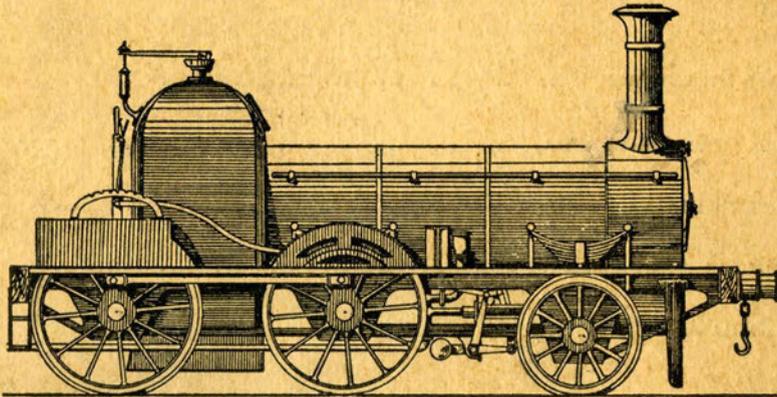


MINISTRY OF COMMUNICATIONS.
EGYPTIAN STATE RAILWAYS
TELEGRAPHS AND TELEPHONES

MUSEUM
CATALOGUE



THE RAILWAY BOARD.

JANUARY 1933.

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حضرة صاحب الجلالة الملك فؤاد الاول
His Majesty KING FOUAD Ist.

Preface

This catalogue is intended to give a general detailed description of the exhibits and photographs shewn in the Museum.

Whilst every endeavour has been made in the short time available to describe accurately the technical features of the exhibits, mistakes may have occurred and it is hoped those interested will draw my attention to any errors which they may discover.

This opportunity is taken to thank all those who have given valuable time and assistance in research work that has made possible the creation of the Museum in so short a period. In addition to the Officials of the Ministry of Communications and the Egyptian State Railways, Telegraphs and Telephones, I would like to particularly mention Dr. Oscar von Miller, the founder of the Deutsch Museum, Munich; Sir Henry Lyons, Director of the South Kensington Technical and Science Museum, London; Sir Henry Fowler; H. N. Gresley Esq.; the Proprietors of the Illustrated London News; the P. & O. S. N. Co.; the Leeds Museum; the Railway and Locomotive Historical Society Inc. of America; R. Stephenson & Co. Ltd.; the Institute of Mechanical Engineers, (England); the Authorities of the British, Belgian and French Railways; the Antiquities Service; the School of Applied Arts; the Suez Canal Company, and a number of other people and commercial houses who have been kind enough to give me so much assistance.

E. W. Slaughter.

Cairo, January 1st 1933.

M. I. MECH. E.

INTRODUCTION.

THE EGYPTIAN STATE RAILWAYS, TELEGRAPHS AND TELEPHONES MUSEUM.

It has been the wish of H.M. King Fouad I, for some time to institute a Railway Museum which would make the foundation for a Technical Science Museum for Egypt.

The Railway Board in January 1932 decided that the Railway Museum should be an accomplished fact as far as was in their power when the International Railway Congress was held in January 1933.

The building which has been erected for this purpose is an extension of the Station building and conforms in its general style; should the ultimate scheme for a larger Museum be agreed upon, the new building can then be used for Administrative Offices.

The building was completed on the 26th October, 1932.

The general colour scheme adopted for the furnishings is national green of cellulose finish with rustless steel or nickel fittings which give a very pleasing appearance.

The Museum will house some 600 models and exhibits, also a collection of technical data and statistical records shewing as far as has been possible to collect in the time available, the evolution of the Egyptian State Railways, Telegraphs and Telephones Administration.

It was also felt that the opportunity should be taken to obtain the loan of some of the most interesting models of other Railway Systems in order that Egypt's position in the railway world might be easily followed, and some of these models it is hoped to copy before their return to the owners.

The Museum will show the development of transport before the advent of steam traction (Section 1). The further improvements effected by the dawn of the steam locomotive, are illustrated by the models and exhibits in Sections 2 and 3, one of these exhibits, of great historical interest, is the Murdock Engine which was the first locomotive ever run in England, in 1783.

In Section 4, a representative selection of Engineers' small tools, accessories and materials, is exhibited.

Various Statistical Block Sheets are displayed in Section 5. A model of the new Railway Workshops at Abu-Zaabal occupies a prominent place in Section 6. Some of the earliest forms of rails used for Permanent Way may be seen in Section 7, while Bridge models are a prominent feature of Section 8. Signalling

and Lighting are confined to Section 9. Telephonic, Telegraphic and Wireless apparatus are displayed in great variety in Section 10. A very comprehensive selection of illuminated diagrams and maps, together with many original prints and reproductions will be seen in Section 11.

The whole will be a great educational asset to the large Railway, Telegraph and Telephone Staff in Egypt who have hitherto not had the opportunity of studying the more intricate technical details, or the growing necessity of keeping in touch with the commercial side of the Railway System. To the Engineering Students in this country and the general public, it will give an opportunity of becoming familiar with the hidden details of every day means of transport and communication.

A great amount of research work had to be done and detailed drawings made, before it was possible to commence making models, as little data in this country was available for the purpose. The various railway workshops in the Administration have carried out the building of models, the construction of exhibits and the making of furniture.

It was considered that Illuminated Photographs would best record development where models were not available, and in this connection an ambitious scheme of illuminated photographs was embarked upon consisting of some 400 photographs arranged in suitable panels. Some 200 ordinary photographs are also shewn as well as a number of original prints and sketches.

Amongst a variety of illuminated panels is one shewing the "Overland Route before the advent of the Railways"; another shows a photographic copy of the original agreement made between Abbas Pasha I and Robert Stephenson for the building of the first section of the Egyptian Railways; while one is devoted to the growth of the Railways during the reign of H.H. Khédive Ismail Pasha who increased the railway kilometrage very considerably, a further panel shows the Railways as they are today with an illuminated photograph of H.M. King Fouad I. Other panels are: Royal Train used by H.M. King Fouad I; Impressions of Transport from 10,000 years ago; Pharaonic Period of Transport; Robert Stephenson; the Suez Canal Company; 2 Panels for Signals; 3 Panels of Telegraph and Telephone installations.

It was considered to be of material interest, in view of Egypt's prominent place in the World's early history, to allot a small section of the Museum to Other Forms of Transport. Models are shown of a Primitive man carrying a load, the Hauling of a Statue on a sledge by Egyptians, a Sail Carriage of the 16th. Century, a Horse Drawn Omnibus of the year 1911, and a Motor driven 29 seater Bus of the type used in Cairo today. A model of the first Aeroplane flown by an Egyptian from Europe to Egypt is exhibited, as well as a miniature of "Hannibal" aircraft used by Imperial Airways at the present time.

Reproduction of the Original Agreement between
Representatives of H.H. Abbas Pasha, and
Robert Stephenson for the construction of the
Railway between Cairo and Alexandria.

Agreement between His Excellency Stephen Bey
charged with the direction of foreign affairs for His Highness
Abbas Pasha Governor General of Egypt acting on behalf and by
authority of His said Highness of the one part and Michael Andrews
Borthwick, acting on behalf and by authority of Robert Stephenson
Esq. & Co. Civil Engineer now residing at No. 34 Gloucester Square,
Hyde Park, London of the other part Whereas His said Highness
is about to undertake the construction of a Railway between Cairo
and Alexandria and is desirous of entrusting the planning and
superintendance of the construction of the said Railway and of all
works and buildings thereto pertaining, and of all the Engineers and
other persons to be thereon employed to the said Robert Stephenson
and is also desirous that the said Robert Stephenson should provide
such Engineers and other persons hereinafter described as it may be
necessary to obtain from England for effectually carrying out and com-
pleting the said Railway and works and buildings and upon the terms
and conditions hereinafter mentioned and Whereas the said Robert
Stephenson by the said Michael Andrews Borthwick is willing to
undertake such planning and superintendance and to provide
such Engineers and other persons above mentioned upon the said
terms and conditions it is hereby agreed between His said Excellency
Stephen Bey acting as aforesaid on behalf of His said Highness
and the said Michael Andrews Borthwick for and on behalf
of the said Robert Stephenson as follows that is to say -

1 That the said Robert Stephenson shall by himself or other
competent persons to be appointed by him and acting upon his re-
sponsibility superintend the planning laying out and construction
of the said Railway and of all works and buildings of whatsoever
nature thereto belonging or necessary for the due and efficient
working

working of the same provided always that the responsibility of completing the bridges and works of the Barrage shall not be with the said Robert Stephenson.

2. That the said Robert Stephenson shall at his own expense procure all such assistant engineers, surveyors, draftsmen or other persons, in such number at any one time as he shall think fit and necessary for the purpose of giving effect to the superintendance mentioned in Article 79, and defray the expense of their passage to and from Egypt, and pay and maintain them while employed upon the said Railway, works or buildings in Egypt.

3. That the said Robert Stephenson shall for the purposes of the said Railway and when and as often as required by any person duly authorized by His said Highness afford, whether in England or in Egypt such advice, information and assistance including specifications for materials of all description and for locomotive engines, carriages and other rolling stock as may be necessary in connection with the said Railway and in accordance with usage in like cases in England.

4. That the said Robert Stephenson shall examine or test or cause to be examined or tested all materials, machinery - locomotive engines, tools implements, and other stock to be used in the construction of the Railway or for bringing the same into effective working order, and so far as such materials or other things last mentioned shall be purchased in England or other country in Europe that he shall before the shipment of the same for Egypt by himself or by some competent person duly appointed by him certify to their efficient state or quality for the purposes for which they shall be required.

5. That the said Robert Stephenson shall supply at his own cost all surveying and mathematical instruments drawing materials stationary and books to be used by the Engineers and other persons to be employed by him.

6. That

6. That the said Robert Stephenson shall when required by His said Highness give all the assistance in his power in selecting and procuring such competent mechanics and artificers as it may be necessary for His said Highness to engage at the cost of His said Highness during the construction of the said Railway and the organization of the working of the same.

7. That His said Highness in consideration of the several duties to be performed and things to be done by the said Robert Stephenson in virtue of this agreement shall pay to the said Robert Stephenson or to his duly authorized agent or agents in London the sum of Fifty-six thousand pounds sterling by instalments as follows - Sixteen thousand pounds sterling on the first day of August next ensuing from the date of this Agreement or as soon after as practicable; eight thousand pounds sterling on the first day of February eighteen hundred and fifty-two; eight thousand pounds sterling on the first day of August eighteen hundred and fifty-two; eight thousand pounds sterling on the first day of February eighteen hundred and fifty-three; eight thousand pounds sterling on the first day of August eighteen hundred and fifty-three and eight thousand pounds sterling on the first day of February eighteen hundred and fifty-four. That His said Highness shall cause to be completed the bridges and works at the Barrage in such manner and time as to be available for the purposes of the said Railway, provided always that the said Railway works on and about the said Barrage shall be done by the said Robert Stephenson.

8. That His said Highness shall provide for the use of the said Robert Stephenson, and the Engineers and persons to be employed by him in and about the said Railway as contemplated by article 2 suitable and convenient offices with the necessary office furniture such as desks, tables chairs, presses cupboards and other minor requisites together with

stabling

Stabling for the horses of the persons employed at such offices and also all such doorkeeper's servants for cleaning the said offices and messengers and carriers as may be requisite for or in connection with the said offices.

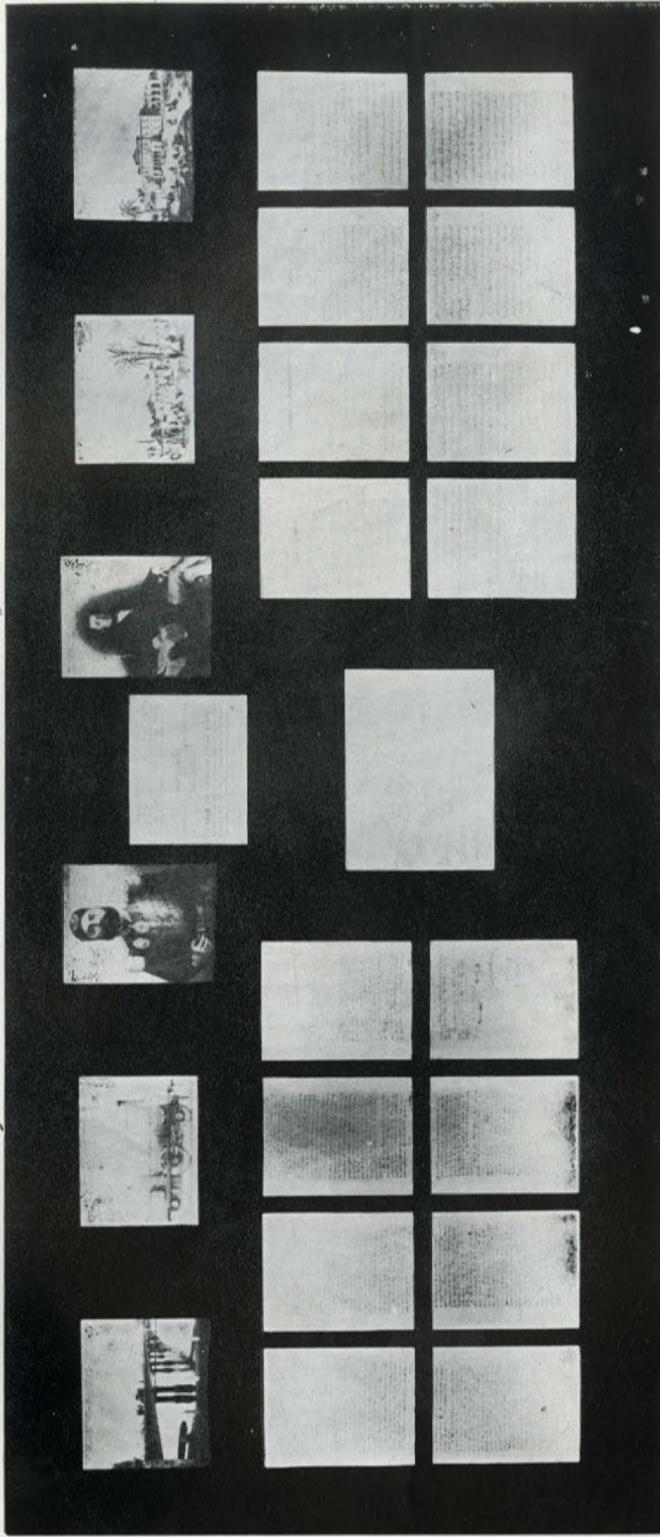
9. That His said Highness shall also provide at the expense of His said Highness for the said Robert Stephenson and the Engineers and other persons to be employed by him such inspectors assistants and messengers, as may be necessary for enabling the said Robert Stephenson and His assistant Engineers and other persons employed by him to effectually carry on the duties devolving upon them under this agreement.

10. That His said Highness shall also provide at the expense of His said Highness competent medical attendance and medicines for the Engineers and other persons employed by the said Robert Stephenson during the construction of the said Railway and other works and buildings thereto belonging.

11. That His said Highness shall provide at the expense of His said Highness all such means of conveyance such as by the Government Steam, or other boats usually plying on the Nile or Mahmondieh Canal, and Burrels as may be necessary for the use of the said Robert Stephenson and the Engineers and other persons to be employed by him when travelling on business for the said Railway it being understood that horses for the personal accommodation of the said Robert Stephenson and others to be employed by him shall not be at the charge of His said Highness.

12. That His said Highness shall also provide at the expense of His said Highness for the said Robert Stephenson and the Engineers ^{to be employed by him} and others ^{during} the course of construction of the said Railway, works and buildings all necessary

means



Agreement between representatives of H.H. Abbas Pasha Ist. and Robert Stephenson, M.P., for the construction of the first railway in Egypt.

اتفاق بين عملي المغفور له عباس باشا الاول وروبرت استيفنسون عضو مجلس النواب البريطاني
 لانشاء اول سكة حديد في مصر

means for the protection of their persons and property, also suitable and convenient tents for their official and personal accommodation and cause the said tents to be transported and erected as required by them.

13. That His said Highness shall supply at the expense of His said Highness for the construction and purposes of the said Railway works and buildings and for putting the same into effective working order, all such expenditure, labour, skill, materials, machines, implements, tools and other things of what nature soever and at such times and in such quantities and manner as by the said Robert Stephenson shall be deemed necessary, excepting so far as it is otherwise provided in this agreement, and provided always that the number of laborers to be furnished by His said Highness shall be in accordance or as nearly conformable as may be practicable with the terms of a memorandum in that behalf to be delivered by the said Robert Stephenson to His said Highness on or before the first day of October next ensuing such memorandum at the same time being framed upon the basis indicated in a certain letter from the said Robert Stephenson dated the fifth day of April eighteen hundred and fifty-one addressed to The Honorable Charles Augustus Murray Her Britannic Majesty's Consul General and Agent and subsequently laid before His said Highness and that all requisition for laborers for the purpose of the work shall be addressed by the Resident Engineer at Cairo or at Alexandria as the case may be to the Government agent appointed, and shall be made as early as possible before the said men shall be required to commence work.

14. That all requisitions in respect of the matters mentioned in this agreement as to be supplied by His said Highness

for.

for the purposes of the said Railway and works and buildings there pertaining shall be in writing and be signed by the Resident Engineer at Cairo in respect of the portion of the Railway under his charge and by the Resident Engineer at Alexandria in respect of the portion of the Railway under his charge or in case of the absence or incapacity of either of them then by their respective assistant Engineers.

15. That the said Highness shall provide all necessary persons and means for the transport, safe custody, and proper account of all materials and other things mentioned in this agreement as to be provided by the said Highness for the construction and purposes of the said Railway works and buildings whether the said materials and other things shall be procured in other countries or in Egypt and that the said Robert Stephenson shall in no way be responsible for the cost transport receiving keeping account of or safe custody of the said materials and other things it being distinctly understood that the liability of the said Robert Stephenson is restricted to the providing the Engineering superintendance as defined by Article 2 of this Agreement.

16. That all accounts in respect of the construction of the said Railway and works and buildings before mentioned ^{shall} be kept on the part of the said Highness yet if the said Robert Stephenson or his agent should apply to the Government agents for any memorandum of account of the expenses occurring they shall be granted from time to time as required.

17. That the whole of the Engineering arrangements together with the nature, quality, form strength and price

price of the materials and locomotives and all other things whatsoever to be used in the construction of and also the mode of laying out managing and directing the works of the said Railway or works or buildings pertaining thereto shall be with the said Robert Stephenson; and no person brought to Egypt by him for the purposes of constructing the Railway or such works and buildings shall be removable except by himself or by some person authorized by him.

18. That the said Robert Stephenson for the said sum of Fifty-six thousand pounds sterling shall give his services and the services of the Engineers and other persons to be provided by him as stipulated in this Agreement until the said Railway, works and buildings shall be completed provided that if the completion of the said Railway, works, and buildings shall be delayed beyond a period of three years to be reckoned from the first day of September next ensuing the date of this agreement and if such delay shall have arisen from a cause beyond the control of the said Robert Stephenson then in such case the said Robert Stephenson shall be entitled to receive from the said Highness not and above the said sum of Fifty-six thousand pounds sterling a further sum of eight hundred pounds sterling for each month or fraction of a month during which the services of himself and of the said Engineers and other persons to be provided by him shall be continued. But if such delay shall have arisen from any fault or neglect on the part of the said ^{Robert Stephenson} ~~Robert Stephenson~~ or the said Engineers or other persons to be provided by him, then in that case the said Robert Stephenson shall be bound to continue the services of himself and of the said Engineers and other persons until the completion of the said Railway

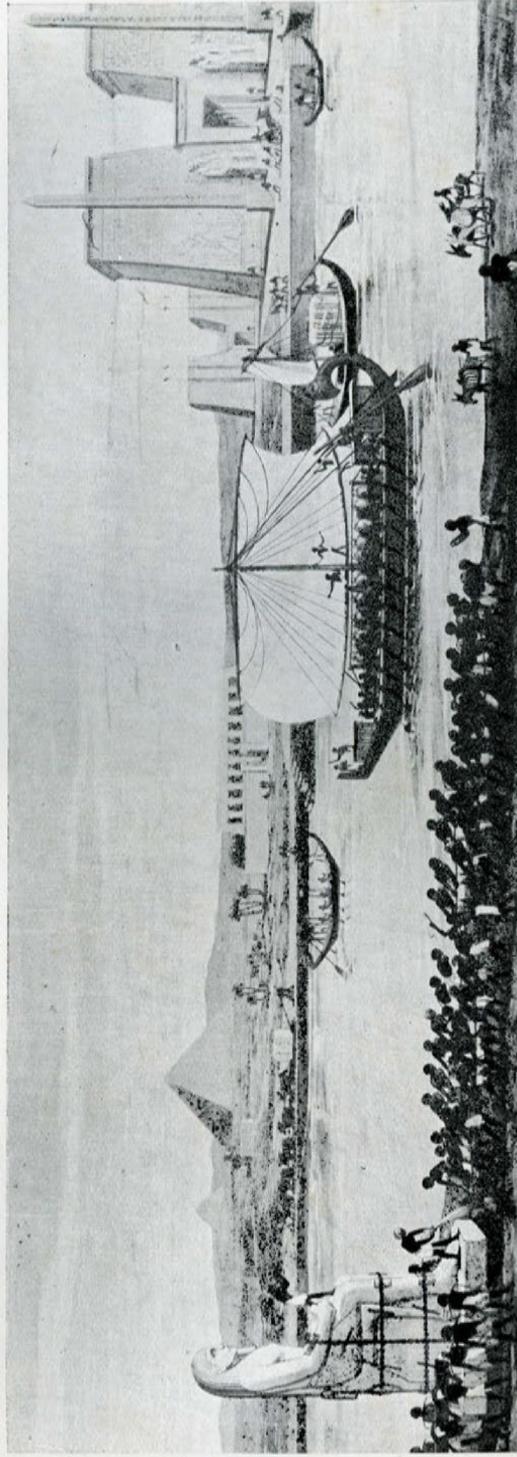
works

works, and buildings, and shall not be entitled to any sum in addition to the said Fifty-six thousand pounds sterling.

Done, ratified, and executed, in duplicate by the above mentioned contracting parties on the twelfth day of July in the year eighteen hundred and fifty-one at Kasr Matjar in Egypt, whose names are hereunto subscribed.

Witnesses *Abdir Rahman - Khalil Bey*
Raghib el Bey *Stephan Bey*
J. W. Borthwick

Agreement between His Majesty
- King Stephen - Bey on behalf
of His Majesty Abbas Pasha
- former Pasha of Egypt, and
- Mr. Borthwick on behalf of
His Majesty's Government
for the construction of a Railway
between Cairo and Alexandria
July 12th 1851



An impression of Ancient Egypt, depicting typical transport scenes.

صورة لمصر القديمة تبين مناظر انواع النقل

SECTION 1.

DEVELOPMENT OF TRANSPORT BEFORE THE ADVENT OF STEAM.

Transport in Ancient Egypt.

This section, supplied by the Antiquities Department, Ministry of Education, illustrates the manner in which goods and passengers were transported from about B.C. 3,000 until about the IIIrd Century, B.C., when Greek influence began to spread over Egypt. The material has been drawn from actual objects, from tomb and temple scenes and from written records.

In dynastic Egypt, the principal means of transport were the boat, the ass or ox and man-power. As the pace of these differs but little, it is only to be expected that as much use as possible was made of water-transport, since most towns and villages lay at no great distance from the Nile or from a navigable canal. The only speedier means of transport — the horse — does not appear in Egypt until the time of the Hyksos domination in the XIIth century B.C., and during nearly the whole of the dynastic history its use seems to have been confined to the nobility and the military. The camel is not known to have been used by the Egyptians until Ptolemaic times.

Water Transport.

The art of boat-building developed early. In predynastic times there are representations of transport-boats of considerable size, though their details are somewhat obscure. In the reign of King Sneferu (about B.C. 2,900) there is a record of a wooden ship, 100 cubits (52 metres) in length having been built. In the reign of King Amenemhêt III (about B.C. 1,800) a block of quartzite weighing some 100 tons was transported by water to his pyramid at Hawâra, and by the XVIIth century B.C., if not much earlier, ships were constructed capable of carrying weights of 1,000 tons and upwards.

Transport by Land.

In ancient Egyptian scenes of transport by land, it is remarkable how rarely the wheel plays any part, though it was known from early times. It must be remembered that up till quite recent times there was no means of driving a wheeled vehicle from Cairo to Luxor, and today there are many villages which cannot be reached by any form of cart. The Nile is the main highway of Egypt, and

roads for wheeled traffic were unnecessary until the advent of the motor-car. In none of the hundreds of scenes of the daily life of ancient Egypt is any baggage-cart shown and hardly ever in scenes of the Egyptian armies in their campaigns abroad. Though roads were not essential in Egypt proper, the reverse was the case in hilly or stony countries like Palestine, Syria or Anatolia, where the great cities were not always connected by waterways. In those countries carts capable of carrying heavy loads were freely used, and we may conclude that the Egyptians used them as freely when they were required.

Egyptians are very rarely represented on horseback; both the king and the nobles always drive in chariots and are even depicted charging the enemy in them. Judging from the proportions, in the scenes, of man to horse, the latter can have been little more than swift ponies between 11 ½ and 12 hands high, the horse capable of carrying weight having perhaps not yet been bred in the Near East. It seems, therefore, that the only means by which a man could obtain a great increase of speed over that which he had previously enjoyed was by harnessing the ponies in pairs to the lightest wheeled vehicle he could possibly construct. Though evidence is scarce, the horse does not seem to have been ridden in war by the Egyptians until about the beginning of the VIth century B.C.

For the transport, by land, of heavy objects, such as building-blocks, statues and even obelisks, the sledge seems to have invariably been used in conjunction with transversely laid planks. Ancient scenes of them being hauled both by men and by oxen are known. The Egyptians also knew rollers as a means of reducing friction, but they do not appear to have used them if sufficient power could be obtained to drag the sledges without them.

Ancient Egyptian Implements and Tools.

The earliest tools were of stone, and stone continued to be used, especially for hammers and mauls, long after the advent of metal. In the Old Kingdom (about B.C. 2,980—2,475) the metal used for tools was almost exclusively copper, which was gradually replaced, as time went on, by bronze. Though iron was known from very ancient times, it did not come into general use until late in dynastic history. Saws were known at all periods and were used not only for cutting wood but also for the hardest stone. Only small models, however, have survived, which give practically no information on their essential details. Although the forms of the metal tools, especially the adze — and axe-blades, varied considerably at different periods, there is nothing to show that any new implement was invented after the Old Kingdom until Graeco-Roman times.

