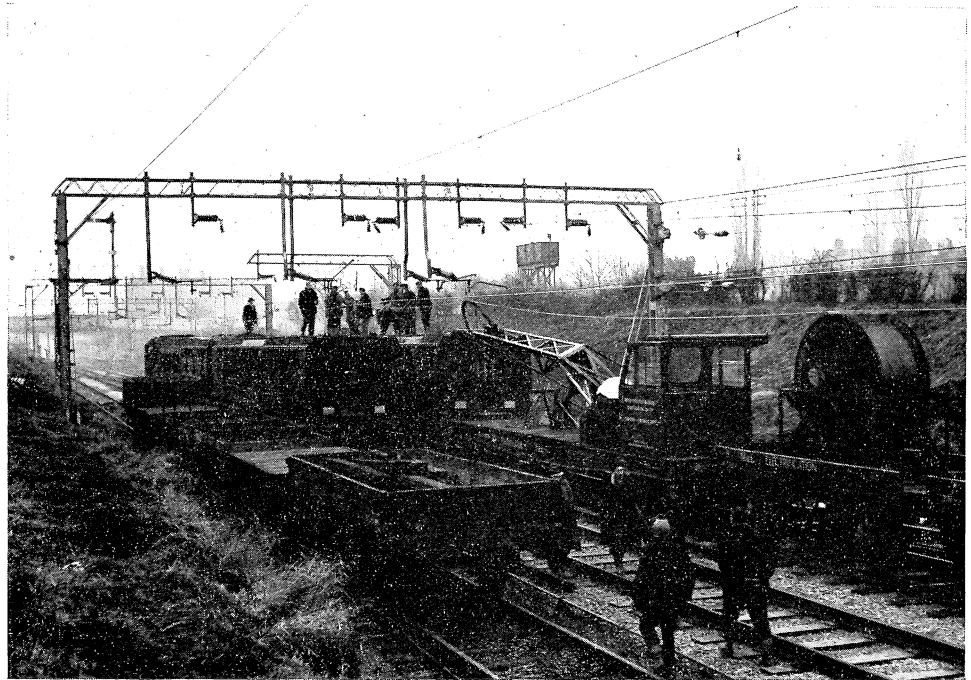


Fig.4 Running out jib

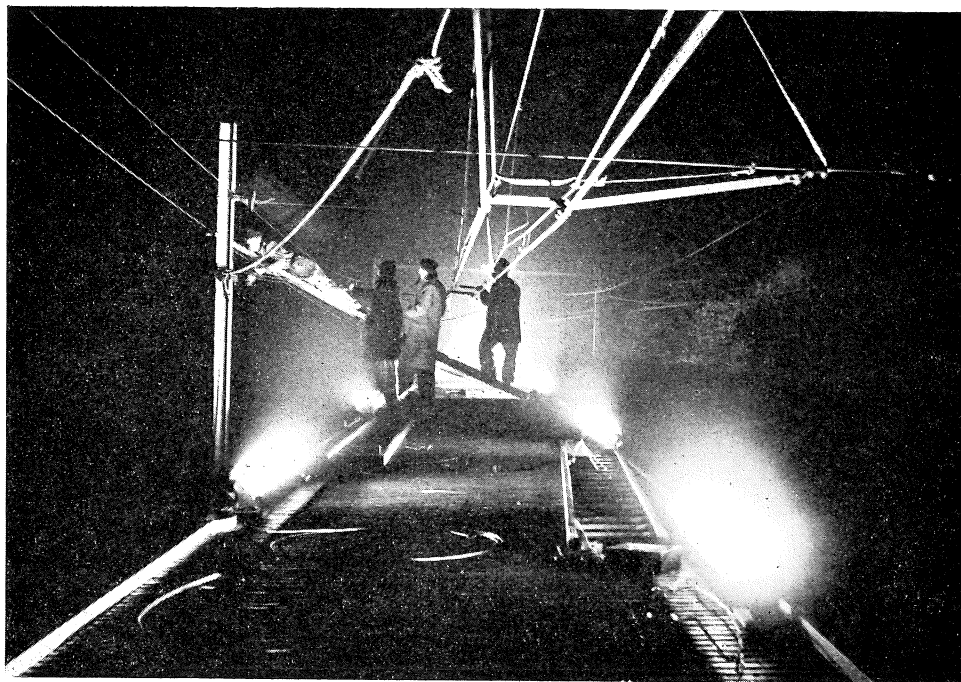


Fig.5 Train lighting