DAHABIA. — OLD EMPIRE.

Dahabia or houseboat of a noble named Sabu of the Vth dynasty (about B.C. 2,750) from Saqqâra, now in the Cairo Museum. Sabu is supposed to be inside while the steersmen are outside the cabin. All Egyptian ships were steered by one or more rudders shaped like paddles, held rigid by lashings or other means and turned by almost vertical tillers. In this boat the details of the rudders are very vague.

LOWERING A MAST. — OLD EMPIRE.

Men lowering the mast of a boat, from the same tomb as No. 1. Double masts, joined at the top and stiffened by bars connecting them for a part of their length, were common in Egyptian ships of all sizes.

SHIP UNDER FULL SAIL. — OLD EMPIRE.

Ship, under full sail, from a scene from the tomb of a noble of the VIth. dynasty (about B.C. 2,500) named Ipi at Saqqâra, now in the Cairo Museum. Several interesting points are to be noted. During the whole of the dynastic period the pulley seems not to have been known; the halliards for hoisting the sail either pass through holes in the mast or through rings or some other attachment (see No. 15) at the masthead. The absence of the pulley must have resulted in great friction being set up at the masthead when the sail was being hoisted, and some of the crew would probably have had to stand up on the lower yard and push from below. This may possibly account for the apparently excessive number of stays holding up the lower yard in this and other representations of ships. Note also the large number of ropes connecting the mast to the stern.

CAST FROM THE TOMB OF TY. — OLD EMPIRE.

Part of a scene from the tomb of a noble named Ty, of the Vth dynasty (about B.C. 2,750) at Saqqâra. It represents a large ship under full sail. Unlike that shown in No. 3, the sail is not fitted with a lower yard.

CARGO-SHIP. — OLD EMPIRE.

Cargo ship of Ipi (see No. 3) with mast and sails stacked, being punted against the current.

SECTION 1. NO. 1.

(END PANEL)
BAY A.

SECTION 1. NO. 2.

(END PANEL)
BAY A.

SECTION 1. NO. 3.

(END PANEL)
BAY A.

SECTION 1. NO. 4.

(END PANEL)
BAY A.

SECTION 1. NO. 5.

(END PANEL)
BAY A.

DAHABIA. — OLD EMPIRE.

SECTION 1. NO. 6, (END PANEL) BAY A.

House-boat of Ipi (see No. 3) with mast and sails stacked on the roof of the cabin.

SECTION 1. NO. 7, (END PANEL) BAY A.

PASSENGER SHIP. — OLD EMPIRE.

Passenger ship of Ipi (see No. 3) with mast and sails stacked on supports. In the tomb-scene this ship is shown towing No. 6.

SECTION 1. NO. 8. (CENTRE TABLE I) BAY A.

MODEL OF CATTLE BOAT. — OLD EMPIRE.

Replica of a model cattle boat of the VIth dynasty (about B.C. 2,700), one of a series found at Saqqâra. All the models were too badly damaged to permit of an accurate restoration of the steering system.

SECTION 1. NO. 9, (END PANEL) BAY A.

FIGHT IN PAPYRUS SKIFFS. — OLD EMPIRE.

Fight between boatmen in skiffs made of papyrus (compare with No. 17). Such craft were mostly used for fishing and for sport. Above the figures are the remarks made by them, such as: "Crack him on his box". "Split open his back", etc.

SECTION 1. NO. 10. (END PANEL) BAY A.

BOAT-BUILDING. — OLD EMPIRE.

Boat-building scene from the tomb of Ty (see No. 4). Note the club-like hammers used with the chisels, the large two-handed mallets and the form of the saw. Models of some of the tools used are shown on the left screen-wall.

SECTION 1. NO. 11. (END PANEL) BAY A.

BOAT AND SCENE OF BOAT-BUILDING. — MIDDLE EMPIRE.

Boat of the XIIth dynasty (about B.C. 1,800) from the pyramid of Amenemhêt III at Dahshûr. It measures 10.20 metres in length, and is constructed of short wooden planks tenoned and dovetailed together, and is without ribs. With it are its plan and a representation of a boat-building scene of about the same date from Beni Hasan. These exhibits recall the statement of Herodotus, who remarks (II.96) on the subject of boat building in ancient Egypt "They cut a quantity of planks about 2 cubits (1.04 metre) in length, arranging the planks like bricks, and attaching them by ties to a number of long stakes or poles till the hull is complete. They give the boat no ribs, but caulk the seams with papyrus from inside".

PRIVATE BOAT. — MIDDLE EMPIRE.

Photograph and replica of an ancient model of boat of a noble named Meketrê, of the XIth dynasty (about B.C. 2,000), from his tomb at Thebes. It is of the traditional papyrus-boat pattern. Although it is being paddled, it has a hole or 'tabernacle' for the mast. In the model, the details of the mast and sail (here represented lowered) have been copied from those in No. 13. The poses of the crew are modern and are intended to illustrate the steering-system of this kind of craft and the shape of the paddles of the period. It may be mentioned that ancient Egyptian boats were also rowed.

DAHABIA. — MIDDLE EMPIRE.

Photograph and replica of an ancient model of the dahabia or houseboat of Meketrê (see No. 12). The figures of the crew in the original are extremely crude and far too large, and both they and the rigging seem to have suffered much damage before they were placed in the tomb. Inside the cabin is a bed with cabin-trunks beneath it. In the model, figures more proportionate to the size of the ship have been substituted for the original figures in order to illustrate how the ship was sailed. Note the support for the mast when it was stacked, which was stepped in the mast-hole or 'tabernacle'. The other end of the mast probably rested on the top of the steering-post.
SECTION 1.—No. 14.

DAHABIA. — MIDDLE EMPIRE.

Dahabia of Mesehti, a prince of Asyût of the XIIth dynasty (about B.C. 1,900). The sails and rigging were not found.

SEA-GOING TRADING SHIPS. — NEW EMPIRE.

Trading ships of Queen Hatshepsut, from the reliefs in her temple at El-Deir el-Bahari (about B.C. 1,500) Note the stiffening-ropes passing over upright supports, the details of the steering-system and the attachments at the masthead through which the main halliards pass for hoisting the sails.

SECTION 1. NO. 12,

(END PANEL
AND CENTRE
TABLE I)
BAY A.

SECTION 1. NO. 13.

(END PANEL
AND CENTRE
TABLE I)
BAY A

SECTION 1. NO. 14.

(END PANEL)
BAY A

SECTION 1. NO. 15.

(END PANEL)
BAY A.

**SECTION 1.
NO. 16.**

(END PANEL)
BAY A.

BARGE CARRYING TWO OBELISKS. — NEW EMPIRE.

Great barge of Queen Hatshepsut (see No. 15) depicted carrying on its deck two obelisks, which are known to have weighed over 300 tons each, mounted on sledges. It is incredible that both could have been placed together on the deck of a boat of traditional design as shown. It is more likely that the great monoliths were carried in the interior of solid rafts made of logs lashed together. In this, as in many other Egyptian scenes, it is difficult to discriminate between fact and artistic convention.

**SECTION 1.
NO. 17,**

(END PANEL)
BAY A.

MODEL OF A PAPYRUS BOAT. — MODERN.

Model (modern) of a papyrus boat. These were probably the origin of the traditional form of Egyptian boats, especially the funerary craft. Papyrus boats were used on the Upper Nile until quite recent times.

**SECTION 1,
NO. 18.**

(END PANEL)
BAY A.
FASCIMILE BY
THE CHICAGO
ORIENTAL
INSTITUTE.

EGYPTIAN FLEET IN ACTION. — NEW EMPIRE.

Scene showing an Egyptian fleet under Ramesses III (about B.C. 1,180) hotly engaged with that of the Levantine nations. It is a good illustration of the manner in which Egyptian artists overcame their ignorance of perspective-drawing.

**SECTION 1.
NO. 19.**

(END PANEL)
BAY A.

A NOBLE IN HIS LITTER. — OLD EMPIRE.

Elaborate litter from the tomb of Ipi (see No. 3). Litters were used freely during the whole of the history of ancient Egypt. For a simple litter, see the transport scene on centre table II.

**SECTION 1.
NO. 20.**

(END PANEL)
BAY A.
FROM LEPSIUS,
DENKMALER.

DONKEY-LITTER AND OTHER SCENES. — OLD EMPIRE.

Fascimile of part of the wall from the tomb of Urkhu at Giza. On the right is a unique representation of the owner being carried on a litter apparently borne by two asses. This also includes scenes of asses, some heavily laden and others treading the corn, of ships, of fishing and of agriculture.

**STELA RECORDING A QUARRYING EXPEDITION.—
NEW EMPIRE.**

Stela from the schist quarries at Wadi el-Hammamât, on the route between Qift and El-Quseir on the Red Sea. It is the record of an expedition under King Ramesses IV (B.C. 1,164) for the purpose of obtaining monumental stone, and gives a list of the personnel. It consisted of the following:—

Ramesse-nakht, Director of Works	1
Civil and military officers of rank	9
Subordinate officers	362
Trained craftsmen... ..	10
Quarrymen and stonecutters	130
Gendarmes	50
Slaves	2,000
Infantry	5,000
Men from <i>Ayan</i> (Tura Quarries)	800
(Dead, excluded from total)	900
	—+—
	8,362
	—+—

This stela also mentions that chariots accompanied the expedition as well as ten transport-waggons, each drawn by six yoke of oxen.

THE EARLIEST KNOWN WHEELS. — ABOUT B.C. 2,800.

Scene showing the earliest representation of wheels, fitted, in this case, to a military scaling-ladder and prevented from slipping back by means of a handspike. From the tomb of Kaemhesit at Saqqâra; Old Empire.

**PHILISTINE WAGGONS ATTACKED
BY EGYPTIANS. — NEW EMPIRE.**

Scene showing the waggons of the Philistines, each drawn by four oxen, being attacked by Egyptian troops and their mercenaries under King Ramesses III (about B.C. 1,190), from the temple of Medînet Habu, Thebes.

**SECTION 1.
NO. 21.**

(END PANEL)
BAY A.
FROM COUYAT
AND MONTEY.
LES
INSCRIPTIONS
DU OUADI
HAMMAMAT.

**SECTION 1.
NO. 22.**

(END PANEL)
BAY A.

**SECTION 1.
NO. 23.**

(END PANEL)
BAY A.
FASCIMILE BY
THE CHICAGO
ORIENTAL
INSTITUTE.

**SECTION 1.
NO. 24.**

(END PANEL)
BAY A.
BY PERMISSION
OF
DR. HOWARD
CARTER.

**WHEELS FROM TUTANKHAMUN'S CHARIOTS.—
NEW EMPIRE.**

Two wheels from chariots of King Tutankhamûn (about B.C. 1,350). That on the left has a single rim consisting of two bent pieces of wood. That on the right, the most solid yet found, is similar, except that it has an extra rim consisting of five bent pieces of wood 'breaking joint' with those of the inner rim, each section being held in place by copper strips. All known wheels of this type have their spokes made in two pieces. It seems that the wheels were fitted with leather tyres, but in these examples the leather has perished.

(See also model of chariot on centre table III).

**SECTION 1.
NO. 26.**

(RIGHT
SCREEN
WALL).
BAY A.

SLEDGE DRAWN BY OXEN. — NEW EMPIRE.

Drawing of a scene from a quarry-face at Tura of the time of King Amasis I (about B.C. 1,570), showing a block of stone being drawn on a sledge by a team of oxen. Although scenes of oxen being used as draught-animals are very rare, they may well have been freely used for this purpose. For other examples of ancient sledges, see Nos. 16, 27-29 and 31.

**SECTION 1.
NO. 27.**

(RIGHT
SCREEN
WALL).
BAY A.

CHARIOT OF RAMESSES III. — NEW EMPIRE.

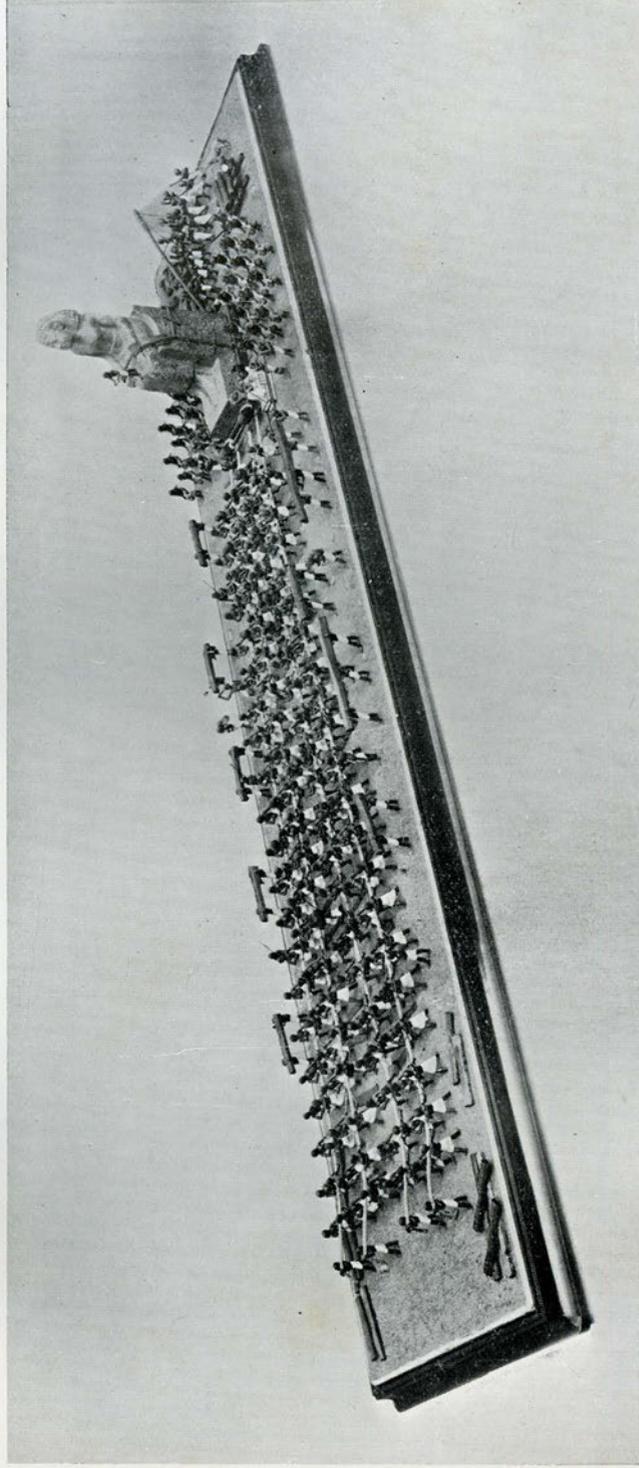
Chariot of King Ramesses III (about B.C. 1,190), showing details of the harness and trappings, from a scene in the temple of Medinet Rabu, Thebes. Compare with the model in centre case III.

**SECTION 1.
NO. 28.**

(RIGHT
SCREEN
WALL).
BAY A.
FROM
NEWBERRY.
EL-BERSHEH.

TRANSPORT OF A 60-TON STATUE. — NEW EMPIRE.

Scene from the tomb of a noble named Thuthotpe at El-Barsha, dating to about B.C. 1,500. It shows a statue, which is stated to be 13 cubits (6.80 m.) high, and consequently weighing some 60 tons, being dragged on a sledge by four teams of 44 men each. It is doubtful whether even this number of men would be sufficient, and considerations of space on the wall may have prevented the true number being shown. In this scene the artist, who was probably no technician, has omitted to show the means by which the haulers are pulling on the cables, which would be too thick to be grasped in the hand. In a similar scene from Nineveh, however, shown in No. 29 (after Layard, *The Monuments of Nineveh and Babylon*), this detail is very well indicated.



Model of Hauling a 60 ton Statue on a Sledge.
An impression of transport in Ancient Egypt.

نقل تمثال وزنه ستون طناً على زحافة
صورة تبين كيفية النقل بمصر القديمة

**TRANSPORT OF A COLOSSUS AT NINEVEH.—
ABOUT THE VIth CENTURY, B.C.**

Parts of a relief from Nineveh, now in the British Museum, of a similar nature to that shown in No. 28. In this scene, however, the means by which the men are hauling on the cables and the method by which the initial friction is being reduced by a large lever are both clearly shown. It also shows numbers of men bringing short planks from behind the sledge and placing them in front.

In the Egyptian scene the last operation is indicated by a plank being carried by three men, three being the conventional sign of plurality.

**MODEL SHOWING THE TRANSPORT OF A 60-TON
STATUE IN ANCIENT EGYPT.**

This model, which is to a scale of 1/15, is based chiefly on the scene from El-Barsha (No. 28), but has certain details copied from the Nineveh reliefs (No. 29). Its object is to give some idea of what must have been the appearance of the transport of a 60-ton statue in ancient Egypt at the moment of getting it on the move. The men pouring out water are probably trying to prevent excessive heat being generated between the sledge and the planks rather than attempting to reduce the friction between them. Note the chanty-man on the knees of the statue, the priest offering incense before it and the noble in his litter (from another scene in his tomb) beside it.

MODEL OF AN EGYPTIAN CHARIOT. — NEW EMPIRE.

Scale model, one-quarter full size, of one of the forms of Egyptian chariot, showing how its component parts were assembled. Unfortunately, no ancient harness has been preserved in anything like an intact condition, and the details on the ancient scenes are always defectively represented.

PLAN OF A SLEDGE. — MIDDLE EMPIRE.

Plan of a sledge 4.21 m. long, of the XIIIth. dynasty (about B.C. 1,800) from Dahshûr. It was used to transport the barge of King Amenemhêt III (shown in photograph No. 11, end panel) from the Nile to his pyramid, where they were buried together. The original is now in the Cairo Museum.

**SECTION 1.
NO. 29.**

(RIGHT
SCREEN
WALL).
BAY A.
FROM LAYARD,
THE
MONUMENTS
OF NINEVEH
AND BABYLON.

**SECTION 1.
NO. 29.**

(CENTRE
TABLE II)
BAY A.
MODEL BY
THE MOULDING
SECTION OF
THE EGYPTIAN
MUSEUM.

**SECTION 1.
NO. 30.**

(CENTRE
TABLE III)
BAY A.

**SECTION 1
NO. 31.**

LEFT SCREEN
WALL).
BAY A.

SOME ANCIENT EGYPTIAN TOOLS.

Note: The exhibits do not pretend to form a complete collection of the tools used in ancient Egypt, but are more or less confined to those which played some part in boat-building, levelling the ground and making embankments for transport purposes. Unless otherwise stated, the specimens shown represent tools dating between about B.C. 1,580 and B.C. 1,000. They differ but little from those of the earlier and later periods.

No. 32.—Replica of a square, from the tomb of Sennûtem at Deir el-Medîna (Thebes). The square played no part in the dressing of stone blocks before laying, which are often not rectangular in any sense, though fitting closely to their neighbours. The dressing of the masonry was carried out after the whole face of the building had been laid; it was then that the mason's square came into use. Squares were, of course, freely used by carpenters.

No. 33.—Model of a level from the same tomb as No. 32.

No. 34.—Model of a plumb-rule, from the same tomb as No. 32.

No. 35.—Model of a typical cubit rod. All measures of length in ancient Egypt were based on the cubit, which measured about 0.52 metre, and which was subdivided into 7 palms or 28 digits. In this model the last two palms are each divided into 4 digits.

Nos. 36-38.—Models of bronze chisels. Smaller chisels of a variety of forms were used by the carpenters, usually fitted with wooden handles.

No. 39.—Model of a mortise chisel of the Middle Empire (about B.C. 1,900).

No. 40.—Ancient mallet, probably dating to the Old Empire, from Saqqâra.

No. 41.—Model of a mallet of the XXIInd dynasty (about B.C. 850), from Meydûm. A representation of carpenters using such mallets can be seen in photograph No. 10 (end wall).

No. 42.—Model of a typical carpenter's axe of the XIIth dynasty (about B.C. 1,900) from Asyût.

No. 43.—Model of a carpenter's adze. The blade is bound to the haft with raw hide.

No. 44.—Wooden hoe (ancient). During the whole of the dynastic period this form of hoe was the cultivators' principal tool. It was also used for excavating in the desert marl.

Nos. 45 and 46.—Models of metal hoes, the parents of the modern *fâs* or *turya*.



Detail of Scene. Hauling a 60 Ton Statue on a Sledge.

تفصيلات عن مدحتر سحب تماثال وزنه ستون طنا على زحافة

TRANSPORT IN THE GRAECO-ROMAN PERIOD.

Our knowledge of the methods of transport during the Graeco-Roman period (332 B.C.—638 A.D.) is founded less on pictorial evidence than on the rather sparse details gathered from papyrological texts and from the classical authors.

The Macedonian conquerors and (since 30 B.C.) their successors, the Romans, had at their disposal all the perfections of mechanical technique created by Greek ingenuity. In spite of this, however, long-established pharaonic methods — which were, indeed, well suited to the geographical conditions of the country — must have undergone but little change. The Nile and the canals remained the main highways of Egypt and the maintenance of them and of the ports occupied the attention of the kings and emperors more than that of the roads.

A canal connecting the Nile and the Red Sea, passing through the Wadi Tumilat and the Bitter Lakes, may have existed in the Middle Empire. One was certainly begun, however, under Necho (609—593 B.C.) and finished under Darius (521—486 A.D.). Later it became sanded up and was cleared for navigation under Ptolemy II (285—246) and again under Trajan (98—117). Destined to facilitate communication with the Red Sea, Arabia and India, this was the ancestor of the present Suez Canal.

The Greeks — past masters in naval construction — introduced into Egypt slender-prowed vessels with several superimposed ranks of rowers. Ptolemy II, Philadelphus, is said to have possessed ships having as many as 30 ranks of rowers, and Ptolemy IV, Philopator (222—204) one of 40 ranks, of which a precise, though no doubt grossly exaggerated account by Callixenes has been preserved. These were, however, but warships, and it is very probable that the types of vessels used for the navigation of the Nile — types founded on the experience of countless generations of native Egyptians — must have undergone but little change.

Callixenes also describes a pleasure boat, or *dahabia* for use on the Nile by Ptolemy IV, Philopator, half a stadium (more than 88 metres) in length and 30 cubits, or nearly 16 metres in breadth. It had a mast 70 cubits high and a sail enriched with purple. Around it ran two promenade-decks, and amidships were luxurious apartments, lavishly decorated with cedar, cypress and *thuisia* - wood and with precious stones and metals. Records also exist of sailing ships with a stowage capacity of 4,000, 5,000 and even 10,000 *artabas*, the *artaba* having a volume of 30 to 40 litres.

Roads were of two kinds. In the Nile Valley and, above all, in the Fayyûm, roads of a sort existed for the transport of agricultural produce and materials, which linked up the villages with one another. In ancient texts the word 'roads' very often

really means 'dykes' or 'canal-embankments', whose ramifications naturally covered the whole country. Be this as it may, their condition for traffic was none too good, since records mention officials hurrying to put them into order for royal visits. The second type of road was the desert caravan-route which connected the Nile Valley with the Oases in the western desert and with the Red Sea on the east. These highways were more than mere tracks, and great expense was necessary for their maintenance, since there were wells, cisterns and rest-houses a day's journey apart throughout the length of the most important of them, while fortified posts at frequent intervals ensured the protection of the convoys.

Although carts drawn by horses, mules and oxen were used, merchandise was usually carried by pack-animals, the donkey and the camel being the most economical for this purpose.

The camel was used in Ptolemaic times and became the commonest means of desert transport during the Roman period. Although bred in the country, they were also continually being imported from Arabia, records mentioning beasts as being "marked with Arabic letters." Horses were employed almost exclusively for riding, and were specially bred for the use of the cavalry. The state could always requisition transport for the journeys of the king and of officials, or for the requirements of the army or public works. Such requisitions were generally, though not always, against indemnity.

Traffic, both by water and by land, was very active in Graeco-Roman times, and its organisation very perfect. This was largely due to the necessity of assuring an adequate supply of corn for Alexandria, and later for Rome. The corn, collected throughout the country and stored in state granaries, was carried on donkey-back to the nearest landing stage, the 'donkey-boys' being organised into guilds. There — on the authority of an official letter from Alexandria — officials handed it, against receipt, to contractors, who owned or hired ships for its transport down the Nile. At Alexandria the weights of the cargoes were checked, and samples in sealed bags, which accompanied them, preventing any falsifications during the journey. These contractors also undertook all kinds of private work, where the state only intervened in order to collect the necessary taxes and customs dues. Other contractors concerned themselves with land transport, particularly on the routes between the Nile and the Red Sea. Large donkey and camel caravans passed along these routes, bearing goods to the Red Sea, destined for Arabia and India, and bringing back to Coptos (Qift), for embarkation on the Nile, the products of the Orient and stones and minerals from the mountains of the Arabian Desert. Numerous quittances have been preserved, delivered by clients to a certain Nicanor who, owing a train of camels, undertook transport between Coptos and both Myos

Hormos (El-Quseir el-Qadim?) and Berenice for Greek and Roman merchants.

There was no postal service available for private individuals, but the Ptolemies, imitating the Persian sovereigns, organised one for themselves and their chancellery. Letters from Alexandria to Upper Egypt and, conversely, letters for the king or the Central Administration, were carried stage by stage by mounted couriers. At each post or stage a postmaster inscribed in a register the date and hour of the arrival of the document, the name of the courier who brought it and of the one who was to deliver it to the next stage, together with the name of the addressee. This organisation lasted until the Byzantine period (395—638), where we again hear of a 'rapid post' for urgent letters and an ordinary mail for heavier objects. With the decline of the Empire, the post fell into decadence, and under Justinian (527—565), the horses were replaced by donkeys, while the great landowners organised their own private postal services.

**Nos. 1—6 PHOTOGRAPHS ILLUSTRATING TRANSPORT
IN THE GRAECO-ROMAN PERIOD.**

TERRACOTTA MODEL OF CHARIOT-ROMAN PERIOD.

Terracotta model of a four-horse chariot in the Egyptian Museum, Cairo. This group is of interest in the details of the harness. The horses have on their necks a yoke similar to those of oxen. The chariot has two shafts attached to the yokes by means of straps, one between the first and second horses and the other between the third and fourth.

**TERRACOTTA MODELS OF CAMELS.—
ROMAN PERIOD.**

Four terracotta models of camels (Egyptian Museum). One carries two baskets, another four jars; the third is merely saddled, while the last seems to be carrying a passenger in a litter covered with a veil.

**MOSAIC WITH REPRESENTATIONS OF BOATS.—
GRAECO-ROMAN PERIOD.**

Fragment of a large mosaic discovered at Palestrina (Italy) depicting a scene in the Nile Delta with various form of ships. In the foreground is a warship, with a narrow prow and rowed by a number of men. Behind is a dahabia with a large sail and a cabin. The scene also shows two small boats in one of which is a man fishing with a line. It is obvious that the boats are meant to be to very different scales.

COLUMN 1.
NO. 1.

COLUMN 1.
NO. 2.

COLUMN 1.
NO. 3.
AFTER
ROSTOVTZEW,
ROEMISCHE
MITTEILUNGEN
XXVI, P. 60.

COLUMN 1,
NO. 4.
PHOTOGRAPH BY
M.C. BOURDON.

BED OF AN ANCIENT CANAL, BETWEEN THE NILE AND THE RED SEA.

Photograph, taken at El-Shallûfa (north of Suez). On the left and right can be seen the high sandy banks of an ancient canal, whose bed is now partly occupied by a modern fresh-water canal and partly by marsh plants.

COLUMN 1,
NO. 5.

ANCIENT MAP OF EGYPT.

Fragment of the "Table of Peutinger", now in Vienna. This is a manuscript dating to about the XIIth century A.D. and reproducing a map made during the Roman Empire of the then known world. The contours of the countries have been very much distorted so that the map could be contained in a very long but rather narrow roll. Its main object was to give a list of all the most important routes, together with the towns and stations along them and the distances between each. Seas, having no interest in this connexion, are reduced nearly to vanishing point. The portion shown in the photograph represents Asia Minor (above) and Egypt (below). The course of the Nile is depicted as being parallel to the Mediterranean for want of a better place elsewhere, while the Red Sea is placed in the opposite direction. The routes, however, along the Nile and those across the desert from Coptos to Berenice can be fairly easily recognised.

COLUMN 1,
NO. 6.
AFTER G.W.
MURRAY,
JOURNAL OF
EGYPTIAN
ARCHAEOLOGY,
XI, 138.

THE ROMAN ROADS IN THE ARABIAN DESERT.

Map of the roads which, in the Roman period, crossed the Arabian desert, together with the stations at which the caravans halted at the end of each day (compare with preceding No.). Some of the identifications of the ancient sites with modern ones are by no means too certain, particularly in the case of Myos Hormos, which should perhaps be sought near El-Quseir, which is here identified as the ancient Leukos Limen.

AFTER BOURDON,
ANCIENS CANAUX
(SOC. ROYALE
DE GEOGRAPHIE
D'EGYPTE).

MAP SHOWING COURSE OF THE ANCIENT CANAL BETWEEN THE NILE AND THE RED SEA.

This map shows (in red) the course of the ancient canal between the Nile and the Red Sea. Originally the canal left the Nile near Zagazig (Bubastis), but later it began further upstream at Bilbeis and finally it was brought up to Old Cairo (Babylon).

RELIEFS OF THE NILE DELTA AT DIFFERENT PERIODS.

In the time of Herodotus (IVth century B.C.), the Nile flowed into the Mediterranean through five branches. Strabo (1st century A.D.) mentions seven, while Arab geographers and authors also give the number as seven, though their courses were by no means constant. Today there are but two branches, that of Rosetta and that of Damietta.

Nos. 7 and 8, PHOTOGRAPHS ILLUSTRATING TRANSPORT IN MEDIAEVAL ARAB TIMES. MINIATURE OF A RED SEA BOAT. — XIIIth CENTURY.

Mesopotamian miniature showing a passenger-boat on the Red Sea. The traveller, Ibn Jubair, who crossed from Aidhab to Jedda, gives the following account of these craft: "The boats which sail on this treacherous and hateful sea are made of planks which are sewn together; there is no nail in their construction. The stitches are cords of cocconut-fibre, which is first beaten and then converted into the string from which the cord is twisted". Oakum from date-palms is used to caulk the boats, which are finally covered with castor-oil or, preferably, with shark-grease. The miniature shows clearly the 'stitches' in the planks and proves that the account of the traveller is not fantastic. Note the two sailors baling out water, which must have percolated freely through such imperfect, 'sewn' joints".

ABU'L-MUNAGGA BRIDGE. — A.D. 1267.

This bridge is near Qaliûb, some 10 kiloms. from Cairo. Stone bridges were rare in Egypt, since they obstructed navigation. The navigable canals were crossed by bridges constructed of moveable planks, which were removed at certain hours to permit the passage of boats. The Nile was crossed by ferries, which constituted a public department maintained by special tolls and taxes. Near the capital, two pontoon-bridges connected Old Cairo and Rôda and the latter with the Giza bank. The first, which was the shorter, contained 36 pontoons.

TRANSPORT IN THE ARAB PERIOD.

The conquest of Egypt by the Arabs (640-642 A.D.), hardly changed the methods of transport already in use in the country, but was not without influence on its communications with other lands. Apart from the commercial role it played in the transport of goods between the East and West, Egypt, now an Arab Province, needed rapid and regular relations with Syria and with

FROM
MEMOIRE
SUR
L'HISTOIRE
DU NIL, BY
H.H. PRINCE
OMAR
TOUSSOUN.

COLUMN 1.
NO. 7.

COLUMN 1.
NO. 8.

Mesopotamia, where there were political centres, such as Damascus and Baghdad, which influenced or dominated it. Above all, Egypt, being now converted to Islâm, had to make sure of means by which thousands of the Faithful could attain the sanctuary of Mekka.

One of the effects of the new political situation was, from 643 A.D. onwards, the reopening by 'Amr Ibn el 'As, the first Arab Governor of Egypt, of the canal connecting the Nile with the Red Sea, which had been neglected for years and had become choked with sand. It proved very useful indeed for the transport, to the barren Hejâz, of Egyptian corn, which was in future to feed Mekka and Medîna instead of Rome and Constantinople. It was a political reason also that induced the Sultan Mansûr, a hundred years later (between 762 and 767 A.D.), to subdue, by hunger, a revolt in Medîna by damming the canal at its mouth and forbidding its maintenance.

The same 'Amr who reopened the canal had also conceived the idea of cutting one connecting the Red Sea directly with the Mediterranean through the Isthmus of Suez. The common belief, however, held since ancient times (Aristotle, Diodorus, Pliny, etc.), that the level of the Red Sea was higher than that of the Mediterranean, caused the project to be abandoned, just as it was to retard it again in the XIXth century.

Neither the coming of Islâm nor the construction of the canal did much harm to the commercial relations between Egypt and the Christian kingdoms of the West and with the eastern countries. A geographer of the IXth century describes Jewish merchants bringing from the West on their boats slaves, eunuchs, embroidery, furs and swords. Disembarking at Farama (the ancient Pelusium), they transported their cargoes on camel-back to Qulzum (Suez) and subsequently across the Red Sea to Jâr, the port of Medîna or Jedda that of Mekka. From thence they went to India and China, returning with pearls, ivory, silk, musk, aloes, camphor and spices for the western markets and for Constantinople. Held up by the Crusades, the activity of this traffic sprang to new life after the expulsion of the Crusaders. In the XIVth century, the port of Alexandria was still one of the foremost in the world and the principal centre for the commerce in spices. The transport of these goods, thanks to customs duties, proved a fruitful source of revenue for Egypt. The exorbitance of these taxes, however, and the vexations for which they were made the pretext, played a large part in the efforts of the western peoples to find another route to the East, with the result that the discovery, at the end of the XVth century, of the Cape of Good Hope, had a cruel effect on the traffic across Egypt.

The network of routes in the Arabian Desert, carefully developed and maintained by the Romans, became, after the Arab

conquest, of even greater importance owing to the closeness of the religious and political relations between Egypt and Arabia and Mesopotamia. Numerous caravans traversed the routes, stopping the night in caravanserais where shelter, water and food was to be had. The route of the Pilgrimage, starting from Cairo, passed across the desert to Qulzum (Suez) from whence the voyage proceeded by water or by land to Mekka. In the middle of the XIIIth century the custom arose, which has been retained ever since, of sending each year, with great pomp, a *Mahmal* with money for charity and pious donations made by rich Egyptians.

Along the most important routes there was a postal service (*barîd*), the successor of the Byzantine post (see p. 19). The chief mail routes were that between Damascus and Cairo via El-Arish, Farama (Pelusium) and Bilbeis; the two routes from Cairo to Alexandria; the route which followed the Nile from Cairo to Aswân with branches to 'Aidhâb (the ancient port of Berenice) and to El-Quseir (see p. 16). It was by these southern routes that the pilgrims visited the sacred sites during the times when the Crusades rendered the ordinary route impossible. At each stage horses were held ready and at the disposal of the state couriers, who could cover in five days the distance between Cairo and Aleppo, which would take an ordinary convoy 34 days. The rapidity of this post enabled a curious service to be organized, under the Mamelukes, of cargoes of snow from the Lebanon to Cairo to cool the drinks of the Sultân and his court. It was also the Mamelukes who methodically organized a pigeon-post, connecting the principal centres with the Citadel at Cairo, and with Gaza, Damascus and Aleppo. The royal pigeons bore special marks on the bill and the feet and the messages were attached under either the wing or the tail.

THE OVERLAND ROUTE. — EUROPE-INDIA.

The revolution in commerce of European Overseas trade which marked the emergence of the modern national state from the confusion of mediaeval times has had a profound influence on the whole of the modern era. The world of the twentieth century has learned to trace the revolution from the commercial movement of the sixteenth, the colonizing activities of the seventeenth, the overseas wars of conquest of the eighteenth, to the industrial revolution of economic imperialism of the nineteenth century.

The first contacts with India were established by way of the Mediterranean and travellers and goods made their way either across Egypt or by way of the Euphrates.

From the voyages of circumnavigation of Drake and Cavendish until the beginning of the second quarter of the nineteenth century the main trade was by way of the Cape of Good Hope.

In 1698, Henry Tistew, an English Consul in Syria, endeavoured to create a trade route through Egypt, but this was foiled principally by the Ottoman ban on the navigation of the Red Sea north of the Port of Jeddah upon all Christian vessels.

Another effort was made in 1768 by James Bruce and Carlo Rosetti, but for various reasons this gave no real result.

It remained for George Baldwin, a merchant, to actually commence a trade route in 1775, and, by 1777, the Indian authorities both in England and in India, were replying on the overland route for their most important communications, and a packet marked "Received Overland" was designed for instant attention. Many difficulties were overcome and merchandise was actually transported across the Isthmus of Suez during this period, but the jealousy between the Continental and the British powers stunted the efforts of George Baldwin who died in poor circumstances in 1799.

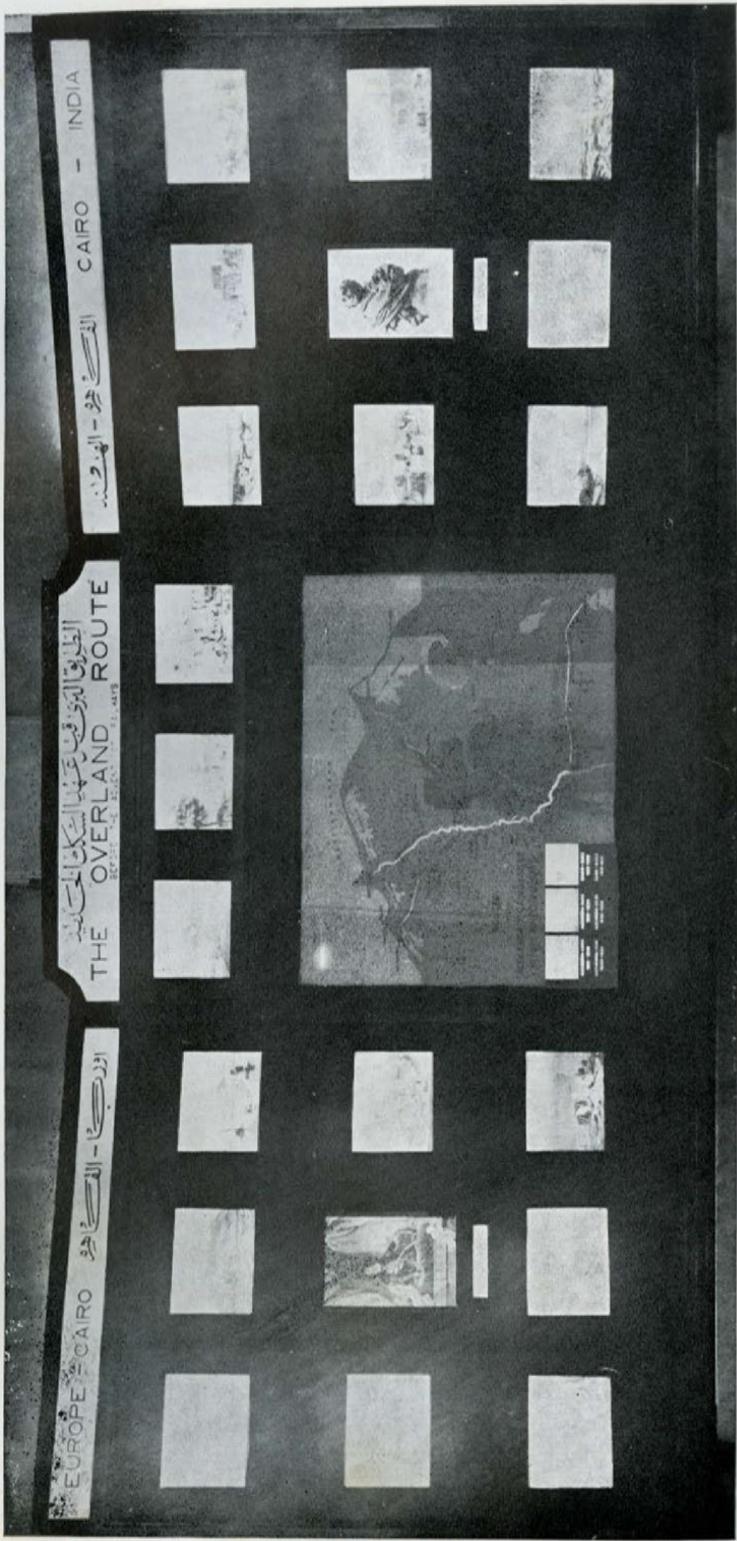
The route through Egypt fell into disuse owing to the opposition to the Navigation of the Red Sea and the prevalence of turbulent political conditions in Egypt. The use of alternative routes through Syria and Mesopotamia declined because of chaotic conditions throughout western Asia and along the European extension of the line, but the growing efficacy of the steam vessel made the old Cape Route increasingly popular.

A unique individual, Thomas Waghorn, whose vocabulary did not contain the word "impossible", became distinguished as the projector of the Overland Route through Egypt to India, and on March 20th. 1830, a sturdy little steamer which was built of Indian teak at Bombay successfully reached Suez a month later.

Many efforts were made by Waghorn personally, and in 1833 he undertook, and carried a mail from London through Egypt to India in 60 days.

The East India Company and business people in England had co-operated to supply vessels to operate the sea portion of the "Overland Route". In 1839 the British Government made an agreement with the French Government for the transmission of mails to and from India by way of Marseilles and overland, whilst heavier packages were conveyed all the way by sea, P. and O's steamers operating between England and Malta, and British Admiralty's vessels between Malta and Alexandria.

The method of transport during these early days in Egypt was by camel between Rosetta and Alexandria, by sailing-boats on the Nile to Bulac (Cairo) and Rosetta, and by camel between Cairo and Suez.



The Overland Route — Europe to India,
 A map of the Overland Route, Alexandria—Cairo—Suez.

الطريق البري من اوربا الى الهند
 خريطة الطريق البري اسكندرية — مصر — السويس

Later, however, in 1840 a definite means of transport was inaugurated. The first part of the transit was by way of the Mahmoudia Canal which had been reconstructed by Mohamed Aly Pasha in 1820. This journey of 48 miles was accomplished in a big mastless canal boat in form not unlike the dahabiahs used today upon the Nile, towed by a steam tug at the rate of 5 miles an hour. Two P. & O.S.N. Co.'s steamers plied on the River Nile between Atf and Cairo; these vessels had been arranged for by Mohamed Aly Pasha and had been the subject of a special concession. They were capable of conveying about 70 persons, each.

In 1841, Mohamed Aly Pasha made at his own cost the way between Suez and Cairo practicable for carriage travelling and furnished the necessary means to afford perfect security to the transit traffic.

The method of transport between Cairo and Suez is best explained by the following extract from a memorandum of the late Scandar Pasha Fahmy, late General Manager of the Egyptian State Railways:—

“The transport of tourists and luggage from Cairo to Suez was by two-wheeled coaches drawn by four mules each, and which could hold six travellers, passing through the desert to Suez and calling at stopping stations known as points 4, 8 and 12. The latter two points had stables for relays of horses and mules, also commodious hotels for the tourists to take their meals and to sleep.

This operation was entrusted to an English contractor named Mr. Shepheard, the proprietor of the famous hotel known by that name.

The travellers, luggage, post, goods and cash when arriving by the steamer used to stop at a place called Bulak Quay surrounded by a big wall where all were unloaded on the Quay and after being checked, they were loaded on camels of Arabs caravans that travel from Cairo to Suez guarded by Turkish kawasses and a pay clerk. The goods and post were in charge of the cameleers”.

In 1844, Mohamed Aly Pasha decided to form a Government

Establishment on a large scale to meet the growing number of passengers through Egypt and for the transit of goods, etc. This Establishment, the Egyptian Transit Administration, was run as a Government Department, thus making it more practicable, and also considerably lessening the cost.

It is interesting to note that in 1849, 5 years later, a wharf and cargo sheds had been built at Gabbary, and a Farm provided just outside Cairo to supply vegetables and fruit for the Tourists.



A Hotel had been built at Suez by the Egyptian Government for the accommodation of passengers and the route between Cairo and Suez, which had been partly macadamized, was divided into 16 stations which number was later reduced to 9, most of which could facilitate a change of horses in from 8 to 10 minutes. The entire distance from the Nile to the Red Sea could be covered in comfortable vehicles in from 16 to 18 hours, out of which about 10 hours were occupied in actual travel on the road, the remaining portion in rests taken for meals, etc. and in changing horses.

This brings this brief note on a most interesting subject to 1851 the date of commencement of the construction of the Railway. The desert route between Cairo and Suez was maintained until the opening of the Railway on the 25th. May 1859.

The routes across Egypt are shewn by an illuminated diagram on the panel, on which are shewn a number of photographs of old sketches and woodcuts of nearly a 100 years ago and which form a very interesting collection of scenes of travel between Europe and India during this period.

ROAD TRANSPORT.

Road Transportation in the early periods was chiefly by donkeys, the roads being made on the banks of the Nile and canals and gave no facilities for wheeled transport.

Since the coming of the internal combustion engine great development of the roads has been made although outside the main towns they consist chiefly of soft earth from the Nile and canal banks, consolidated by water and the heat of the sun, and gives quite a good surface for light traffic. The total length of these roads is 6,266 kilometres. In addition to these, there are Macadam roads with a total length of 393 kilometres, and 1st and 2nd class roads (earth and Macadam) having total lengths of 2,361 and 4,298 kilometres respectively.

Private motor cars and taxis have increased from 5,000 to 25,000, motor lorries from 600 to 4,200, and motor buses from 200 to 1,200. This shows that although the general opinion that Egypt has not developed road transport as much as other countries, it has been a very rapid growth.

WATER TRANSPORT.

Water Transportation from the earliest period has been of much assistance to the development of Egypt. The Pharaonic Section shows photographs and models of that period. The felucca and dahabia of today are very little different to those of the earliest period of Egypt's history. There are now some 10,000 plying on the Nile and its navigable canals ranging from 5 tons capacity up to 30 tons, having an aggregate tonnage of nearly 200,000 tons.

Since 1920 a rapid development of power driven vessels has taken place; they range from 25 tons to 300 tons capacity, the aggregate tonnage about 30,000 to 35,000 tons and numbering about 350 units.

The total length of navigable canals in Egypt is as follows:—

River Nile, total branches ...	1,447	kilometres.
Lower Egypt Canals	1,212	„
Upper Egypt Canals	347	„
	<hr/>	
Total... ..	3,006	„

THE DEVELOPMENT OF CIVIL AVIATION IN EGYPT.

Preliminary.

In the year 1919 the Government first considered the establishment of a bureau of Civil Aeronautics for the control and development of Civil Aviation in Egypt.

In 1925 a definite policy was formulated and the post of Air Consultant was created in the Ministry of Communications. Squadron Leader W.D. Long of the Royal Air Force was appointed to occupy this post. In May 1927 the title of this appointment was changed to that of Controller General of Civil Aviation.

The drafting of the necessary Air Navigation Laws and Regulations, the consideration of possible sites for Aerodromes and the preparation of various schemes proceeded.

Development.

It was eventually decided to construct a Landplane Airport at Almaza near Heliopolis and a combined Marine Aircraft and Landplane Airport at Dekheila near Alexandria, these were to be the principal Airports of Egypt.

The preparation of Almaza Aerodrome viz: levelling of surface and marking of boundaries, fencing of the entire perimeter, construction of a hangar and offices and internal roadways to connect with the road through Almaza Village, was eventually completed and the Airport was officially inaugurated by His Majesty King Fouad 1er. on June 2nd. 1932 on the occasion of the arrival of the first Egyptian Army Air Force Aeroplanes piloted by Egyptian Officers.

The preparation of the Dekheila site presented considerable difficulties, a large portion of it was low lying and subject to flooding in the rainy season, in addition, only about ½ the area was Government land, so the remainder had to be expropriated.



After much consideration it was decided to raise the level of the low lying ground, and filling operations were commenced; a very extensive area being raised to a level of approx. 70 cms., above the original level. The surface was eventually planted with Negil grass which although only partially successful at first is now by constant cultivation and continuous replanting of bare areas, becoming established and firm enough to bear the traffic of Aircraft.

Dekheila Aerodrome was opened for use, as a landing ground, for light aircraft on the 1st. October 1932.

Further Development.

The installation of Boundary lights, flood lighting and Aerodrome Identification Beacon at Almaza Aerodrome during the next few months will enable this Airport to offer facilities for the landing of Aircraft by day or by night, equal to any other Airport in the world.

The building of the necessary Control Office, First Aid Room and Garage Accommodation for Ambulance and Fire Tender, etc., at Dekheila is now proceeding and it is hoped that the completion of these and the cultivation of a sufficiently extensive area to provide a minimum of 600 yards "take off" in any direction of wind will enable the Aerodrome to be declared available for all types of landplane Aircraft by April, 1933.

Investigations are being made with a view to selecting suitable sites for the establishment of landing grounds along the different Air Routes and at all principal towns.

It is the intention to provide hangar accommodation at Dekheila and Mersa Matruh during the year 1933 and also commence the construction of a large hangar at Almaza to meet increased traffic requirements.

Training and Employment of Egyptian Nationals.

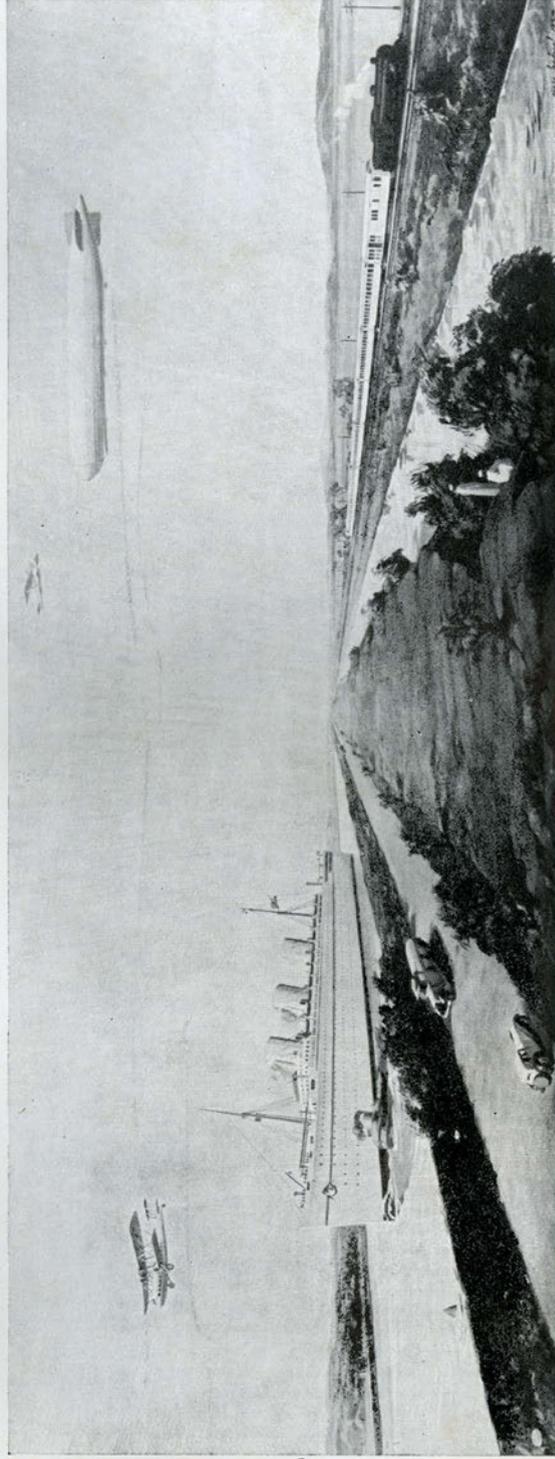
Annually since 1927 certain selected candidates have been sent to England to specialise in various aviation subjects with a view to their appointment to posts in the Civil Aviation Department.

These duties comprise Technical Inspection of aircraft, and examination of ground engineers, and Aerodrome Control.

At the present time five candidates have completed their training and are actually employed, three are still undergoing training.

Operation of Civil Air Lines.

In 1926 a provisional agreement was concluded between the Egyptian Government and Messrs. Imperial Airways Ltd., for



An impression of typical transport scenes in Modern Egypt.

صورة لمناظر أنواع النقل بمصر الحديثة

the operation of a Civil Air Service for the carriage of passengers, mails and goods between Egypt, Palestine, Iraq and India.

In 1929 this authorisation was extended to the operation of a service of Flying Boats between Europe and Alexandria.

In 1930 the services of this Company were authorised to extend through Egypt to South Africa and intermediately.

In 1930 the Royal Dutch Air Lines (K.L.M. Company) were authorised to operate a "bi" monthly Air Service for the carriage of mails through Egypt between Holland and Batavia; this was subsequently in October, 1931, extended to permit a weekly service and include the carriage of passengers and goods in addition to mails.

Formation and Operation of an Egyptian Aviation Company.

The Council of Ministers on 31st. December 1931, gave authorisation to the first Egyptian Aviation Company "Société Misr Airwork" to undertake certain aeronautical enterprises in Egypt, including the establishment and operation of flying training schools, Aircraft Service Stations, Regular and Occasional Air Services within Egypt and between Egypt and abroad, etc., etc. The Company commenced its enterprises in May 1932. A number of Egyptian candidates have already been trained and have qualified for licences to fly private aircraft.

The Company operates a service station for the housing, provisioning, maintenance and repair of civil aircraft at Almaza.

The Government has, with a view to assisting and encouraging the development of aviation, granted certain subsidies to this Company.

Formation of Clubs.

In 1930 the Aero Club of Egypt was created with a view to filling the same role in Egypt as that which is filled in other countries by the National Aero Clubs which are affiliated to the Federation Aeronautique Internationale, namely, the encouragement, development and general welfare of private and sporting aviation.

The club has been recognised by, and, has become affiliated to the Federation.

New appointments.

During July 1932 the post of Controller General of Civil Aviation was suppressed and the post of Director General of Aviation (Civil and Military) was created, Wing Commander Sir C.J.Q. Brand, K.B.E., D.S.O., M.C., D.F.C., of the Royal Air Force was appointed to occupy this post on 1st. August, 1932.

SECTION 1.
NO. 47.
FIRST FLOOR
BAY N.

CAMEL TRANSPORT.

The camel has been used for centuries as a medium for the transport of goods across the desert and in the cultivated areas along the Nile valley.

These four models represent camels loaded with stones, earth, cotton bales and sugar canes respectively.

When stones and earth are carried they are loaded into baskets known as the Maktaf, which are slung pannier wise on the back of the camel. These baskets are made of palm leaves, which are torn off the main stem and split into the desired width, and are then woven into a very long plait. Extra leaves are constantly incorporated, till the necessary length is completed. These plaits are sewn together in the form of a spiral, a cord of twisted palm leave strands being used for this purpose.

Two rope handles are attached to each basket the rim of which is strengthened with the same material. Cotton bales and sugar canes are also carried pannier wise being bundled together and secured with ropes.

SECTION 1.
NO. 48.
FIRST FLOOR
BAY N.

EGYPTIAN DONKEY CART.

One of the commonest forms of transport which is still in use is the donkey cart. The model represents a typical vehicle of this kind, and its women passengers. The platform is flat and framed up from boards about 1" thick. It is bolted through cross bearers on to the framework, two sides of which are formed by the extended shafts of the vehicle. The front and rear of the platform are supported by inclined flat steel or iron bars, which are bolted at their lower extremity to the axletree.

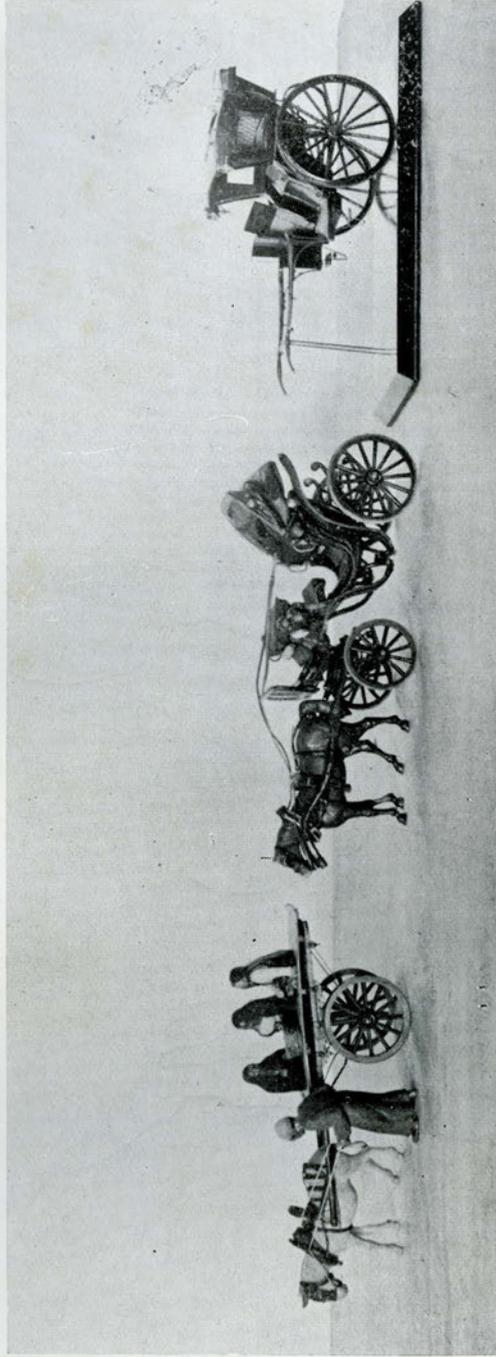
There are no bearing springs fitted, all road shocks being transmitted to the passengers.

SECTION 1.
NO. 49.
FIRST FLOOR
BAY N.

MODEL OF PRIMITIVE MAN CARRYING LOAD.

This model represents a primitive man carrying a load. In primitive times as climatic conditions improved, game became more plentiful, and the horse (very much smaller than it is today) was commonly hunted and killed for food.

There being no other means of transport on land, all loads were carried on the back, or slung on a pole between two men.



Model :

عربة كارو يجرها حمار

Egyptian Donkey Cart

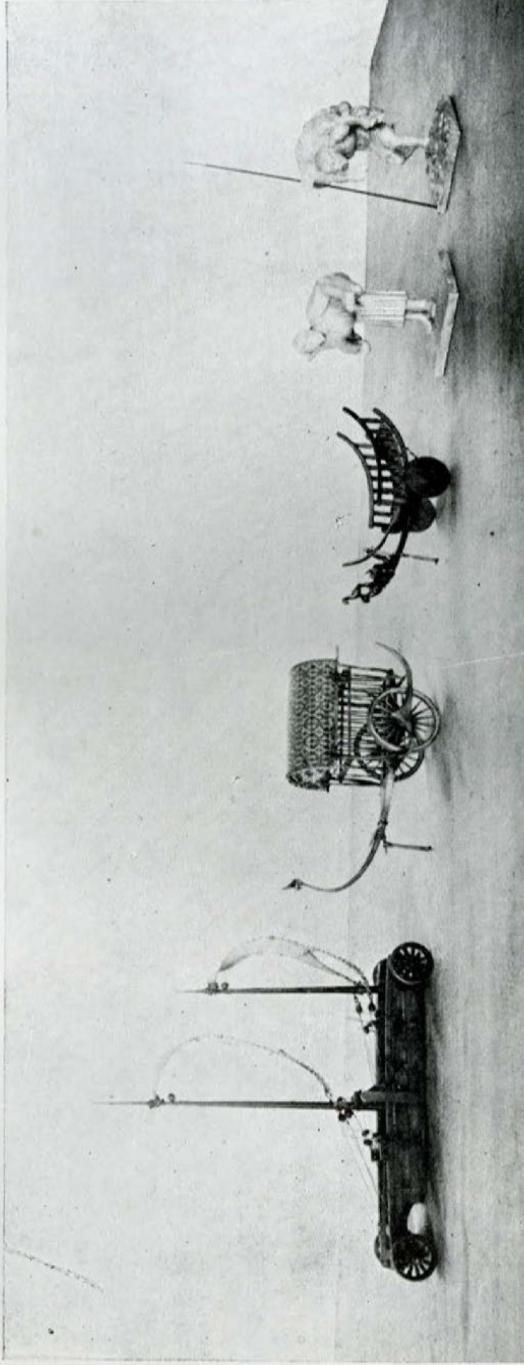
دو كار مصري

Egyptian Gharry

انموذج :

عربة هانسام

Hansom Cab.



Model :

- (1) Sail Carriage
- (2) Siamese Cart.
- (3) Burmese Cart
- (4) Sakkà (Water Carrier)
- (5) Primitive man carrying a load.

(1)

(2)

(3)

(4)

(5)

أمثلة :

- (١) عربّة ذات شراع
- (٢) عربّة تستعمل في سيام
- (٣) عربّة من سيام
- (٤) سقا
- (٥) رجل فطري يحمل حملا

SAIL CARRIAGE.

This model represents a sail carriage dating to about 1600. Vehicles of this kind were used on the low lying coast of Holland. Wood was used in their construction, and the force of the wind was utilised to propel them, two sails being fitted for this purpose. Deviation from a straight course was made possible by the axle of one pair of wheels being fixed on a pivot which was operated by a tiller.

MODEL OF SAKKA (Water Carrier).

This model represents a Sakkà or Water Carrier. In the days before water was available in the houses of the inhabitants of many Egyptian towns, and to a less extent today, these men made their livelihood by supplying them with water from the Nile. During the rising of the river the Sakkàs drew their water from it. When the distance to be covered is long, camels and donkeys are employed to convey the water in skins. The water skins of the camel are a pair of wide bags of ox-hide. The donkey carries a bag made of goat skin, (called "kirbeh" in Arabic) and so too does the Sakkà.

When the distance to be covered is short the goat skin, filled with water is slung across the water carrier's back.

MODEL OF A BURMESE CART.

This form of two-wheeled bullock cart is common in Burma and Bengal, and is a survival of a primitive type of wheeled vehicle. It has solid disc wheels, which are, however, provided with long wooden bushes running on a fixed axle-tree; the oxen are tied to a yoke bearing against their humps and lashed to an ornamental pole, which is forked at the inner end for attachment to the axle and to the body framing.

MODEL OF A SIAMESE CART.

This represents the ordinary travelling cart used in Siam. It is constructed entirely of wood and has a long narrow body, with sides formed of vertical bars inclining outward at the top, surmounted by a semicircular roof of matting. It has two spoked wheels with very long hubs, each running loose on a separate axle, these axles are supported at both ends, the inner ends by a cross-beam under the floor, and the outer ends by side bars which are mortise'd into long cross beams attached to the body before and behind the wheels. The sides of the cart are supported from these cross beams by inclined bars and stayed by twisted cords.

SECTION 1.
NO. 50.

FIRST FLOOR
BAY N

SECTION 1.
NO. 51.

FIRST FLOOR
BAY N.

SECTION 1.
NO. 52.

FIRST FLOOR
BAY N.

SECTION 1.
NO. 53.

FIRST FLOOR
BAY N.

The two main beams of the framing are brought together at the front and prolonged to form the pole to which are yoked a pair of water-buffaloes. The rear ends of the outside frame bars are curved upward and serve to extricate the cart should it sink into soft ground.

**SECTION 1.
NO. 54.**

FIRST FLOOR
BAY N.

MODEL OF TAKHARAWAN.

This exhibit represents a form of transport used in Egypt and Palestine by pilgrims when travelling from Cairo to Jerusalem.

These old carriages were each carried by two camels and the model shows how this was done.

**SECTION 1.
NO. 55.**

FIRST FLOOR
BAY N.

EGYPTIAN GHARRI AND HORSE.

One of the commonest means of transport in the towns and cities in Egypt is the horse drawn four-wheeled Gharri or buggy. It is not unlike the Hansom cab in appearance, except that the driver sits on a seat in front of the passengers.

The body is sprung on elliptic laminated springs on the rear axle, while the driver's seat is sprung on elliptic laminated springs over the front wheels which are free to turn about a centre. The hood is collapsible and the wheels are rubber typed. A pair of horses is the usual yoke, but occasionally a single horse is employed.

**SECTION 1.
NO. 56.**

FIRST FLOOR
BAY S.
PRESENTED BY
THE ROYAL
AIR FORCE.

ROLLS-ROYCE "FALCON" III AEROPLANE ENGINE.

This is one of the most successful war time aeroplane engines, and was fitted notably to the Bristol Fighter type of machine. In order to shew details of construction it is partly sectioned.

It is a high compression engine with twelve cylinders, and develops 270 H.P. at 2,000 r.p.m. The petrol consumption is 19 gallons per hour. Dual ignition is from two twelve-point B.T.H. Magnetos. The Carburetters are of the Rolls-Royce Claudel-Hobson type.

The speed ratio between airscrew and crankshaft is 56:95 and the drive is through epicyclic gear.

Lubrication is by dry sump, oil being delivered at 40 lb. per sq. inch to main crankshaft journals, big and small ends, and at 2 lbs. per sq. inch to camshaft and timing gears.

The engine exhibited was used in Palestine until 1931, its weight is 660 lbs.

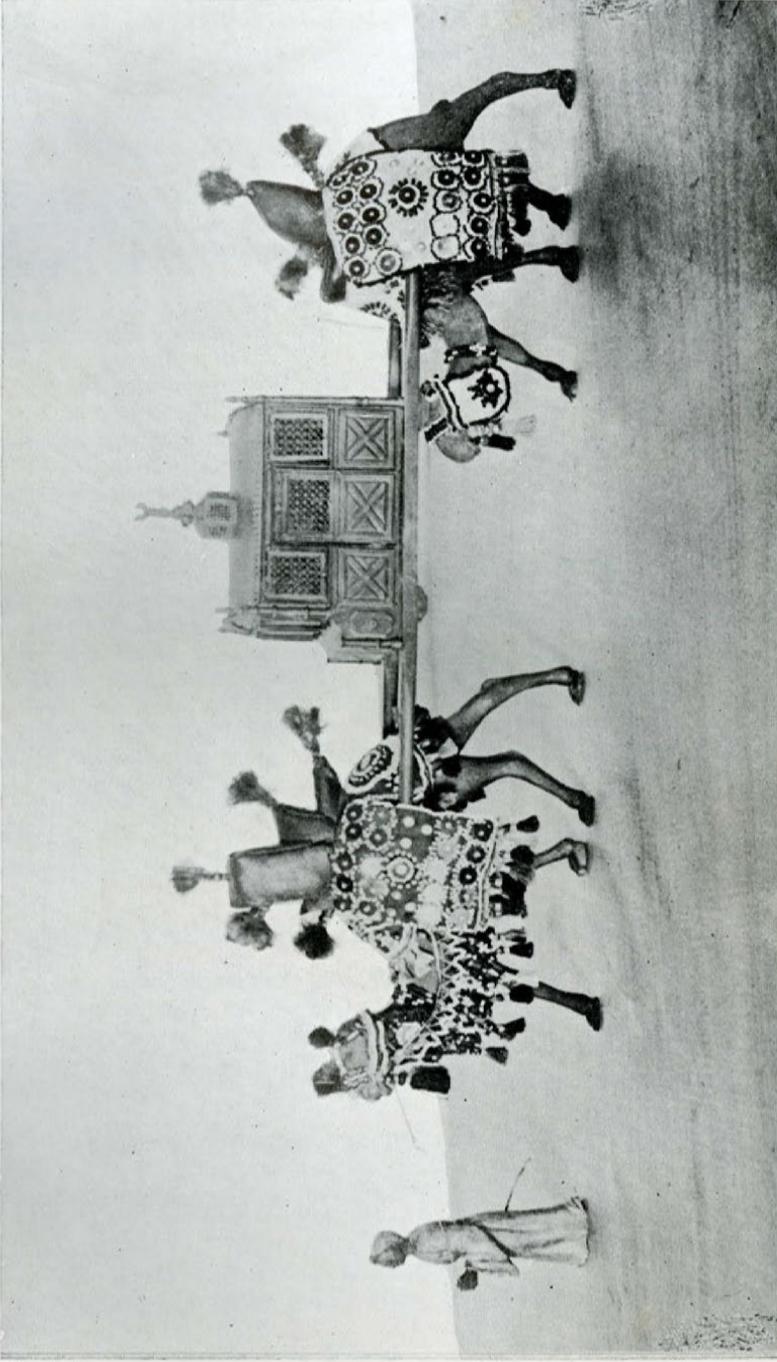
**SECTION 1.
NO. 57.**

FIRST FLOOR
BAY N.

EGYPTIAN STONE CART AND HORSE.

This model represents the type of vehicle used to transport stones for building purposes.

The wheels which are of large diameter, somewhere in the region of 7'-0" are made thus to provide easier running on uneven ground.



Model of Takhtarawan.
Used by Pilgrims travelling from Cairo to Jerusalem.

أخذوا تختروان
يستعمله الحجاج الذين يسافرون من القاهرة إلى بيت المقدس

MODEL OF NILE PADDLE STEAMER "EGYPT".

This represents a typical Nile Paddle Steamer, used for tourist traffic during the winter season-October to April. Vessels of this type are specially designed to enable the passengers to see the ever changing life and scenery of the Nile to the best advantage.

They have three decks, the topmost of which is 50 feet across and includes a large open lounge with sliding wind screens and a glass-enclosed observation room forward, where one can sit and watch the river life.

On the deck also are the smoking and drawing rooms, and accommodation consisting of two suites with private bath, two large double bedrooms with private bath, and several single cabins. The two large double bedrooms are similar to those in the suites. A single cabin adjoining has a communicating door so that families of three can use the private bath.

On the saloon deck all the cabins are single. Four have each a private bath and a communicating door into the adjoining cabin, whereby two persons may have the use of the bath if required. The dining saloon is situated on this deck forward. Tables are arranged for two or four persons, and the large windows ensure that nothing of interest is missed even at meal times. On the main deck there are eight large cabins with two beds, and more with one bed. These cabins enjoy more privacy and quietness than those above, and, being protected, are warm in cold weather and cool in warm weather. All of the bedrooms are comfortably furnished and have hot and cold running water.

Each of the steamers is in charge of an experienced Manager, First-class chefs are carried, and there are ladies' maids, a hair-dresser, and a fully-qualified Medical Officer.

A library of works on Egypt is provided in the drawing-room and a piano and gramophone are available for dancing and concerts.

MODEL OF THORNEYCROFT OMNIBUS.

This is an exact model of the type of omnibus employed in Cairo City service, and represents the latest type of "Thornycroft" 29 seater saloon Bus. The chassis is mounted on Dunlop pneumatic tyres size 36" x 7" twin tyres on the rear axle. The power unit known as type MB. 4 has four cylinders developing 59 H.P.

This chassis being designed specially for passenger work is fitted with two entirely independent braking systems. The foot brake which is assisted by a powerful Vacuum-Servo cylinder, supplied by Westinghouse, operates internal expending shoes, in drums attached to all four wheels. The hand brake operates on a drum fitted to the rear end of the intermediate propeller tube. On the foot brake, the fully laden Bus, travelling at 20 m.p.h.

SECTION 1. NO. 58.

FIRST FLOOR

LENT BY
THOS. COOK &
SON, LIMITED.

SECTION 1. NO. 59.

FIRST FLOOR
BAY N.

LENT BY
H.E. AHMED
ABOUD PASHA

(32 kilos) can be brought to rest in 25 feet (7.6 m.).

Interior and exterior lighting is supplied by a 12 volts C.A.V. lighting set, with a 105 amp. hour battery. Other equipment includes mechanical tyre pump operated from the gear box, and full range of dashboard instruments, fire extinguishers and electrical signalling device.

Ventilation is supplied by three patent Flettner rotary ventilators, fitted on the outside of the roof, in order to ensure the coolness of the interior of the body in summer time, a double roof is fitted, with an air space between.

There are more than one hundred of these vehicles in daily circulation in Cairo, each covering approximately 140 miles per day. The model is electrically lighted.

MODEL OF HANSOM CAB.

This model represents a Hansom Cab, so named after its inventor. Vehicles of this kind were in common use on the streets of London, and English provincial cities, at the latter end of last century and the early years of this.

Seating is provided for two passengers, with folding flaps, and windows, which completely close up the front when desired. The sides and roof are a permanent structure. The driver's seat is placed high up at the rear, a trap door in the roof permitting communication between driver and passengers. The springing consists of semi-elliptic side springs attached by long links to points under the front step flooring, and attaching to a transverse spring at the rear, carried by a bracket extending downward from the driving seat. The hansom was superseded on the London streets by the motor cab during the period 1905-12.

MODEL OF HORSE—DRAWN OMNIBUS, 1911

This model represents one of the many horse-drawn omnibuses, owned by the London General Omnibus Co. Ltd., which plied in the streets of London in 1911. They were the forerunners of the present day motor bus. These buses were drawn by a pair of horses and the drivers sat on the elevated seat in front of the passengers compartment.

The lower compartment was covered in, while the top deck was open. Passengers on top were protected from the elements by water-proof aprons.

The modern motor bus body follows closely the design of these early buses.

AIR SCREW — AEROPLANE.

This exhibit is an air screw from a De-Haviland Moth Aeroplane E. 102, which was flown to Egypt from England in June 1932.

SECTION 1. NO. 60.

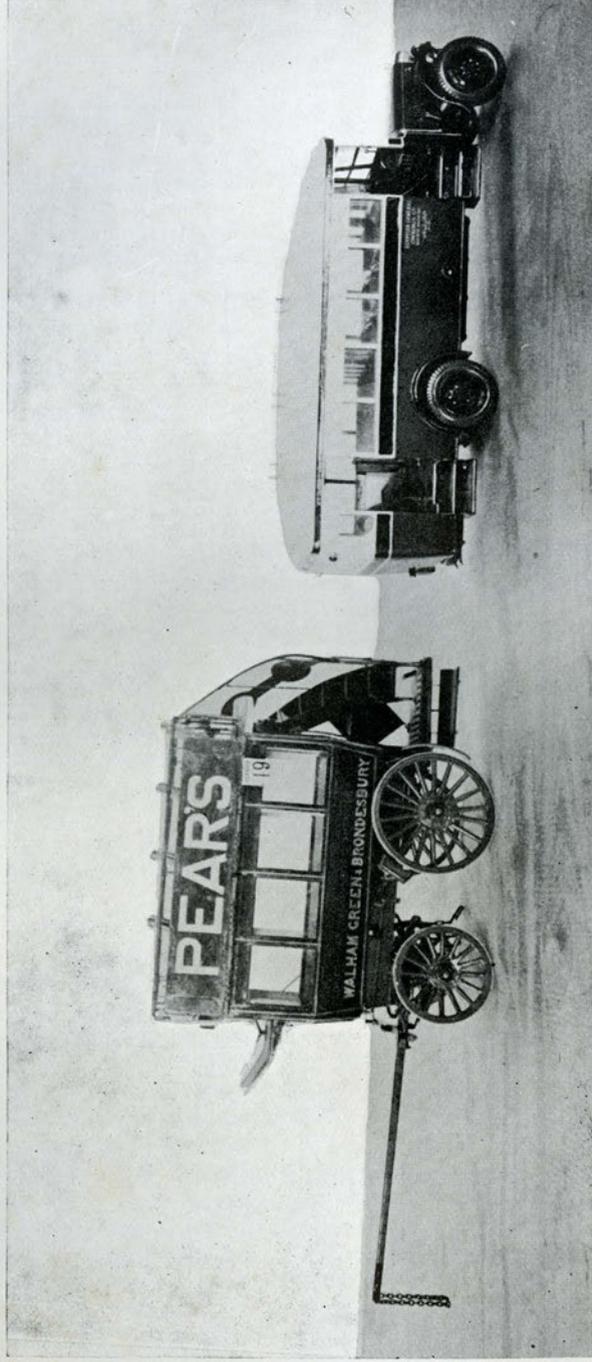
FIRST FLOOR
BAY N.

SECTION 1. NO. 61.

FIRST FLOOR
BAY N.

SECTION 1. NO. 62.

FIRST FLOOR
BAY S.



Model of a London

Horse-drawn bus of 1911

النموذج العربي يجرها حصان

كانت تستعمل في لندن في سنة ١٩١١

Model of Motor Bus

النموذج سيارة اومنيبوس

SECTION 2.

LOCOMOTIVES AND RAILWAY

ROLLING STOCK.

The World-wide Evolution of Railways.

The commencement of the railway era may be said to date from the opening of the Stockton and Darlington Railway on 29th September 1825, that being the first public railway in the world on which the steam locomotive was used.

The Liverpool and Manchester Railway which was constructed by George Stephenson, and opened on 15th September 1830, was however the great experimental railway, and that on which the possibilities of the steam locomotive became apparent, due largely to the success of Stephenson's "Rocket" in the Rainhill trials of October 1829. The success of this railway gave great impetus to railway extension and between 1830 and 1840 several lines obtained Parliamentary sanction.

In America the first steam Railway was opened in 1830, and in Europe in 1832.

The year 1836 marked a most important stage in railway development as in it the first substantial attempt was made to link up the more important centres, and more than 1,000 miles of new lines were sanctioned in England.

In 1837 the total mileage of railway in England had reached the figure of 2,469 miles.

The Great Western Railway (England) for which the broad gauge of 7'-0" was adopted by Brunel, was opened between 1838 and 1841.

The year 1852 saw the opening of the first section of railway in Egypt, this was constructed by Robert Stephenson.

The first steam railway in Asia was opened in 1853 and in 1854 the first Australian railway was opened for traffic. Since that date railways have been constructed at a rapid pace in all parts of the world, opening up rich virgin tracts of country. The difficulties encountered in this work have in many cases been almost unmountable, but by dint of grit and hard work success has crowned the efforts of the pioneers.

The steam locomotive still holds its own, but owing to the increasing demand for greater power and higher working pressures the multitubular locomotive boiler, which has undergone little change in design since the early days of railways, will it seems from present indications give way to the water-tube type

of high pressure boiler. Railway engineers in different countries working independently have evolved designs incorporating boilers of this type, notable examples being the Schmidt locomotive (Germany), the L.N.E.R. (England) No. 10,000, and the high pressure water-tube boilered locomotives of the Hudson and Delaware Railroad in the United States.

Electric traction is now largely employed in some countries, notably Switzerland, where large hydro-electric undertakings produce the necessary current.

Diesel engines have also been employed, and from the experience gained with their use it appears that this form of motive power will have an increased field of usefulness in countries where fuel oil is cheap and readily obtainable.

The Diesel Electric Locomotive is now an accomplished fact, and from running tests made on this type great developments are anticipated in the near future.

A SHORT HISTORY OF THE EGYPTIAN STATE RAILWAYS.

Egypt was one of the early countries, and certainly the first in Africa to adopt railway transport. To the illustrious Mohamed Ali Pasha is due the credit of initiating the first Railway in Egypt. In 1833 he entrusted T.J. Galloway to survey the route between Cairo and Suez. Photographic copies of the original correspondence between Mohamed Ali Pasha and Galloway are displayed which shew conclusively that a good amount of work and the purchase of rails was accomplished during the Pasha's reign. Many difficulties were however encountered and consequently the Overland Desert Route (as described later) was thoroughly organized to deal with the increasing traffic.

H.H. the Khedive Abbas I entered into negotiations with Robert Stephenson, then the universal adviser on railway work, for the construction of a line of railway from Alexandria to Cairo and a contract was signed with him in 1267 Hegira (12.7.1851) for the first railway in Egypt. Begun in 1852, the first section, from Alexandria to Kafr el Eiss on the side of the Nile opposite Kafr el Zayat where the Nile had to be crossed, was opened in 1854, and completed to Cairo in 1856 a distance of 210 kilometres. Pending the construction of a bridge at Kafr El Zayat, connection between the two sections of the line was maintained by a ferry.

With the completion of the line from Alexandria to Cairo, a direct line was constructed from Cairo to Suez and opened for traffic in November 1858, thus completing the rail over land route



H.H. MOHAMED ALY PASHA,
Reigned 1805-1848.
The initiator of Egypt's first railway.

المغفور له محمد علي باشا
حكم من سنة ١٨٠٥
الى سنة ١٨٤٨ وهو الذي ادخل
اول سكة حديد في مصر

linking India with Europe; the conception of which founded the State Railways. Traffic from the overland route alone yielded a revenue in the region of three quarters of a million per annum, before the coming of the Canal.

Further railway development in the Lower Egypt Section proceeded apace, the line from Cairo to Alexandria was double tracked by 1861 and branch and connecting lines between the important Lower Egypt towns were rapidly pushed forward.

When H.H. Khedive Ismail Pasha (Father of H.M. King Fouad 1st.) began his reign in 1863 he instituted a vigorous programme of railway construction, and due to his initiative a considerable increase in the length of track resulted. With the opening of the Suez Canal in 1868, the "Overland Route" gradually ceased to serve the purpose of its original projection as a direct route between Cairo and Suez only. In 1867 the Main Line, was extended from Zagazig to Ismailia, with a branch line from Nafisha Junction to Suez, which was opened for traffic in 1870, thus completing a main line route Cairo—Suez providing better gradients and avoiding the worst portions of the desert. The direct Cairo—Suez Line then ceased to be used and was subsequently dismantled in 1879. Connection to Port-Said by rail, was, until 1904, effected by a light railway, Ismailia—Port-Said constructed in 1891 and operated by the Suez Canal Co. In 1904 the light railway was taken over and relaid as standard gauge and operated by the Egyptian State Railways under agreement providing for payment of an annuity expiring in 1968, of L.E.19,930 to the Suez Canal Co as acquisition cost.

The policy of continued expansion of the State Railways in the Lower Egypt Section extended to acquisition of lines constructed and operated by companies as opportunity occurred. The following private owned railways were acquired and merged with the State Railways (Lower Egypt) system:—

HELWAN LINE.

The line was constructed between 1870-72 by the then Khedive of Egypt, Ismail Pasha. It was opened for traffic in 1872 and was worked as a State Railway until 1888, when the concession for the exploitation of the line was given to the Société Anonyme Metropolitan and Cairo-Helwan Railway (Suarès Frères). The concession was subsequently transferred to the Delta Light Railway Co. In 1914 the Government resumed working of the line as on payment of L.E.90,000, (includes L.E.20,000 value of Helwan Hotel, Sulphur Baths and Midan Said), by way of cash compensation and as with responsibility for redemption of the original Helwan Railway Bonds (L.E.81,500).

MARYUT LINE.

Constructed and worked by Abbas Hilmi the then Khedive of Egypt, as his private property. Extending from Wardian to Abu-Hagag, a distance of 239 kiloms. The section Wardian—Dabaa (168 kiloms.) being standard gauge and the section Dabaa—Abu Hagag (71 kiloms.) narrow gauge.

In consequence of negotiations being opened with intent to sell the property to a foreign company, the line was taken over by the Government in 1914 at a purchase cost of L.E.376,000.

During the War, the track Hammam to Abu-Hagag was removed to provide material required elsewhere for military purposes. In 1928, track was relaid (standard gauge throughout) to Dabaa and thence in 1930 to Fuka, the present terminus.

RAIL CONNECTION WITH PALESTINE.

Previous to 1916 there was no rail connection between Egypt and Palestine.

In 1916 for military purposes the construction of a standard gauge line running East from Kantara was commenced and by the end of 1918 completed to Haifa.

Until 1917 the exchange of rolling stock between the Egyptian State Railways and the Military Railway was by ferry over the Canal. In 1917 the military operations in Palestine had intensified to a degree requiring quickened transport between Egypt and Palestine. The Suez Canal Company accorded permission to a swing bridge being built on condition that it was removed after the War.

The bridge remained in operation until March 1921, when it was removed at the desire of the Canal Company.

On the conclusion of the War, rail connection with Palestine and Syria was maintained by the retention by the British Authorities of the Military constructed railway Kantara—Ludd, of which the section Kantara—Raffa lies in Egyptian territory. The British Government proposed that the Egyptian Government should take over and work the Kantara—Raffa line as an extension of the Egyptian State Railways. Having regard to the high ratio of costs of operation, with but small prospect of revenue, the offer was declined. The line Kantara—Ludd remains the property of the British Government and is worked by the Palestine Railways on behalf of the British Government under agreement. The Egyptian State Railways maintains a ferry service at Kantara for passage of passengers and transport of goods wagons.



H.H. ISMAIL PASHA.
Reigned 1863-1879.
Considerably extended the State
Railways during his reign.

المغفور له اسماعيل باشا
حكيم من سنة ١٨٦٣ الى سنة ١٨٧٩
وقد تقدمت السكة الحديد تقدمما
عظيما في عهده

UPPER EGYPT.

In 1867 work was begun on the Upper Egypt Section, which starting from a terminal station (Bulak-El-Dacrou) on the west bank of the Nile, was for some years practically an independent system, pending the construction (in 1891) of a third Nile Bridge at Embaba, just outside Cairo.

The Upper Egypt line was gradually extended from Assiut 1874 to Kena 1897. Construction from Kena to Assuan was by private enterprise. A company, the Kena-Assuan Railway Co. having been formed to construct and operate the line from Kena. The section Kena—Luxor was built as a standard gauge line, the section Luxor—Assuan (Gezireh) as a narrow gauge line (3' 6" gauge), connecting with a then existing narrow gauge line, 11 kiloms. in length, Assuan (Gezireh) to Shellal constructed in 1884 as a military line during the first Sudan Campaign to accelerate transport of military stores past the 1st. Cataract.

The line Kena-Assuan, was taken over by the Government and opened for traffic in 1898 under arrangement by which the Kena—Assuan Railway Co., were compensated by annuity payments of L.E.24,750 expiring 1978. The military line Assuan (Gezireh) to Shellal was, on the conclusion of the Sudan Campaign, absorbed into the system of the State Railways. Shellal now forms the Junction between the State Railways and the Sudan Government Steamers for traffic exchanged between Egypt and the Sudan. In 1926, the Section Luxor—Shellal was converted from narrow gauge to standard gauge.

Other private constructed lines as absorbed into the State Railways system were:—

WESTERN OASIS LINE.

(2'-6" gauge). This line was constructed under concession given in 1906 to the Corporation of Western Egypt and was opened for traffic in 1907. The line was taken over by the Government in 1909 at an acquisition cost of L.E.125,000. The line leads from Oasis Junction on the main line, 540 kiloms. South of Cairo, to the Oasis of Kharga, a distance of 195 kiloms.

AUXILIARY RAILWAYS.

These lines divide into two sections, the Northern (kiloms.256) and Southern (kiloms. 61) not having through connection with each other. The Northern section being on the West bank of the Nile, parallel with and having connection with the main line. The Southern section being also on the West bank of the Nile, without connection with the Main Line which runs here on the

East bank of the river. The lines are of standard gauge. The lines were constructed between 1870 and 1878 by the Daira Sanieh in the reign of the Khedive Ismail, mainly for transport of sugar cane from fields to factories. In 1903 the lines were acquired by the Sucreries Cie. In 1906 the lines were taken over by the Government as on payment of a purchase consideration of L.E.390,000.

Apart from their main function of transporting sugar cane to factories, the lines are of little traffic importance. The Northern Section, in 1916 served a military purpose. The section Beni-Mazar—Sandafa, serving as a connecting link between the main line and the Baharia Military Railway (2'-6" gauge) which was projected 130 kiloms. into the desert. The military line was pulled up in 1918-19.

ROLLING STOCK.

LOCOMOTIVES.

In a period extending over 30 years, the number of locomotives has increased from 372 as in service in 1900 to 721 as on charge at end of 1931. Of this number 582 are now in service, 92 are laid by and held in reserve and 47 are on the scrap list.

Until 1914 the services were, with few exceptions, run by five types of locomotives all working with saturated steam, viz: 2-4-0, 2-2-2, 4-4-0, for passenger service, 0-6-0 for goods service and 0-6-0 saddle-back tank engines for suburban and shunting services.

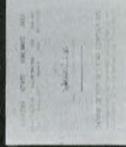
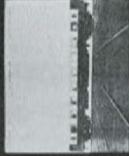
These engines were all similar in regard to details, interchangeability having been followed in the designs.

Cylinder diameters did not exceed 18 inches. Pressures were 160 to 180 lbs., the wheel diameters being according to service.

In 1914 superheated engines were introduced. The economical advantage proved to be so pronounced that the policy has been rigidly adhered to since. At the present time there are 314 superheated locomotives in service.

The wisdom of this policy is instanced by the fact that in 1913 when all locomotives were using saturated steam the coal consumption was 12.8 kilogrammes per kilometre. Since that date the superheated engines which have been gradually introduced are considerably heavier and have a much greater hauling capacity whilst the coal rate of consumption is practically the same.

The later type of locomotives in use are 4-4-2 for express passenger service, 2-6-0 for goods service 2-6-2 and 2-6-4 tank engines for mixed traffic and shunting services. The cylinder diameters have been increased to 21".



Egyptian State Railways — 1932.

This series of photographs shows typical rolling stock, permanent way, buildings, and bridges on the Egyptian State Railways system.

سكة حديد الحكومة المصرية سنة ١٩٣٢
هذه المجموعة من الصور الشمسية تبين انواع الوابورات والعمارات والسكة الحديد والبناني
والكبارى على كافة خطوط سكة حديد الحكومة المصرية

STEAM RAIL CARS.

Experiment was first made in 1926 with one single unit car, having a carrying capacity of 65.

Experience proved that cars of a double unit, articulated, with the engine in the centre and controls at each end, with a carrying capacity of 100 were the most suitable. At end of April 1932, there were 21 steam rail cars, of which 16 are of the articulated type. They are mainly employed to maintain service on branch lines and also to work shuttle services on main lines, where conditions of density and road competition obtain in particular sections.

COACHING STOCK.

Passenger carrying stock has expanded from 781 with a seating capacity of 29,200 in 1904 to 1,103 with a seating capacity of 60,300 as on charge at end of 1931.

Advantage was taken of the extensive renewals effected under the Programme of 1925 to considerably improve the stype of stock.

All renewal was as by bogie stock, replacing six wheel stock. The number of bogie vehicles in 1904 was 44, at end of December 1931, the number of bogie vehicles was 774.

The replacement in years following the year 1925 was mainly by steel stock; out of the 774 bogie vehicles, 275 are steel built.

Arguments were advanced to the effect that steel stock would be insufferable in a hot climate such as Egypt. Elaborate tests have proved that, whilst the steel coaches are admittedly hotter by day they are considerably cooler by night. Briefly they give up the heat at night much more rapidly than wooden stock.

Experience has justified adherence to a policy of steel vehicles as being more suitable to Egypt than wood construction apart from durability and economy in maintenance.

Tests have also been carried out to decide upon the most suitable colour with which the stock should be painted.

Temperatures were taken periodically over an extended period in a carriage standing in the full glare of the sun at Assuan. The result indicated that white and aluminium were far superior to other colours the latter being $\frac{1}{2}^{\circ}\text{C}$ cooler than the former. Aluminium was therefore adopted as the standard colour.

GOODS STOCK.

The number of vehicles has risen from 7,713 (1904) to 16,142 (1931).

Development in type has been mainly in the direction of steel trucks, chiefly of the "Box" type of 10 ton capacity.

The close of the War found the stock in a very delapidated condition. Goods vehicles in particular having suffered severely from constant usage, with a minimum of maintenance. A number of vehicles, had also to be written off as destroyed and unaccounted for through enemy action, E.S.R., stock having been very largely employed in the military operations, on the Canal and East of the Canal. Under the Renewal Programme of 1925, provision was made for immediate replacement of 1,500 wagons to bring up arrears of renewal, with provision also for an annual current quota of 320 vehicles. The number of new vehicles actually put into service in the six years ending April 1931, was 2,890 at a total cost of L.E.661,000. The number of old vehicles taken out of service and broken up in the same period was 2,429.

SECTION 2. NO. 1.

FIRST FLOOR
BAY M.
SCALE 1/12.

MODEL OF THE FIRST LOCOMOTIVE IMPORTED INTO EGYPT. E.S.R. No. 1.

This model built in the Boulac Workshops of the E.S. Railways represents E.S.R. Engine No. 1; and was one of an order for six engines placed with Stephenson & Co., the makers Nos. being 822 to 825 and 867-868. The original of this model was the first locomotive imported into Egypt, and was put into service when the first section of railway was opened in 1852.

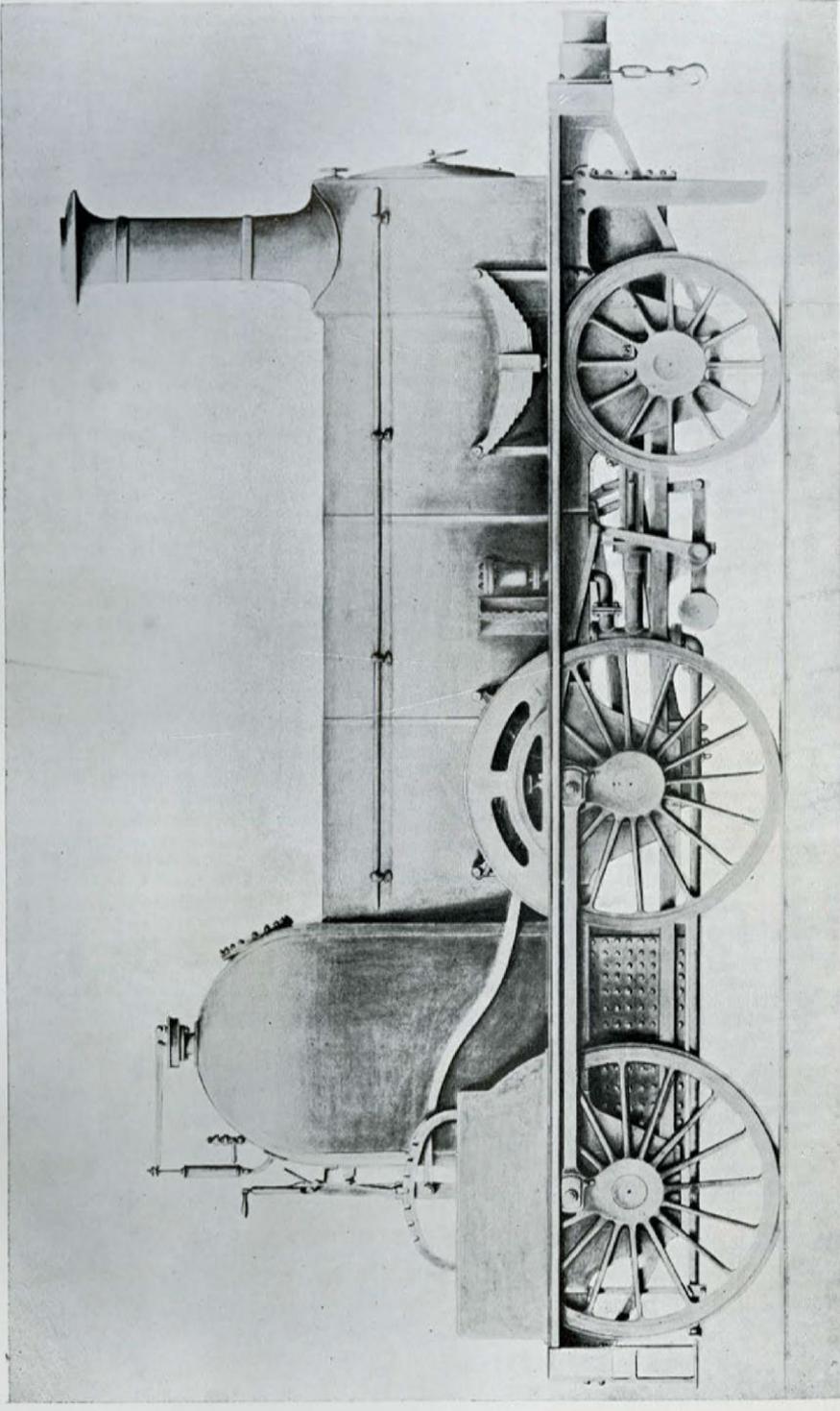
The engine was six-wheeled, four wheels being coupled, and was used for passenger service.

The inside cylinders were 14" dia. x 20" stroke, and drove the crank axle of the first coupled wheels.

The valve motion was of the Stephenson type, actuating "D" Slide Valves. The boiler which had a firebox of the raised "Gothic" type, was fed by a pump driven from the crosshead.

The leading coupled wheels were flangeless, and brakes were not fitted. Semi-elliptic laminated springs were fitted, these were slung high above the frame. No cab was fitted. Of the six engines supplied to this orders the first three, built in 1852 had 5'-0.3/4" coupled wheels, and the other three had 5'-7.1/4" drivers.

A four-wheeled tender was fitted having brakes on all four wheels.



Egyptian State Railways. Engine No. 1.
The first locomotive imported into Egypt, built by
Robert Stephenson & Co. and delivered in 1852.

سكة حديد الحكومة المصرية — قاطرة نمرة ١
أول قاطرة وردت لمصر بنساعا الخواجات روبرت استيفنسون وشركاه
وسلمت سنة ١٨٥٢

Principal Dimensions of Engine No. 1.

Gauge	...	...	...	...	...	...	...	...	4'-8.1/2"
Type	...	...	...	...	...	...	...	...	2-4-0
Cylinders (2) diameter	...	...	...	...	...	...	...	...	14"
Cylinders—stroke	...	...	...	...	...	...	...	...	20"
Wheels (diameter of coupled)	...	...	...	...	...	...	...	...	5'-0.3/4"
Wheels (diameter of pony)	...	...	...	...	...	...	...	...	3'-8"
Wheelbase, rigid	...	...	...	...	...	...	...	...	7'-0"
Wheelbase, total	...	...	...	...	...	...	...	...	14'-3"
Heating Surface, Tubes (137-1.7/8" diam.)	...	...	...	...	...	...	...	...	727.47 sq. feet.
Heating Surface—Firebox	...	...	...	...	...	...	...	...	63.23 "
Heating Surface—Total	...	...	...	...	...	...	...	...	790.70 "
Grate Area	...	...	...	...	...	...	...	...	10.66 "

Principal Dimensions of Tender for Engine No. 1.

Water capacity	...	...	...	...	...	...	...	...	400 gallons.
Fuel capacity	...	...	...	...	...	...	...	...	.72 ton.
Diameter of Wheels...	...	...	...	...	...	...	...	...	3'-4.1/2"
Wheelbase	...	...	...	...	...	...	...	...	8'-6"
Total Wheelbase of Engine and Tender—									
Engine No. 1	...	...	...	...	...	...	...	...	Approx. 31'-0".

MODEL OF STEPHENSON'S "LONG BOILER" LOCOMOTIVE, SUPPLIED TO THE EGYPTIAN RAILWAY ADMINISTRATION IN 1855.

This model which was built in the Gabbary Workshops of the E.S.R. in 1932, represents the locomotives Nos. 7, 8, 10 and 11, which were supplied by R. Stephenson & Co. in 1855.

These engines were known as the "Long Boiler" type, which R. Stephenson patented in 1841. The principal object of this type was to provide greater boiler power accompanied by reduced loss of heat. The boiler barrels at that date, rarely exceeded 8'-6" in length by 3'-6" diameter, with a total heating surface of 650 sq. ft., and a grate area of 10 sq. ft., and, as much forcing was necessary to provide sufficient steam for fast running, a great deal of the heat was lost and fuel blown out of the chimney. In order to increase the heating surface Stephenson decided to lengthen the barrel and tubes, without increasing the boiler diameter, this being limited by the idea that a low centre of gravity was essential.

All the axles were placed between the firebox and the smoke-box and the general construction was simplified.

SECTION 2. NO. 2.

FIRST FLOOR
BAY M.
SCALE 1/12.

The E.S.R. engine had plate frames; and overslung bearing springs, which were compensated, were fitted to the first and second axles. Underslung springs were fitted to the rear axle. The cylinders which were outside the frames drove the rear axle, the slide valves were of the "D" type, and the valve gear of the Stephenson type, fitted with Howes link. Brakes were not fitted to the engine.

A six wheeled tender with horse shoe shaped tank was used. A hand brake was fitted, all wheels being braked.

Principal Dimensions of Engine.

Gauge	... ..	4'-8.1/2"
Type	... ..	2-2-2
Cylinders (2) diameter	... ..	14"
Cylinders—stroke	... ..	22"
Wheels (diameter of driving)	... ..	6'-0"
Wheels (diameter of carrying)	... ..	3'-6"
Wheelbase—Total	... ..	12'-7"
Heating surface, tubes—103-2" diameter	... ..	750.5 sq. ft.
Heating surface, firebox	... ..	56.0 "
Heating surface, total	... ..	806.5 "
Grate Area	... ..	9 "

Principal Dimensions of Tender.

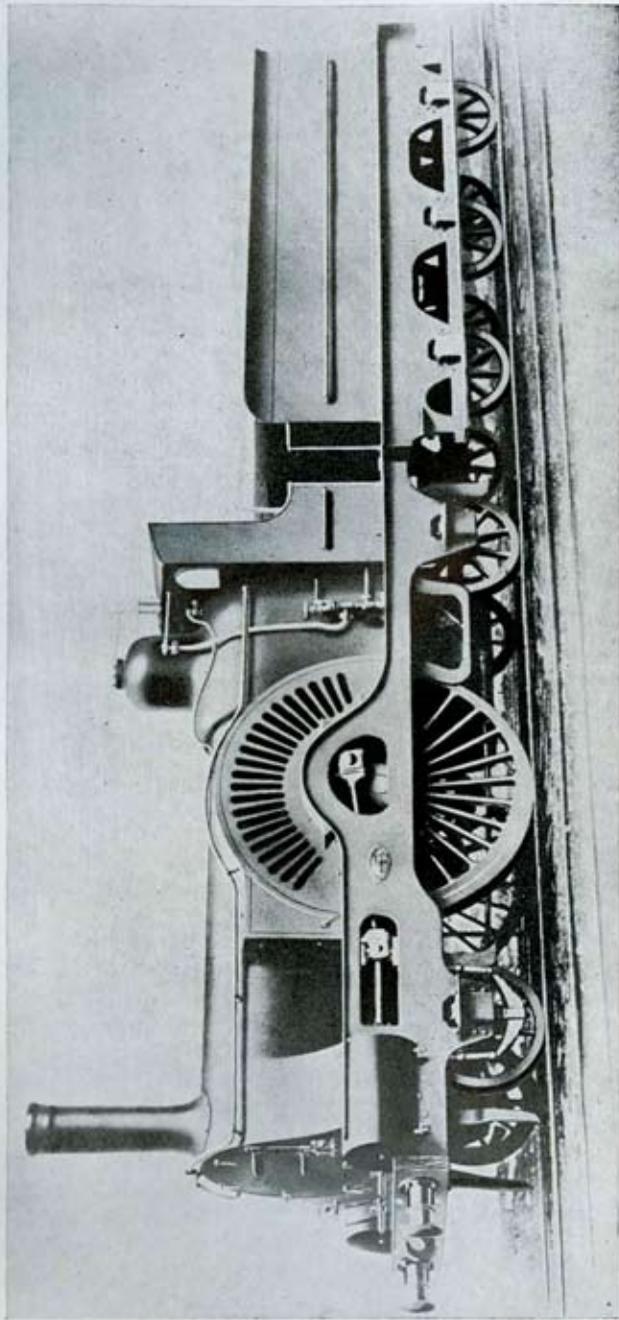
Water capacity...	... ..	1300 gallons.
Diameter of wheels	... ..	3'-6"
Wheelbase	... ..	11'-6"

SECTION 2. NO. 3.

FIRST FLOOR
BAY M.
SCALE 1/12.

MODEL OF 8'-2" SINGLE DRIVER EXPRESS LOCOMOTIVE. No. 68, EGYPTIAN STATE RAILWAYS, 1864.

This model represents one of the most celebrated engines ever imported into Egypt. It was built by Neilson & Co. in 1862, for the Caledonian Railway, and was exhibited in the 1862 exhibition. The engine was purchased by Said Pasha, who wanted, so the legend goes, to possess an engine to carry him at 80 miles an hour. It is open to grave doubt whether this wish was ever fulfilled, as the old permanent way in Egypt was not suitable for such a high speed. Although this engine and two others similar to it were engaged on the fast train service between Cairo and Alexandria, they were never so well suited to local conditions as the inside cylinder double-framed engines, for the large amount of dust, added to frequent sand storms, occasionally caused the cross-heads to seize in the exposed slide bars.



8'-2" Single Driver Express Locomotive.
Built by Neilson & Co. in 1862, and exhibited
at the 1862 Exhibition in London.—The engine
was bought by H.H. Said Pasha, and ran on
the E.S.R. until 1895, when it was broken up.

قطار اكسپريس لها عجلة ادارة واحدة قطرها (٢ بوصة - ٨ قدم)
قام بصنعها نيلسن وشركاؤه في سنة ١٨٦٢ وعرضت في معرض سنة ١٨٦٢ بلندن
اشترى هذه القطار المغفور له سعيد باشا واشتغلت على خطوط السكك
الحديدية المصرية الى ان كسرت في سنة ١٨٩٥

The engine had outside cylinders, which were horizontal, the side valves were of the D type actuated by Stephenson valve motion, with lever reversing gear. The boiler had a round top firebox, and was fed by a horizontal pump driven from the eccentric and a Giffards Injector, which delivered the feed water through clackboxes fitted to the underside of the boiler barrel near the smokebox. A lever safety valve was fitted on top of the dome, which was over the firebox.

The regulator was of the piston type, operated by a lever from the cab, steam being admitted to the regulator through an open ended pipe in the dome.

A six-wheeled tender was used, this was fitted with hand brake, wooden brake blocks acting on all wheels. During the last ten years of this engines' existence it worked local trains in the Suez district, and also between Cairo and the Barrage, it was broken up in 1895.

Principal Dimensions of Engine.

Gauge	... ..	4'-8.½"
Type	... ..	Single driver
Cylinders (2) diameter	... ..	17.¼"
Cylinders—stroke	... ..	24"
Wheels (diameter of driving)	... ..	8'-2"
Wheels (diameter of carrying)	... ..	3'-8"
Wheelbase	... ..	15'-8"
Heating surface, total	... ..	1,172 sq. feet
Grate area...	... ..	13.3 sq. feet.
Total weight (in working order)	... ..	30.65 tons

Principal Dimensions of Tender.

Water capacity	... ..	1,600 gallons
Diameter of wheels	... ..	3'-8"
Wheelbase	... ..	11'-5.½"

MODEL OF THE KHEDIVIAL TRAIN.

These models which were built in the Boulac and Gabbary workshops of the E.S. Railways are intended to show representative stock as used by the Khedive, and does not necessarily represent the actual marshalling.

The engine (old No. 41) with tender was built by R. Stephenson of Newcastle-on-Tyne, England, in the year 1859.

It was elaborately ornamented as shown, and ran in that condition until 1887 when it was rebuilt for ordinary service.

SECTION 2. NO. 4.

FIRST FLOOR
BAYS K. & L.
SCALE 1/12.

When built this engine had 16" dia. x 20" stroke cylinders. The boiler was 11 ft. long and 4 ft. diameter having 174 tubes 2" diameter giving a heating surface of 1,032 sq. feet. The firebox heating surface was 87 sq. feet, making a total heating surface of 1,119 sq. feet. The grate area was 14.9 sq. feet.

The driving wheels were 6'-6" diameter and the leading and trailing wheels 4'-0" diameter.

The tender carried 1700 gallons of water.

The first vehicles behind the engine is a "Saloon for Officers" built by the Egyptian State Railways in 1868. The underframe had steel sole bars and wood struts, outside buffers and long drawbar. The body of wood framing had sheet iron panels with mouldings.

The trimming throughout was of buff leather.

This vehicle was converted to a service car and eventually scrapped in 1929.

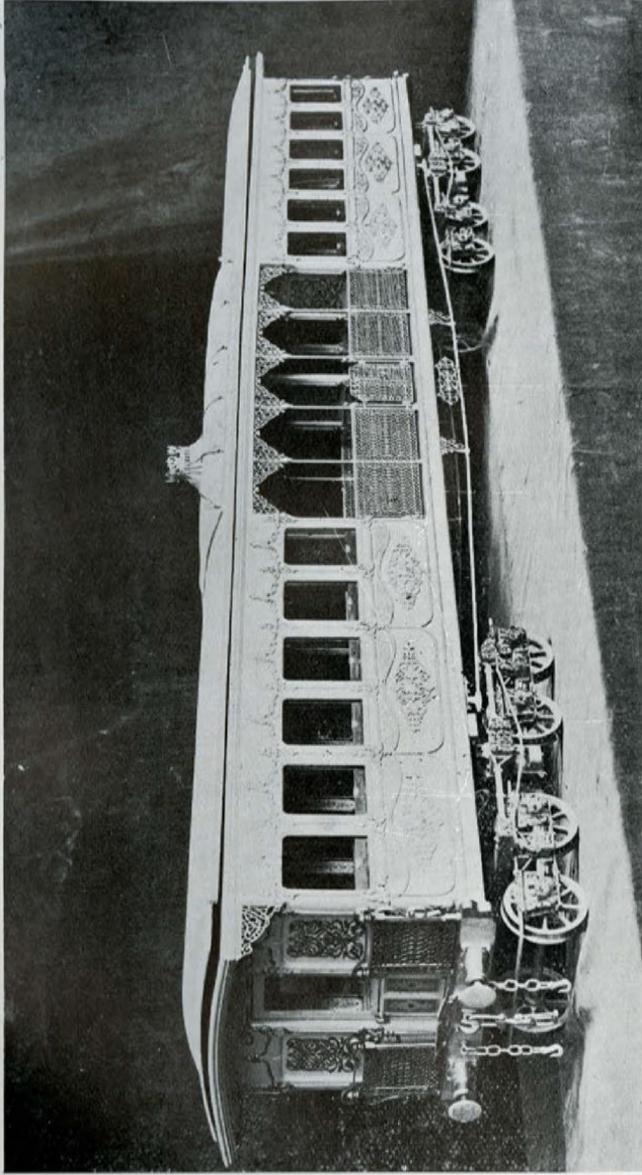
The second vehicle is "The Princesses Carriage" built by Wright & Co. in 1858.

The underframe is built of iron with wood headstocks fitted with transverse springs for drawbars and buffers.

The body is of wood. The inside trimmings are of crimson and amber silk with green silk blinds. The windows are fitted with glass and brass wire gauze. The body of this carriage was scrapped in 1924 but the underframe is still in use on a motor car carrying wagon.

The third vehicle is the "State Saloon" built by Mason & Co. of America in 1858. It is elaborately ornamented both inside and outside. The underframe is built entirely of wood and is carried on two 8-wheel bogies of very unusual design. Each of these bogies is actually comprised of two 4-wheeled bogies, which are free to revolve about their respective centre pivots; they are provided with bolsters and India Rubber springs. An intermediate frame rests on the two bogie centres, and incorporates another bolster, also sprung with India Rubber springs, and provided with a main pivot and side bearers, upon which one end of the coach is supported, the load being equally distributed over the eight wheels.

The framework of the body is of wood, filled in with "Papier Maché" panels. This carriage has short outside buffers and short drawbar with volute spring. The trimmings are buff leather, all windows and doors being fitted with pink silk curtains. There are four large plate glass doors (which as well as the twenty-four windows) have ground glass borders. The Venetian blinds are of Mahogany. Each saloon has four mirrors and six silver lamps. The saloon is still running as a Bacteriological car, the inside painted ceiling and body sides having been cleaded over and most of the ornamental brasswork having been removed.



Model of State Saloon—KHEDIVIAL TRAIN.
Egyptian State Railways.

Original built by Mason & Co. of America in 1858.

نموذج صالون حكومة — القطار الخديوي
سلك حديد الحكومة المصرية

الصالون الاصلى قام بصنعه ماسون وشركاؤه بامريكا سنة ١٨٥٨

The fourth carriage is the "Family Saloon" built by R. Stephenson in 1863. The underframe is of iron with buffers and drawbar. The body framework and panels are of wood. All sashes of windows and Venetian blinds are made of ebony and are fitted with brass gauze and glass windows. The trimmings are crimson and green figured silk. This carriage was scrapped in 1928.

The fifth carriage is also a "Family Carriage" built by Wright & Sons in 1855. The underframe is built of angle iron with wood headstocks. The body framework is of wood with "Papier Maché" panels.

The body was scrapped in 1924 and the underframe used for a perishable goods van, which is still in service.

The last vehicle is a "Saloon for Ministers" and was built by the Egyptian State Railways in 1872. The underframe has angle iron sole bars and wood struts and is carried on two four wheel bogies also constructed of iron and wood. The headstocks are of wood. The body framing is of wood with "Papier Maché" panels. The inside trimmings are of buff leather and all doors and windows have pink silk curtains. There are eight mirrors and two half glass doors, and the roofing is of polished Mahogany. There are four oil and eight candle lamps. This saloon was scrapped in 1913.

MODEL OF 0-6-0 TYPE GOODS ENGINE. EGYPTIAN STATE RAILWAYS, 1864.

This model represents a 0-6-0 type Goods Engine which was put to work in 1864. Three engines of this type were built by Messrs. Koechlin & Co. of Mulhouse in 1863 for the P.L.M., but were taken over at the makers works by the Egyptian State Railways. They were of the 0-6-0 type so well known in France as the "Bourbonnais" and the makers numbers were 845-847. The original Egyptian State Railways numbers were 81-83, but after the renumbering of the Egyptian Engines they became Nos. 225 to 227.

The engines had two outside cylinders, which were horizontal and drove the axle of the middle coupled wheels.

The valve chests were inside the frames, and were operated by Stephenson valve gear, the D slide valve buckle was attached to a crosshead on the intermediate valve spindle, which was made with an enlarged stirrup so that it cleared the leading axle. The boiler which was domeless had a round top firebox, and was fed by a horizontal pump and Giffards injector delivering feed water through clackboxes. A spring balance safety valve was fitted on top of the firebox.

SECTION 2.
NO. 5.
FIRST FLOOR
BAY M.
SCALE 1/12.

The regulator was located on a seating riveted on top of the front end of the boiler barrel, near the smoke box.

The regulator valve was of the slide valve type, operated by a rod from the cab.

The frame was 1.1/8" thick, stiffened by cross stays of plate and angles. Wood buffer beams were fitted. A four-wheeled tender was attached on which was fixed a warning bell. The frame of the tender was double.

Principal Dimensions of Engine.

Gauge	...	4'-8.1/2"
Type	...	0-6-0
Cylinders (2) diameter	...	17.3/4"
Cylinders—stroke	...	25.1/2"
Wheels (diameter of coupled)	...	4'-3.1/4"
Wheelbase, rigid	...	11'-0.1/2"
Heating surface, tubes	...	1,287.5 sq. feet
Heating surface, firebox	...	86.2 sq. feet
Heating surface, total	...	1,373.7 sq. feet
Grate area...	...	14.53 sq feet
Working pressure	...	120 lb. per sq.in.

Principal Dimensions of Tender.

Diameter of wheels	...	3'-11.1/4"
Wheelbase	...	8'-2.1/2"
Total Wheelbase of engine and tender	...	33'-3.1/2"
Overall length of engine and tender (over buffers)	...	47'-3"

SECTION 2. NO. 6.

FIRST FLOOR
BAY L.
SCALE 1/12.

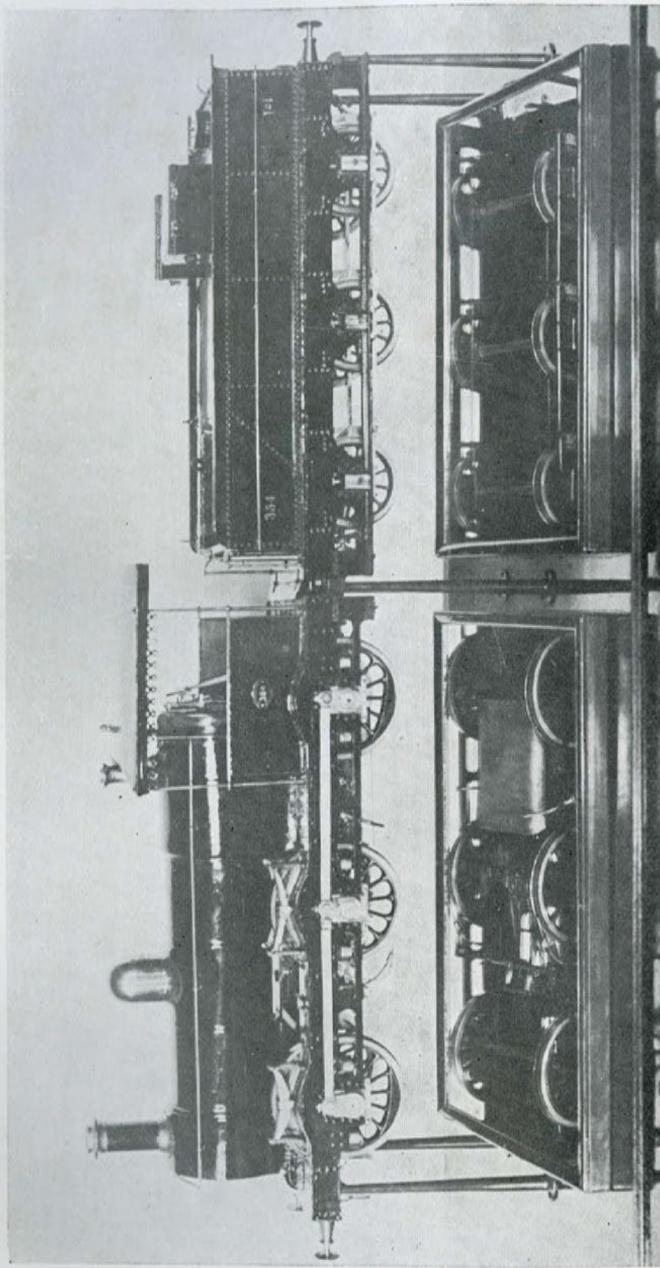
MODEL OF 0-6-0 TYPE GOODS LOCOMOTIVE AND TENDER No. 354, E.S.R. — 1898.

This model represents one of the 0-6-0 type Goods Locomotives and Tenders, built by Neilson, Reid & Co. in 1898. They had inside cylinders inclined at an angle of 1 in 10.1/2 driving the crankaxle of the second pair of coupled wheels.

The valve motion was of the Stephenson type, with D slide valves, and lever and sector reversing gear. The frame was double, strengthened by vertical stay pieces left in the slotted portions. Outside cranks were fitted to the axles, and the coupling rods were of rectangular section.

The boiler had a firebox with a raised top, and was fed by injectors fitted on the firebox back delivering the feed water through internal pipes. Two-4" safety valves were fitted on top of the firebox. Brass tubes were used. Overhung laminated springs were fitted.

Sanding gear was fitted, delivering sand in front of the second pair of coupled wheels.



Model of Goods Locomotive—0-6-0 type.—No. 354.
Egyptian State Railways.

Built by Neilson, Reid & Co., in 1898.

نموذج قاطرة بضاعة من نوع (٠-٦-٠) رقم ٣٥٤
لسكك حديد الحكومة المصرية

بناها الخواجات نيلسون ريد وشركاه بإنجلترا سنة ١٨٩٨

A Steam Brake was fitted on the engine, and hand brake on the tender.

The tender was of the six wheeled type.

Principal Dimensions of Engine:

Gauge	... ..	4'-8.1/2"
Type	... ..	0-6-0
Cylinders (2) diameter	... ..	18"
Cylinders—stroke	... ..	24"
Wheels (diameter of coupled)	... ..	5'-0.1/4"
Wheelbase, rigid	... ..	16'-6"
Wheelbase, total	... ..	16'-6"
Heating Surface, tubes	... ..	1011.5 sq. feet
Heating Surface, firebox	... ..	114.7 sq. feet
Heating Surface, total	... ..	1126.2 sq. feet
Grate Area	... ..	18.75 sq. feet
Working pressure	... ..	140 lb. per sq.in.
Tractive effort (taking 85% working pressure)	... ..	15358 lb.
Total weight (in working order)	... ..	37.35 tons

Principal Dimensions of Tender:

Water capacity	... ..	1800 gallons
Fuel capacity	... ..	3.1/2 tons
Diameter of wheels	... ..	3'-8"
Wheelbase	... ..	13'-0"
Total weight (in working order)	... ..	26.8 tons
Total wheelbase of Engine and Tender	... ..	38'-2.5/8"
Total weight of engine and Tender (in working order)	... ..	64.15 tons
Overall length of Engine and Tender (over buffers)	... ..	50'-9.5/8"

Subsequently some of these engines were modified, some being fitted with 17" cylinders, and others with 17.1/2".

MODEL OF 2-4-0- TYPE PASSENGER ENGINE, E.S.R.

This model represents one of the 2-4-0 type Passenger Engine and Tenders, built by the Société Franco-Belge, who delivered 52 of this class between the years 1890 and 1894. They had inside cylinders, driving the crank axle of the first coupled wheels. The standard motion was horizontal with Stephenson links, and valve spindle guides attached to the motion plate. The valve chests were between the cylinders, the D slide valves working on vertical faces. The frames were double and the outside cranks were polished.

The boiler had a round top firebox, and was fed by injectors fixed on the back plate, which delivered the feed water through internal pipes. Sanding gear was fitted delivering sand in front of the leading coupled wheels.

A six-wheeled tender was used. Vacuum brake was fitted.

**SECTION 2.
NO. 7.**

FIRST FLOOR
BAY M.
SCALE 1/12.

Principal Dimensions of Engine:

Gauge	4'-8." $\frac{1}{2}$
Type	2-4-0
Cylinders (2) diameter	17." $\frac{1}{2}$ "
Cylinders—stroke	24"
Wheels (diameter of coupled)	6'-3"
Wheels (diameter of pony)	4'-0"
Wheelbase, rigid	8'-6"
Wheelbase, total	16'-6"
Heating Surface, tubes	1011.6 sq. feet
Heating Surface, firebox	116.4 sq. feet
Heating Surface, total	1128.0 sq. feet
Grate Area	18.75 sq. feet
Working pressure	140 lb. per sq. in.
Tractive effort (taking 85% working pressure)	11660 lb.
Weight on coupled wheels (in working order)...	26.25 tons
Total weight (in working order)...	37.65 tons

Principal Dimensions of Tender:

Water capacity...	1800 gallons
Fuel capacity	3." $\frac{1}{2}$ tons
Diameter of wheels	3'-8"
Wheelbase	13'-0"
Total weight (in working order)...	26.55 tons
Total wheelbase of Engine and Tender	38'-1." $\frac{7}{8}$ "
Overall length of Engine and Tender (over buffers)	50'-8." $\frac{7}{8}$ "

SECTION 2.
NO. 8,
 FIRST FLOOR
 BAY M.
 SCALE 1/8.

MODEL OF 2-2-2. TYPE PASSENGER LOCOMOTIVE.

FITTED WITH FEED—WATER APPARATUS.

This model represents one of the 16 to 25 class 2-2-2 type passenger locomotives, built to the designs of Mr. F.H. Trevthick in 1894. These engines as delivered were not fitted with feed water heaters. The engine represented by the model was equipped with this experimental apparatus, by Mr. Trevthick in 1901.

The engines had inside cylinders 17." $\frac{1}{2}$ " diameter by 24" stroke, with D slide valves, operated by Stephenson gear with lever and sector reversing. The driving wheels were 7'-0" diameter, and the carrying wheels 4'-0" diameter.

The boiler had a firebox of the round top type. The tube heating surface was 1,011.6 sq. ft., and the firebox surface 116.4, giving a total of 1,128 sq. ft. The firebox grate area was 18.75 sq. ft. the boiler worked at a pressure of 140 lb. per sq. inch.

Two 4" safety valves were mounted on top of the firebox. Feed water was delivered by two Injectors fitted to the firebox back plate delivering through internal pipes into the barrel. The total weight of the engine was 35.35 tons of which 14.7 tons was on the driving wheels.

A six-wheeled tender was used having a water capacity of 1,800 gallons, and a coal capacity of 3.½ tons, the weight in working order was 28.17 tons.

The year in which these engines were put into service—1894 saw the first continuous brakes, applied to passenger trains in Egypt, and these engines were some of the first to be fitted with the automatic vacuum brake.

The feed water heater, which consisted of a closed horizontal cylinder was carried over the top of the boiler. The front end was fitted to an extensive of the smokebox and the hind end was supported by a bracket on the firebox top. Each end of the cylinder terminated in a smokebox, the back portion of the back smokebox was conically reduced to the diameter of the chimney, whilst the front of the front smokebox was provided with a door similar to the usual smokebox door. With a view to reducing the emission of moisture from the chimney, the 9" central pipe was threaded by an 8" pipe, which made good the connection between the blast nozzle and the cylinder exhaust port, the ½" space between the two pipes forming a "jacket". Round the central pipe boiler tubes were fitted into tube plates at each end of the heater through which the waste gases passed to the chimney. Crosshead pumps were used at first but these were afterwards abolished in favour of a steam pump, which delivered the feed water through clackboxes into the back end of the heater.

After circulating among the tubes, the water passed out of the front end of the heater, through clackboxes placed one on each side of the boiler, into the boiler barrel near the smokebox.

In August 1901 this engine was attached to the Alexandria-Cairo express, a train of 15 coaches (225 tons) and ran comfortably to the then scheduled time of 3 hours and 20 minutes, thus considerably exceeding the limit of 10 coaches prescribed for this class of engine on these expresses.

Although the additional central pipe and "jacket" of furnace gases considerably reduced the emission of moisture from the chimney, there remained sufficient to be a serious objection. The arrangement was therefore abandoned as unpractical.

**SECTION 2.
NO. 9.**

FIRST FLOOR
BAY K.
SCALE 1/8

**MODEL OF EXPRESS PASSENGER LOCOMOTIVE,
"HIS HIGHNESS THE KHEDIVE".**

This model represents an express passenger locomotive, designed by the late Mr. F.H. Trevithick, and built by the North British Locomotive Co. Ltd., ten engines of this class, Nos. 725 to 734 (renumbered 351 to 360) entered the service in 1908.

The engine is of the 4-6-0 type, with inside cylinders, which drive the crankaxle of the first coupled wheels. The valves are placed above the cylinders and the valve gear is of the Walschaerts type. The boiler has a conical barrel and a Belpaire firebox.

The tender is mounted on six wheels. The Vacuum Brake is fitted to the wheels of engine and tender.

Principal Dimensions of Engine:

Gauge	... ..	4'-8.1/2"
Type	... ..	4-6-0
Cylinders (2) diameter	... ..	19"
Cylinders—stroke	... ..	26"
Wheels (diameter of coupled)	... ..	6'-3"
Wheels (diameter of pony)	... ..	3'-0"
Wheelbase, rigid	... ..	14'-0"
Wheelbase, total	... ..	27'-6"
Heating Surface, tubes	... ..	2149 sq. feet
Heating Surface, firebox	... ..	172 sq. feet
Heating Surface, total	... ..	2321 sq. feet
Grate Area	... ..	28.8 sq. feet
Working pressure	... ..	180 lb. per sq. in.
Tractive effort (taking 85% working pressure)	... ..	19147 lb.
Weight on coupled wheels (in working order)	... ..	52.6 tons
Total weight (in working order)	... ..	69.7 tons

Principal Dimensions of Tender:

Water capacity	... ..	4000 gallons
Fuel capacity	... ..	9 tons
Diameter of wheels	... ..	3'-8"
Wheelbase	... ..	14'-0"
Total weight (in working order)	... ..	42.1 tons
Total wheelbase of Engine and Tender	... ..	53'-3"
Total weight of engine and tender (in working order)	... ..	111.8 tons
Overall length of Engine and Tender (over buffers)	... ..	63'-4"

MODEL OF 4-4-2. TYPE EXPRESS PASSENGER
LOCOMOTIVE. — EGYPTIAN STATE RAILWAYS, 1906.
(WORKING MODEL).

SECTION 2.
NO. 10.
FIRST FLOOR
BAYS K. & L.

This model represents the 4-4-2 type express passenger locomotive No. 678 (afterwards renumbered No. 194) built in 1906 by the North British Locomotive Co. Ltd. This engine had three high pressure cylinders 13.3/4" dia. by 24" stroke, all driving the leading coupled crankaxle. The valve gear was of the Stephenson type, and slide valves were fitted.

The coupled wheels were 6'-3" diameter. The leading bogie wheels were 3'-0" and the trailing pony wheels 3'-8" diameter.

The boiler had a conical barrel, and a Belpaire firebox. The tube heating surface was 1,533 sq. feet and that of the firebox 138.5 sq. ft. giving a total of 1,671.5 sq. ft. The grate area was 23.7 sq. ft. and the boiler carried a working pressure of 228 lbs. per sq. inch. The total weight of the engine was 64 tons of which 34 tons was on the coupled wheels. The tender was of the standard six-wheeled pattern with a water capacity of 3,000 gallons, and a coal capacity of 9 tons; with a weight in working order of 35 tons.

In 1919 the engine was rebuilt being fitted with a new superheater boiler working at a pressure of 180 lbs. per sq. inch. The boiler centre line being raised 8 1/2", two outside cylinders 19" diameter by 24" stroke, with piston valves actuated by Walschaerts gear, took the place of the three high pressure cylinders. The boiler had a tube heating surface of 1,324 sq. ft. and a firebox heating surface of 160 sq. ft. giving a total evaporative surface of 1,484 sq. ft.

The superheater heating surface was 463 sq. ft. and the grate area 23.56 sq. ft.

A tender with a water capacity of 4,000 gallons and a coal capacity of 9 tons was used, having a weight in working order of 42.9 tons.

The engine was again rebuilt, being fitted with a saturated boiler having a tube heating surface of 2,175 sq. ft., with 160 sq. ft. of firebox surface giving a total of 2,335 sq. ft. the grate area was 23.56 sq. ft.

This boiler was taken from a 0-6-0 type engine and lengthened, the working pressure was 180 lbs. per sq. inch. Friedmann horizontal non-lifting restarting injectors, were fitted, delivering feed water through clackboxes.

The engine ran in this rebuilt form until it was decided, in 1932, to cut through the boiler, cylinder etc., in order to shew details of construction.

It is exhibited in this form, and may be seen on the ground floor of the Museum No. 194.

The model shews the engine as first rebuilt in 1919 with superheater boiler with Belpaire firebox and 19" x 24" cylinders with Walschaert valve gear.

**SECTION 2.
NO. 11.**

FIRST FLOOR
BAY J.
SCALE 1/16.

MODEL OF 2-6-2 TYPE SIDE TANK ENGINE, E.S.R.

This model represents the 2-6-2 type side tank passenger engines, which were built by Henschel & Sohn, Cassel, Germany. They were put into service in 1912 by Mr. F.H. Trevithick, at that time Chief Mechanical Engineer of the Egyptian State Railways.

They were constructed to the specification of Mr. Trevithick, and constituted an almost new departure for Egypt, in that outside cylinders and Walschaerts valve gear were employed.

The cylinders, which are horizontal drive the middle pair of coupled wheels, and are fitted with piston valves.

The leading and trailing wheels are arranged with Bissel radial trucks. The boilers were not superheated. Subsequently six engines of this class were modified, by having the side tanks removed, and were fitted with tenders.

Principal Dimensions of Engine.

Gauge	... ..	4'-8.1/2"
Type	... ..	2-6-2
Cylinders (2) diameter	... ..	20"
Cylinders—Stroke	... ..	26"
Wheels (diameter of coupled)	... ..	5'-6"
Wheels (diameter of bissel)	... ..	3'-8"
Wheelbase, rigid	... ..	15'-1.1/8"
Wheelbase, total	... ..	31'-9.7/8"
Heating surface, tubes	... ..	1622 sq. feet
Heating surface, firebox	... ..	154 "
Heating surface, total	... ..	1776 "
Grate area	... ..	22.6 "
Working pressure	... ..	180 lb. per sq.in.
Tractive effort (taking 85% working pressure)	... ..	24109 lb.
Weight on coupled wheels, (in working order)	... ..	51.05 tons
Total weight (in working order)	... ..	76.2 tons
Tank water capacity	... ..	1590 gallons
Bunker coal capacity	... ..	4.1 tons
Overall length of engine (over buffers)	... ..	41'-8.7/8"

MODEL OF 2-6-0 GOODS LOCOMOTIVE, CLASS 545-604, EGYPTIAN STATE RAILWAYS.

SECTION 2. NO. 12.

FIRST FLOOR
SCALE 1/12.
PRESENTED BY
MESSRS. R.E.
ANDERSON AND
F.F. MACDONALD
AND THE STAFF
OF THE MINIA
AUX. RLY.
WORKSHOPS
1932

This model represents one of the 545-604 class goods locomotives. Of the sixty engines of this class, forty were supplied by the North British Loco. Co. Ltd., Glasgow, and entered the service in 1928.

The other twenty engines were built by Messrs. Armstrong Whitworth & Co. Ltd., Newcastle-on-Tyne and were put to work also in 1928.

They have two outside cylinders, which drive the second coupled axle. The piston valves are 10" diameter and are actuated by Walschaerts valve gear. The boiler is of the Belpaire type and fifty eight of the engines have Friedmann type A.S.Z. No. 10. Non-Lifting Restarting Injectors, of the other two engines one (No. 584) is fitted with Friedmann Exhaust Steam Injectors (Type L.F. 10) and the other (No. 604) is fitted with Davies and Metcalfe Exhaust Steam Injectors (Type H.).

Two-3" Ross Patent Muffled Pop Safety Valves are fitted. The Superheater has 24 elements.

Lambert wet sanding gear is applied in front of the leading pair of coupled wheels, and in the rear of the trailing pair. A Wakefield mechanical lubricator is fitted. Vacuum and hand brakes as fitted.

An eight wheeled tender with a water capacity of 5,500 gallons and a coal capacity of 8.½ tons is used.

Principal Dimensions of Engine:

Gauge	... ..	4'-8.½"
Type	... ..	2-6-0
Cylinders (2) diameter	... ..	21"
Cylinders—stroke	... ..	26"
Wheels (diameter of coupled)	... ..	5'-6.¾"
Wheels (diameter of pony)	... ..	3'-8.¾"
Wheelbase, rigid	... ..	15'-11"
Wheelbase, total	... ..	25'-5"
Heating Surface, tubes	... ..	971 sq. feet
Heating surface Superheater Flues	... ..	437 sq. feet
Heating Surface, firebox	... ..	161 sq. feet
Heating Surface, total	... ..	1569 sq. feet
Grate Area	... ..	25.25 sq. feet
Working pressure	... ..	160 lb. per sq.in.
Tractive effort (taking 85% working pressure)	...	23,400 lb.
Weight on coupled wheels (in working order)...	...	55.4 tons
Total weight (in working order)...	... ..	66.9 tons

Principal Dimensions of Tender :

Water capacity... ..	5500 gallons
Fuel capacity	8.5 tons
Diameter of wheels	3'-8.¾"
Wheelbase	15'-0"
Total weight (in working order)... ..	57.75 tons
Total wheelbase of Engine and Tender	52'-8.1½"
Total weight of engine and tender (in working order)	124.65 tons
Overall length of Engine and Tender (over buffers)	63'-5.1¼"

SECTION 2. NO. 13.

FIRST FLOOR
BAY J.
SCALE 1/12

MODEL OF 4-WHEELED 3rd. CLASS CARRIAGE (EARLY TYPE), EGYPTIAN STATE RAILWAYS.

This model, which was made in the Boulac Carriage Works of the Egyptian State Railways, represents 3rd. class 4-Wheeled Carriage, which was built about 1859.

The underframe is of steel angles, with cross and diagonal bracings. It is fitted with long buffers and drawbar and has two large transverse laminated combined draw and buffing springs.

The body is of teak, louvres are fitted and the doors are fitted with drop windows. The seats are teak boards, and there is no upholstery.

The overall length of underframe is 23'-0" and the width of body 8'-4". The wheels are 3'-6" dia. with a wheelbase of 13'-0".

SECTION 2. NO. 14.

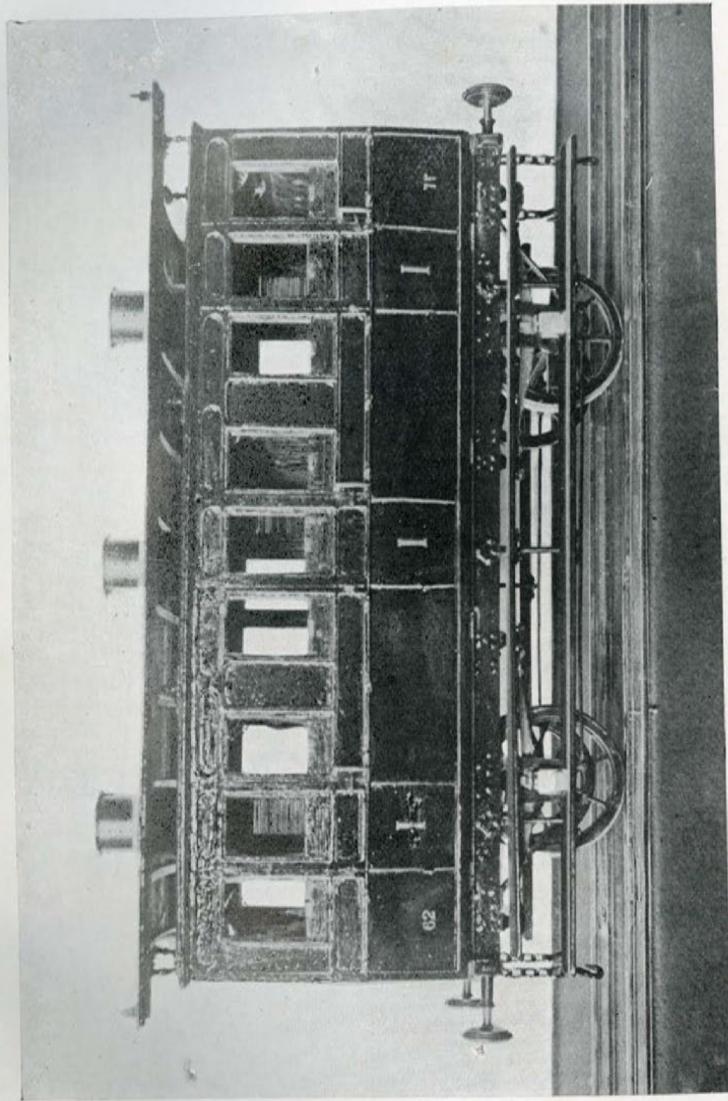
FIRST FLOOR
BAY J.
SCALE 1/12.

MODEL OF 4-WHEELED 1st. CLASS CARRIAGE (EARLY TYPE), EGYPTIAN STATE RAILWAYS.

This model, which was made in the Boulac Carriage Works of the Egyptian State Railways represents a 1st. Class 4-Wheeled Carriage, which was built in 1870. The underframe is of steel angles, with cross and diagonal bracings. It is fitted with long buffers and draw-bar and has two large transverse laminated combined draw and buffing springs.

The body is of teak fitted with double roof and windows and louvres both balanced and sliding. The inside of the body is finished in mahogany, and is upholstered in dark red leather.

The overall length of body is 20'-1" and the width 8'-9". The wheels are 3'-6" dia. with a wheelbase of 11'-0".



Model of First-Class Carriage-Early Type.
Egyptian State Railways.

This type of 4-wheeled carriage was built
in 1870.

نموذج عربية راكب درجة أول (طراز قديم)
سلك حديد الحكومة المصرية
هذا النوع من العربات ذو أربع عجلات وقد صنع في
سنة ١٨٧٠

MODEL OF OLD TYPE—10 TON OPEN WAGON No. 3581.

This model of the old type 10 ton open wagon, was made in the Gabbary workshops of the E.S.R.

It conveys a good impression of the old type of wooden wagon which was formerly in service but which has now been superseded by the improved all steel vehicle represented by the model wagon No. 7804.

Principal Dimensions of Wagon.

Carrying capacity	... ..	10 tons
Tare	... ..	6.93 tons
Wheel diameter	... ..	3'-3"
Wheelbase	... ..	12'-0"
Overall length (over buffers)	... ..	26'-0"

MODEL OF NEW 10 TON STANDARD ALL-STEEL OPEN WAGON No. 7804.

This model of the new type 10 ton standard all steel open wagon which was built in the Gabbary Workshops of the E.S.R., shews the type of wagon, which was designed and built to overcome the defects inherent in the old design of wooden wagon.

The principal features of improved design in the new type of wagon are.

(1) Plate axleguards fitted with wearing strips which can be changed when worn.

(2) Low camber bearing springs.

(3) Pressed steel spring shoes with a detachable wearing piece.

These spring shoes are designed to distribute the load over the wagon frame, and not on one frame member as in the old design.

(4) Centre uprights which can be tilted to facilitate loading and unloading.

(5) Gedge type coupling is fitted.

(6) Coil buffing and draw bar springs are fitted instead of the combined draw bar and buffing spring of the laminated type.

(7) Cast steel axleboxes are used, which are many times more durable than the old cast iron ones fitted to the old type of wagon. These new type axleboxes are provided with a deep oil well.

(8) The oiling rings which ensure that oiling is effected at regular periods.

(9) The tyres are secured to the wheel centre by a retaining ring instead of rivets as previously used.

(10) The general construction of this all steel wagon is infinitely stronger than the old type of wooden wagon, and is capable of standing very hard wear, whilst its tare is comparable to that of the older type.

SECTION 2.
NO. 15.
FIRST FLOOR
BAY J.

SECTION 2.
NO. 16.
FIRST FLOOR
BAY J.

Principal Dimensions of Wagon.

Carrying capacity	...	...	...	...	...	10 tons
Tare	...	...	...	...	...	9 tons
Wheel diameter	...	...	...	...	...	3'-3"
Wheelbase	...	...	...	...	...	12'-1.1/2"
Overall length (over buffers)	...	...	...	...	...	26'-1.1/2"

SECTION 2. NO. 17.

FIRST FLOOR
BAY M.
SCALE 1/12.

MODEL OF 30 TON COVERED BOGIE WAGON, WITH TUBULAR FRAME.

This model represents a 30 Ton Covered All-Steel Wagon with a frame of unusual design. This consists of eight longitudinal steel tubes, with an external diameter of 2.7/8" and a bore of 2.1/2". The tubes are braced together at intervals, and are strengthened by truss rods stretched over brackets, the rods are in two parts, and an adjusting nut screwed right and left hand, connects the two. Four longitudinal rods act as ties to the head stocks.

The frame is braced transversely by solid steel tie bars. The body panels are of steel plate 1/8" thick with channel section stiffeners. Two sliding doors are provided on each side of the vehicle.

A continuous drawbar is fitted, the pull being taken by a laminated draw spring, which also absorbs the impact on the buffers.

The superstructure is mounted on two four-wheeled bogies of diamond pattern, which are sprung on spiral springs.

Principal Dimensions.

Length over buffers	...	...	...	...	...	35'-11.1/4"
Length over frame	...	...	...	...	...	33'-0"
Centres of bogies	...	...	...	...	...	5'-1"
Bogie Wheelbase	...	...	...	...	...	22'-11.5/8"
Diameter of Wheels	...	...	...	...	...	3'-2"
Height from rail to top of roof.	...	...	...	...	...	11'-9.7/16"
Load	...	...	...	...	...	30 tons

These wagons were built by Baume and Marpent, Belgium, and were put to service in 1904-5.

SECTION 2. NO. 18.

FIRST FLOOR
BAY K.
SCALE 1/8.25.
FORGES, USINES
ET FONDERIES
DE HAINE,
ST. PIERRE,
BELGIUM, 1932.

MODEL OF 10 TON PETROLEUM TANK WAGON.

This model represents the 10-Ton Petroleum Tank Wagons which were built by the firm of Forges, Usines et Fonderies de Haine-St. Pierre, Belgium. They were put into service in 1926.

The superstructure of these wagons consists of a cylindrical tank with dished ends, carried on wooden bolsters reinforced by steel plates and angles fixed to the underframe. The tank is held in position by adjustable wire ropes and steel bands, all end movement being prevented by horizontal wooden beams fitted to channels which are carried on tee uprights, and held in position

by adjustable steel tie bars. A dome built up of steel plates and angles is attached to the top of the tank, and is covered by a cast iron cover hinged to the dome and tightened down thereon by a bridge type locking bar and screw. Two small gunmetal pressure release valves are fitted. An internal gunmetal wing mushroom valve, which seats on a mild steel block riveted to the tank bottom, is actuated by an internal spindle and leverage by means of a hand wheel placed in the dome. A stop cock and delivery pipes are also fitted.

Steel disc wheels are fitted, with tyres secured by retaining rings.

Principal Dimensions of Wagon.

Carrying capacity	10 tons
Tare	10.9 tons.
Length of Underframe	23'-0"
Total length (over Buffers)	26'-1.1/4"
Wheelbase	12'-0"
Diameter of wheels	3'-3"
Overall Height (from rail)	11'-10.3/8"

MODEL OF 30 TON OPEN LOW SIDED BOGIE WAGON.— EGYPTIAN STATE RAILWAYS.

This model, which was made by Ateliers de la Dyle, in their works at Louvain, Belgium, shews a 30 Ton low-sided bogie wagon of the type in use on the Egyptian State Railways. The wagons represented by this model were made by the firm named, and were put into service in 1928; they are known as type 'R' on the E.S.R. The superstructure is built up of steel plates, and sections. The sole bars of the underframe are rolled steel channels, stayed and braced by cross members and gussets. The headstocks which are steel channels are attached to the ends of the frame by riveted knees. The frame is strengthened by truss rods stretched on pillars, each truss rod is in two parts connected together by a steel adjusting nut screwed right and left hand.

A cast steel centre which engages with the centre of the bogie bolster is riveted to the underframe, and also two cast steel top side bearers. The underframe is carried on two bogies of the diamond type, built up of rolled steel sections, plates and bars riveted together. The bogie centre is a steel casting, as are the bottom side bearers; these are all bolted in position. The centre pin is of 40-45 tons tensile steel, as are the wearing plates attached to the bogie cross girders; these plates take the wear of the cast steel rubbing blocks bolted in each end of the bolster. Check chains are fitted.

Steel disc wheels are fitted with tyres secured by retaining rings.

SECTION 2. NO. 19.

BAY L.
SCALE 1/10.
PRESENTED BY
ATELIERS DE LA
DYLE, LOUVAIN,
BELGIUM, 1932.

Principal Dimensions of Wagon.

Gauge	...	...	...	...	...	...	...	...	...	4'-8.1/2"
Load	...	...	...	...	...	...	...	...	...	30 tons
Tare	...	...	...	...	...	...	...	...	...	16.8 tons
Length of Underframe	...	...	...	...	...	...	...	...	...	45'-0"
Total length (Over Buffers)	...	...	...	...	...	...	...	...	...	48'-1.1/2"
Length between Bogie Centres	...	...	...	...	...	...	...	...	...	33'-6"
Bogie Wheelbase	...	...	...	...	...	...	...	...	...	5'-6"
Diameter of Wheels	...	...	...	...	...	...	...	...	...	2'-9.1/2"
Outside Length of Body	...	...	...	...	...	...	...	...	...	45'-0"
Outside Width of Body	...	...	...	...	...	...	...	...	...	8'-9"
Width between Side Members	...	...	...	...	...	...	...	...	...	7'-1.1/2"
Height of Sides	...	...	...	...	...	...	...	...	...	1'-6.5/16"

SECTION 2. NO. 20.

FIRST FLOOR
BAY J.
SCALE 1/10.
PRESENTED BY
ATELIERS DE LA
DYLE, 1932.

MODEL OF BOGIE FOR THIRD CLASS ALL-STEEL CARRIAGES.

This, model represents the bogies fitted to a number of third class all-steel carriages supplied to the Egyptian State Railways in 1927.

The pressed steel work for the carriages to which these bogies were fitted was manufactured by Ateliers de la Dyle, Louvain, Belgium.

The bogies are of the standard Egyptian State Railways 4-wheeled design, with equalising bars to transmit the weight of the vehicles from the helical bearing springs to the tops of the axleboxes.

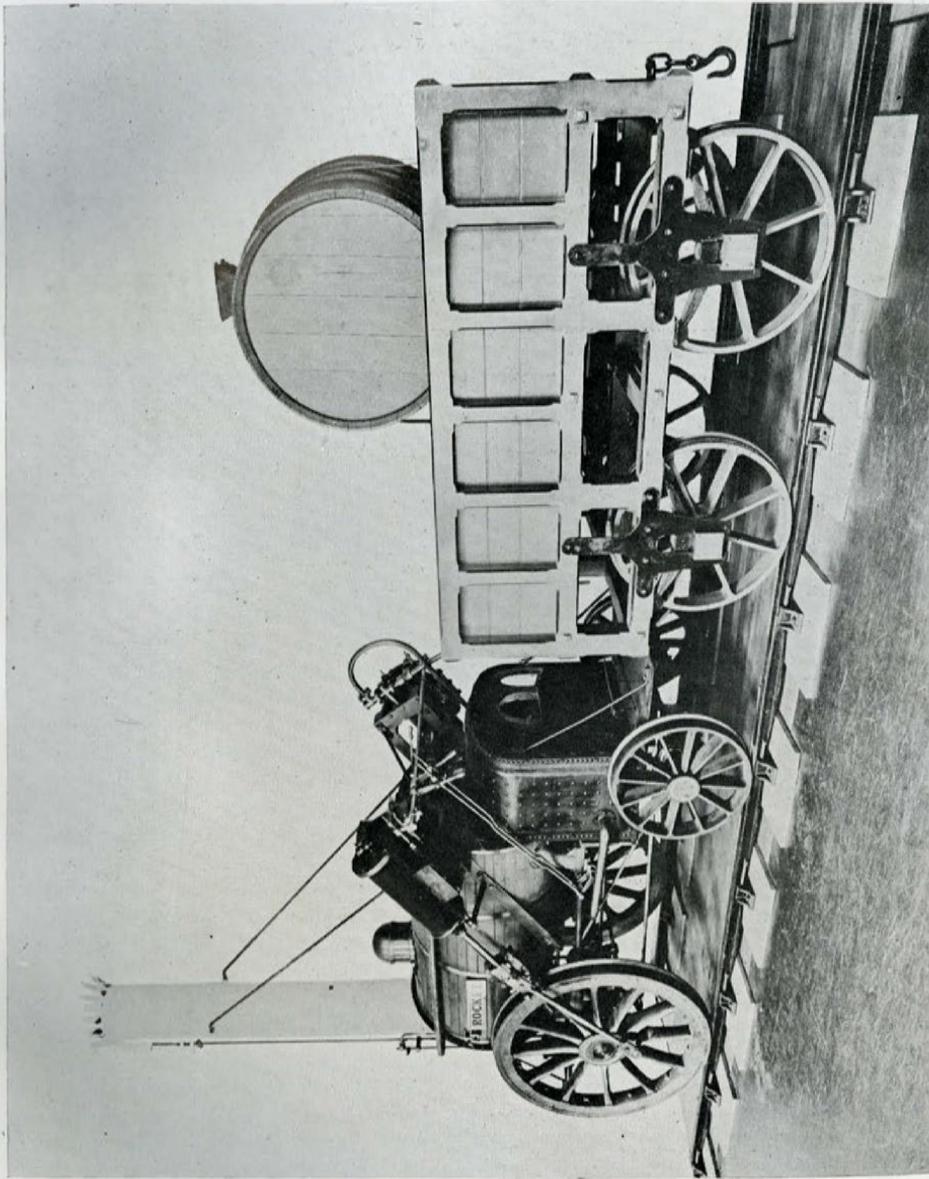
The bogie frames are of pressed steel, the hornblocks of cast steel are riveted to the frames, and the horn stays of mild steel are bolted thereto.

The bolster is built up of pressed steel plates, and the centre is of cast steel, as are the two side bearers. The bogie cross bearers and the bolsters are provided with wearing plates where they come in contact. The bolster side check springs are housed in cast steel casings, and the suspension links, suspension link hangers, and rocking bars are of 40-45 tons tensile steel.

The wheel centres are pressed steel discs fitted with tyres secured by retaining rings. The axles are pressed in to the wheels no keys being used to secure them. The axleboxes are of standard Egyptian State Railways design, the bearing being 9" x 5". The bearing is of bronze with white metal lining, and a dust shield and oil pad are fitted.

Principal Dimensions of Bogie:

Wheelbase	...	...	...	...	...	...	...	...	...	8'-0"
Wheel diameter	...	...	...	...	...	...	...	...	...	3'-9"
Length over bogie frame	...	...	...	...	...	...	...	...	...	13'-3"



“Rocket” Locomotive.—1829.

The locomotive which by its success in the Rainhill trials of 1829 proved the utility of the steam locomotive.

قارورة روكيت سنة ١٨٢٩

بنجاح هذه القارورة في تجربتها بجبهة رينيل سنة ١٨٢٩
أثبتت نجاح القارورة البخارية

MODEL OF "ROCKET" LOCOMOTIVE AND TENDER, 1829.

This model which is partly in section, represents the famous locomotive "Rocket" as originally built for the Rainhill trials in 1829.

The engine ran on four wheels and had two cylinders, 8 in. diameter by 7 in. stroke, placed at the rear end of the boiler and inclined downwards at 35 deg. with the horizontal; the piston rods drove the front wheels, which were 56.5 in. diameter, thus giving a tractive factor of 19.4. The trailing wheels were 30 in. diameter and the wheel base 7.17 ft. The cylinders were mounted on iron plates, which were bolted to the boiler shell and supported by stays; these plates also carried the guide bars, which were of square section, set diagonally, while the crossheads were of brass in halves, bolted together and embracing the bars. The steam chests were below the cylinder and the slide valves were driven through an intermediate shaft and levers, by a pair of eccentrics fixed to a loose sleeve which could be moved endwise along the shaft by a pedal so as to engage with either of two drivers, one set for forward and the other for backward running. The valve rods had gab ends, so that the valves could be disengaged and worked by hand levers when reversing. The crankpins had spherical ends, to allow for irregular motion of the engine relative to the driving axle.

The boiler was a cylindrical shell, 40 in. diameter by 6 ft. long, made in two rings, with a circumferential lap joint and longitudinal butt joints; the flat ends were secured by angle rings and tied together by longitudinal stays. The shell was traversed by twenty-five copper tube, 3 in. diameter, secured in holes through the end-plates. The firebox had a double copper wrapper plate forming a water-jacketed top and sides, but the front and back were dry plates. Copper pipes connected the water and steam spaces of the firebox with those of the barrel: The total heating surface of the boiler was 138 sq. ft., that of the firebox being 20 sq. ft., the grate area was 6 sq. ft. The chimney was nearly 15 ft. high, above the rails, and was swelled out at the base to cover the tube ends; it was supported by stays from the cylinder plates.

Steam from the boiler was admitted to the cylinders by two pipes leading from a regulating cock fixed above the firebox and which received steam from a dome through an internal pipe. The boiler pressure was limited to 50 lbs. per sq. in. by two safety valves, one of which was loaded by a weight and lever, while the other was a lock-up spring loaded valve covered by a small dome. A mercurial gauge was fitted beside the chimney and was arranged to indicate the steam pressure from 45 to 60 lbs.; a water gauge was fitted behind one of the cylinders and two gauge cocks near

SECTION 2. NO. 21.

FIRST FLOOR
BAY C.
LENT BY THE
SCIENCE
MUSEUM,
SOUTH
KENSINGTON.
LONDON, 1932.

the front end of the boiler. The feed water was introduced by a long-stroke feed pump worked from one crosshead, while the exhaust steam was passed into the chimney by two pipes, each fitted with a brass nozzle 1.5 in. diameter.

The framing of the engine was wholly between the wheels, and was built up of 4 in. by 1 in. flat bar iron bent down at the rear end to accommodate the firebox and rear axle; to this the cast-iron axle box guides were secured, and four brackets to support the boiler. The weight was transmitted to the axles by plate springs. The driving wheels were constructed with cast-iron bosses, in which the crankpins were fixed, oaken spokes and felloes, and iron tyres secured by bolts. The engine weighed 3.25 tons when empty and 4.25 tons in working order.

The tender was a four-wheeled wooden truck carrying the fuel in the body and the water in a large barrel above it. The axles had outside bearings and plate springs, the wheels were 36 in. diameter, and the wheel base was 4 ft. It weighed 3.2 tons when loaded, so that the total weight of engine and tender in working order was 7.45 tons.

SECTION 2. NO. 22.

FIRST FLOOR
BAY J.
SCALE 1/12

MODEL OF SUGAR CANE TRUCK. — AUXILIARY RAILWAY, EGYPTIAN STATE RAILWAYS.

This model represents a 5 ton truck built specially for the transport of sugar canes. In 1872 trucks of this type 233 in number entered the service, they were built by Messrs. Cochrane & Co., Dudley, England.

Principal Dimensions of Truck.

Gauge	...	...	...	...	...	...	...	...	...	4'-8 1/2"
Type	...	...	...	...	...	...	...	...	...	4 wheel
Wheel diameter	...	...	...	...	...	...	...	...	...	2'-8"
Wheelbase	...	...	...	...	...	...	...	...	...	6'-5 1/2"
Overall length (Over buffers)	...	...	...	...	...	...	...	...	...	16'-5"
Body (length)	...	...	...	...	...	...	...	...	...	14'-2 1/2"
Body (width)	...	...	...	...	...	...	...	...	...	8'-2 1/2"
Load	...	...	...	...	...	...	...	...	...	5 tons
Tare	...	...	...	...	...	...	...	...	...	2,970 kilogs.

SECTION 2. NO. 23.

FIRST FLOOR
BAY J.
SCALE 1/12

MODEL OF FIRST CLASS CARRIAGE. AUXILIARY RAILWAYS, EGYPTIAN STATE RAILWAYS.

This model represents first class carriage No. 119. When supplied by Messrs. Cochrane & Co. in 1872, it entered the service as a sugar cane truck, but was converted to its present form in 1908, the work being done in the Minia Workshops. During 1908 nine carriages of this type entered the service.

Principal Dimensions of Coach.

Gauge	...	...	...	...	...	...	...	...	...	4'-8 1/2"
Type	...	...	...	...	...	...	...	...	...	4 wheel
Wheel diameter	...	...	...	...	...	...	...	...	...	2'-8"
Wheelbase	...	...	...	...	...	...	...	...	...	6'-5 1/2"
Overall length (Over buffers)	...	...	...	...	...	...	...	...	...	16'-5"
Body (length)	...	...	...	...	...	...	...	...	...	14'-2 1/2"
Body (width)	...	...	...	...	...	...	...	...	...	8'-2 1/2"
Load	...	...	...	...	...	...	...	...	...	5 tons
Number of passengers (men)	...	...	...	...	...	...	...	...	...	8
Number of passengers (ladies)	...	...	...	...	...	...	...	...	...	4

MODEL OF PLOUGH TRUCK-AUXILIARY RAILWAYS. EGYPTIAN STATE RAILWAYS.

This model represents a 20-ton plough truck for loading agricultural ploughs on the Auxiliary Railways, and built by Leeds Forge Co. Ltd. in 1905. Six trucks of this type, Nos. 1621-1626 entered the service in 1905.

Principal Dimensions of Truck.

Gauge	...	...	...	...	...	...	...	...	...	4'-8 1/2"
Type	...	...	...	...	...	...	...	...	...	Bogie.
Wheel diameter	...	...	...	...	...	...	...	...	...	2'-4"
Overall length, (over buffers)	...	...	...	...	...	...	...	...	...	33'-5 1/2"
Body (length)	...	...	...	...	...	...	...	...	...	30'-11 1/2"
Body (Width)	...	...	...	...	...	...	...	...	...	10'-6 1/2"
Loading ramp	...	...	...	...	...	...	...	...	...	10'-11"
Load	...	...	...	...	...	...	...	...	...	20 tons.
Tare	...	...	...	...	...	...	...	...	...	12,700 kilogs.

MODEL (IN STONE) OF PULLMAN CAR.

This model is the work of an employee of the Mechanical Department, Egyptian State Railways.

SECTION 2. NO. 24.

FIRST FLOOR
BAY K.
SCALE 1/12.

SECTION 2. NO. 25.

FIRST FLOOR
BAY J.
PRESENTED BY
HILAL EFF.
MISHRIKI.

**SECTION 2.
NO. 26.**

FIRST FLOOR
SCALE 1/5.
LENT BY CIE.
INTERNATIONALE
DES
WACONS-LITS
ET DES GRANDS
EXPRESS
EUROPEENS.
1932.

SECTIONAL PULLMAN 2nd. CLASS CARRIAGE.

The model represents a 2 berth compartment of a 2nd. class Pullman Coach.

**SECTION 2.
NO. 27.**

GROUND FLOOR.
BAY P.-Q.-R.

**SECTIONAL 4-4-2 TYPE EXPRESS PASSENGER
LOCOMOTIVE No. 194. — EGYPTIAN STATE RAILWAYS.**

This exhibit is a 4-4-2 type Express Passenger Locomotive No. 194 (old No. 678) originally built in 1906, by The North British Locomotive Co. Ltd., it was subsequently rebuilt in 1919 and again at a later date.

For the purpose of showing details of construction the boiler, firebox and smokebox have been cut through and one half removed. The cylinders, V.B. cylinder, injector, ejector and other parts have been similarly treated.

The engine as it existed when last in service, and as it is now exhibited, had a boiler with a tube heating surface of 2,175 sq. ft., with 160 sq. ft. of firebox surface, a total of 2,335 sq. ft., and a grate area of 23.56 sq. ft. This boiler which was taken from a 0-6-0 type goods engine was lengthened in the barrel, and worked at a pressure of 180 lbs. per sq. inch. The firebox is of the Belpaire type, with direct roof stays, the first two rows of which are arranged for expansion.

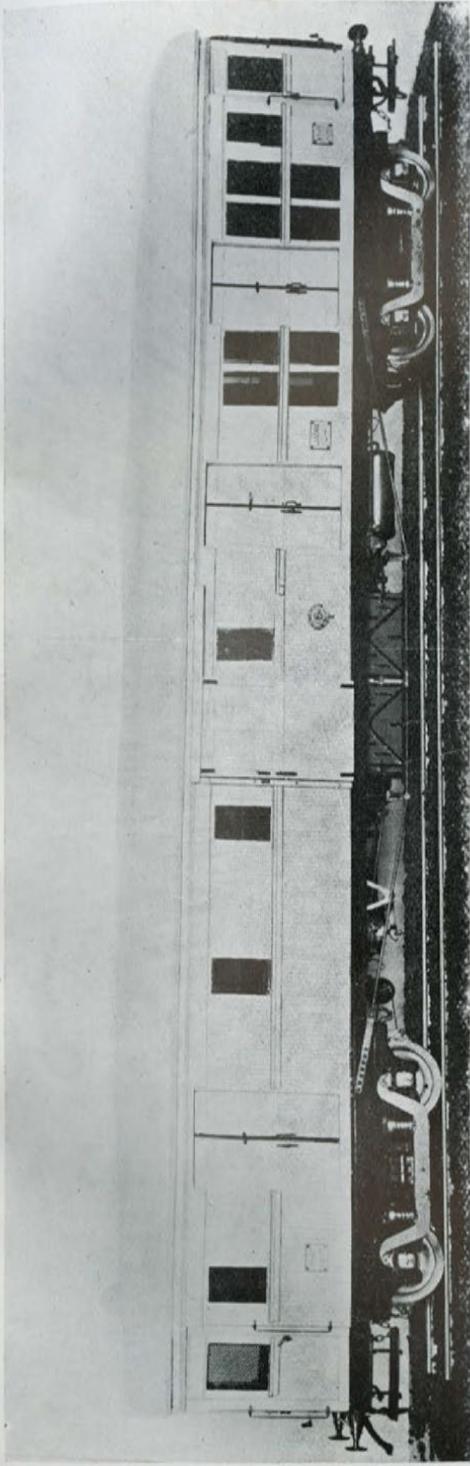
Transverse stays are fitted with swelled ends, screwed into the firebox wrapper. The firebox is of copper stayed by copper water-space stays. The longitudinal stays are of steel, each being in two lengths connected by an adjusting nut screwed right and left hand.

The boiler was fed by Friedmann non-lifting restarting injectors, through clackboxes.

The two outside cylinders are 19" dia. by 24" stroke, with piston valves 10" diameter actuated by Walschaerts valve motion, with screw reversing gear. Crossheads of the single bar type are fitted. The coupling and connecting rods are of fluted section, the former having brasses lined with white metal, and steel straps incorporating syphon oil boxes.

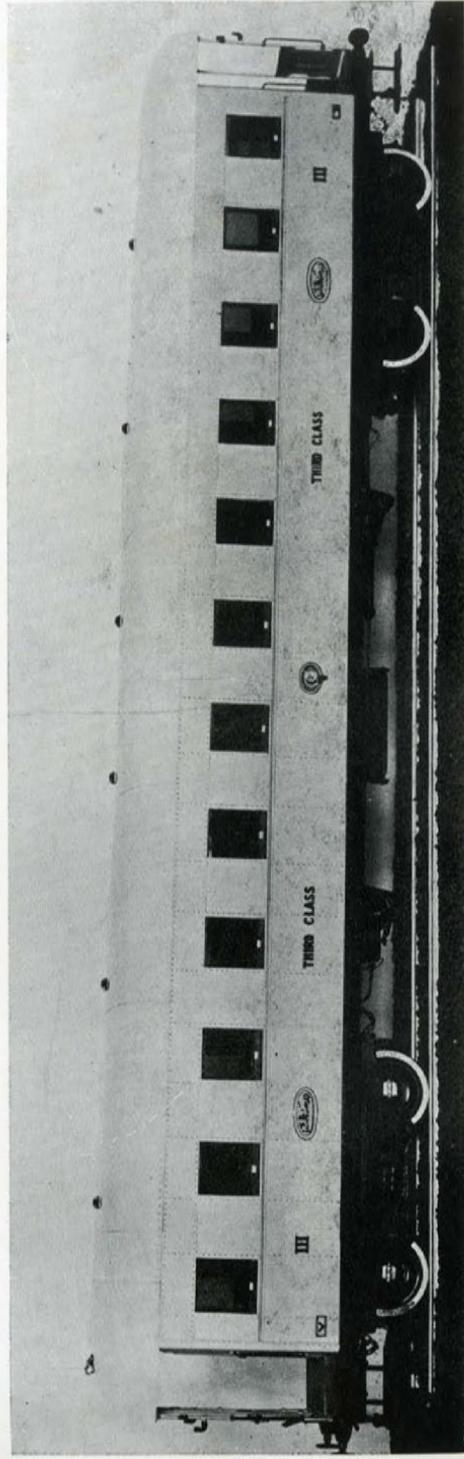
The coupled wheels are 6'-3" diameter, and the front of the engine is carried on a bogie, with 3'-0" diameter wheels having a wheelbase of 7'-0".

The trailing pony wheels are 3'-8" diameter.



Model of Brake, Perishable, Luggage and Post Van
 Egyptian State Railways.—The latest type of vehicle of this class.
 The bodies were made in the Boulac Carriage Works.

النموذج عربية سبينة وخضار وعفش وبوستة
 سلك حديد الحكومة المصرية — أحدث طراز لعربيه من هذا النوع
 ولقد صنعت اليانك بورش عربات بولاق



Model of Bogie-Steel Third Class Carriage.—Egyptian State Railways.
 Built by the Birmingham, Carriage and Wagon Co. Ltd.

النموذج عربيه درجه ثالثة بوجي صلب — سلك حديد الحكومة المصرية
 صنعت في شركة بيرمنجهام لعربات الركاب والبضاعة

Both hand screw and vacuum brakes are fitted. Each van is fitted with a dynamo driven from axle pulley, with batteries, for lighting the vehicles electrically.

The engine weighed 66.95 tons, of which 33.25 tons was on the coupled wheels. At 85 % of the working pressure the tractive effort was 17,674 lbs. The total wheelbase of the engine is 27'-8" of which 6'-7.1/4" is rigid.

MODEL OF BRAKE, PERISHABLE, LUGGAGE AND POST VAN. — EGYPTIAN STATE RAILWAYS.

This model, which was made in the Boulac workshops of the Egyptian State Railways represents a brake, perishable, luggage and post van of the latest type.

The van bodies are of wooden construction, and were built in the Boulac Carriage Works of the Egyptian State Railways. Separate compartments are provided for Brake, Perishable-Goods, Luggage and Post. Sliding doors are fitted on each longitudinal side of each compartment, except at the ends of the van where hinged doors are fitted. There are two Postal compartments, one of which is fitted with sorting benches, and a through passage between the two is obtained by a sliding door in the partition dividing the compartments, ventilation is provided by fine gauze panels.

The undercarriage, which is of steel construction was made abroad, is composed of longitudinal channels, with cross bracings of H beams and channels, and gusset plates. Diagonal bracings are flat bars attached to the longitudinal members by gussets.

The longitudinal channels are strengthened by truss rods stretched on pillars, each truss rod is in two parts connected by a steel adjusting nut screwed right and left hand. The headstocks are of channel section attached to the ends of the frames by riveted knees.

The bogies are of standard Egyptian State Railways design, the frame plates are of pressed steel, with cast steel hornblocks riveted to the frame, and horn stays bolted thereto. The bolster is of pressed steel plates with cast steel centre and side bearers. The cross girders and the bolsters are provided with wearing plates where they come in contact. The bolster side check springs are housed in steel castings, and the suspension links, hangers and rocking bars are of 40—45 tons steel.

The wheel centres are of pressed steel with tyres secured by a retaining ring. The axleboxes are of cast steel, and have journals 9' x 5".

SECTION 2. NO. 28.

FIRST FLOOR
BAY D.-E.
SCALE 1/12

Principal Dimensions:

Length over buffers	69'-1.1/4"
Length over body	65'-8.1/2"
Centres of bogies	45'-0"
Bogie Wheelbase	8'-0"
Width over sides	9'-3"
Width over step boards	9'-2.1/2"
Height from rail to top of roof	14'-2"
Diameter of wheels	3'-9"
Tare	39 tons

SECTION 2. NO. 29.

FIRST FLOOR
BAY J.
SCALE 1/12

MODEL OF 2-6-4. SIDE TANK LOCOMOTIVE CLASS 1301-1340. EGYPTIAN STATE RAILWAYS.

This model which was built in the workshops of the Egyptian State Railways, represents one of the 1301-1340 class side, tank locomotives. Twenty of these engines were built by the firm of E. Breda, Milan, in 1929 and the other twenty were supplied by the North British Locomotive Co. Ltd., Glasgow in 1930. These locomotives are of the 2-6-4 type and are used for miscellaneous service. They have two outside cylinders which drive the second coupled axle. The piston valves are 10" diameter and are actuated by Walschaert valve gear. The Belpaire boiler is fed by two Friedmann No. 10 A.S.Z. Horizontal injectors fixed under the footplate, two 3" Ross Patent Muffled Pop safety valves are fitted. Sanding gear is applied in front of the leading pair of coupled wheels and in the rear of the trailing pair. Vacuum and hand brakes are fitted.

SECTION 2. NO. 30.

FIRST FLOOR
CENTRE TABLE
BAY G.-H.
PRESENTED BY
ABBAS EFF.
MOSTAFA 1932.

MODEL OF VERTICAL SINGLE CYLINDER ENGINE.

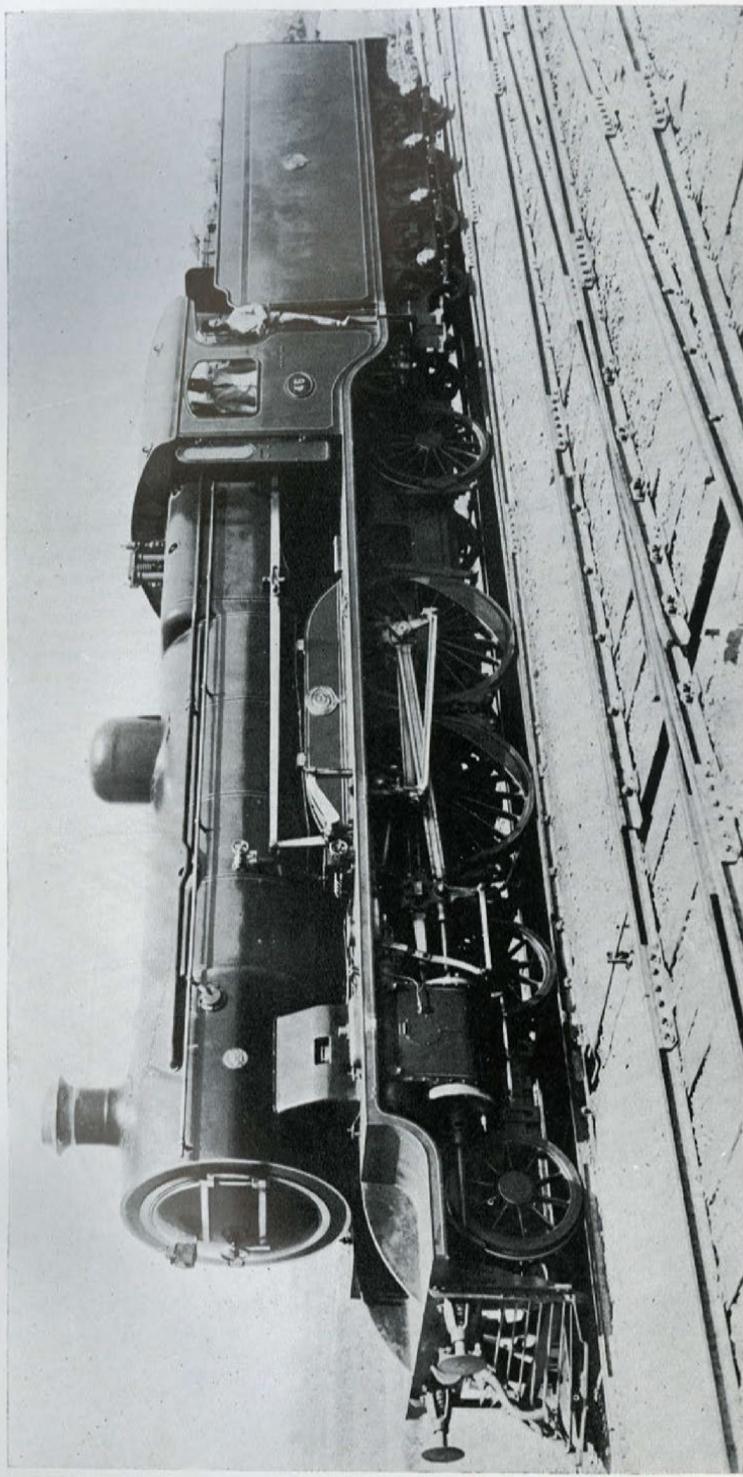
This model represents a single cylinder vertical engine; the original of which was built by George Forrester & Co. of Liverpool in 1861.

The engine was first installed in the Arment Sugar Factory, where it remained at work from 1861 to 1863. This sugar factory was attached to Daira El-Sania, and in 1863 the engine was transferred to the Matana Shops, which belonged to the same Daira, there it has remained until the present day. It is still used for driving all the lathes and machines in these shops.

When the Daira El-Sania Sugar Factories were sold to the present Sugar Factory Co., the shops at Matana continued to repair the locomotive and sugar factory pumping plants, and in 1905-06, the Auxiliary Railways were sold to the Government.

When first put to work the engine had brass piston rings, but at a later date cast iron rings, were fitted, these with slide valves are the only parts which have been renewed, and the engine is still in very good condition.

The cylinder is 8" diameter by 10" stroke.



Express Passenger Locomotive No. 46.
Egyptian State Railways.

This 4-4-2 type locomotive was built by the North
British Locomotive Co. Ltd., in 1925.

قاطرة ركاب اكسبريس رقم ٤٦
سكك حديد الحكومة المصرية

هذه القاطرة من نوع ٤/٢ وقد صنعت في الشركة الشمالية للقاطرات الانجليزية ليمبد
في سنة ١٩٢٥

MODEL OF ELECTRIC LOCOMOTIVE, METROPOLITAN RAILWAY — LONDON, 1921.

This represents one of twenty electric locomotives supplied to the Metropolitan Railway for working main line trains which run over both the steam worked, and the electrically equipped parts of the line.

It is mounted on two bogies each with four wheels $3'-7\frac{1}{2}"$ diameter, the total wheelbase being $29'-6"$. Each axle is driven, through single reduction gearing, by a 300 H.P. motor, giving a total of 1,200 H.P. Direct current at 600 volts is collected from a third rail, and control is of the all-electric automatic multiple unit type. The overall length of the locomotive is $39'-6"$ and its weight is 56 tons.

MODEL OF HIGH SPEED ELECTRIC PASSENGER LOCOMOTIVE. LONDON AND NORTH EASTERN RAILWAY, 1922.

This model represents a high speed electric passenger locomotive, designed by Sir Vincent Raven, the then chief of the North Eastern Railway, and erected at the Company's works at Darlington.

The electrical equipment was supplied and manufactured by the Metropolitan-Vickers' Electrical Co. Ltd.

This equipment consists of three pairs of motors, each motor has a capacity of 300 H.P. so that the total capacity of the locomotive (1 hour rating) is 1,800 H.P. measured at the tread of the wheels.

Each pair of motors is mounted in the locomotive framework immediately above the corresponding driving axle. Concentric with this axle is a hollow shaft or quill, carrying at each end a spider. The arms of this spider mesh with the spokes of the driving wheels and are connected to them by springs called "quill" springs. The quill carries a gear wheel which engages with the two pinions of the pair of motors. The quill runs in "suspension" bearings which form part of the motor frame, and the distance between the gear centres is thus definitely maintained. This arrangement allows a pair of motors to be geared to a single driving axle through a flexible connection allowing the axle to move up and down on the axle-box guides, without transmitting the movement to the motors. An electric boiler is fitted for producing the steam necessary for the heating of the passenger coaches. Direct current at a pressure of 1,500 volts is used.

SECTION 2. NO. 32.

FIRST FLOOR
BAY D.
LENT BY
METROPOLITAN-
VICKERS ELEC-
TRICAL CO. LTD.,
1932.

SECTION 2. NO. 33.

FIRST FLOOR
BAY D.
LENT BY THE
METROPOLITAN-
VICKERS ELEC-
TRICAL CO. LTD.,
1932.

The main particulars of this locomotive are briefly as follows:

Wheel arrangement	... ..	4-6-4
Electrical system	... ..	Direct current.
Voltage	... ..	1,500
Length overall	... ..	53'-6"
Width overall	... ..	8'-10"
Height pantograph locked down	... ..	13'-0.1 $\frac{1}{8}$ "
Driving wheel diameter	... ..	6'-8"
Bogie wheel diameter	... ..	3'-7.1 $\frac{1}{4}$ "
Rigid wheelbase	... ..	16'-0"
Weight of locomotive	... ..	102 tons
Weight per driving axle	... ..	18.5 tons

One hour rating.

Tractive effort	... ..	15,900 lb.
Speed	... ..	43 m.p.h.
Horse Power	... ..	1,800

Continuous rating.

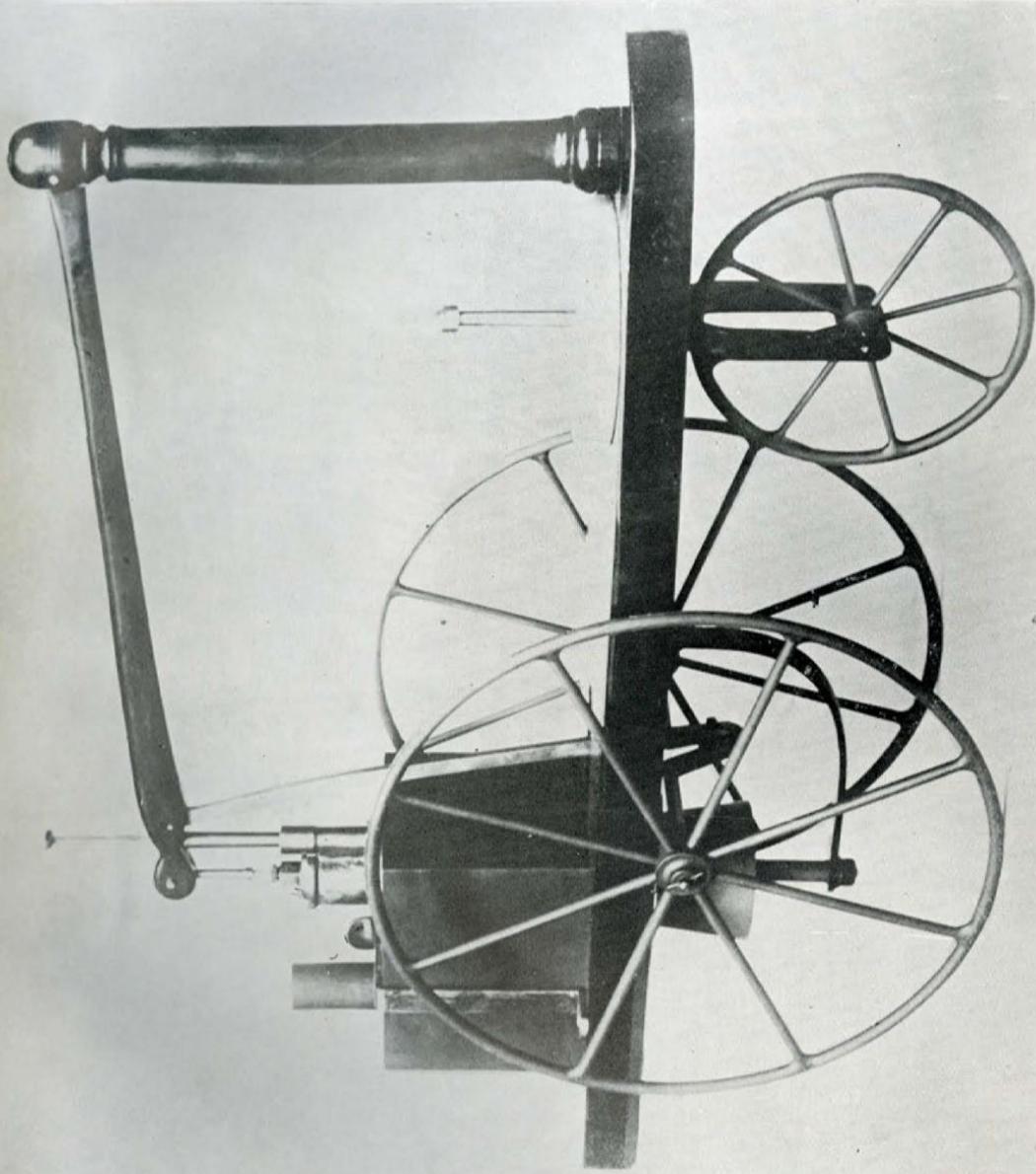
Tractive effort	... ..	9,480 lb.
Speed	... ..	51.5 m.p.h.
Horse power	... ..	1,300

MURDOCK LOCOMOTIVE, 1781.

This exhibit is of great historical interest, being in fact the first locomotive ever run in England. It was constructed by Murdock, the well-known assistant to James Watt, and also a co-inventor with him of the steam engine, second only in importance of Watt himself. It was constructed in 1781, but it was not tried in actual operation till 1784, at Redruth, in Cornwall. It is only a working model, but is nevertheless quite sufficiently large to demonstrate the practicability of steam locomotion. It stands altogether about 14 inches high, is 19 inches long, and the extreme width over the driving wheels 7 inches. It has a copper boiler, with firebox and flue, a spirit lamp, and one double-acting steam cylinder, two driving wheels and a steering wheel. According to Dr. Smiles' interesting book, "Lives of Engineers", Vol. IV, page 267, Watt had long thought on the subject, his attention being drawn to it by his friend Dr. Robinson, of Glasgow University, at the early age of twenty-three, and in his patent of 1784 he describes a locomotive, but in that year Murdock, no doubt familiar with Watt's speculations, actually succeeded in constructing and working the model in question. Quoting from Dr. Smiles: "The first experiment was made in Murdock's own house, at Redruth, when the little engine successfully hauled a model engine round the room, the single wheel

**SECTION 2.
NO. 34.**

GROUND FLOOR
CENTRE TABLE
ENTRANCE TO
GROUND FLOOR.
LENT BY
TANGYES LTD.,
1932.



Murdock Engine.

This engine was built in 1781, and in 1784 ran a trial at Redwith in Cornwall. — It was the first locomotive ever run in England.

قاطرة مردوك

بُنيت هذه القاطرة في سنة ١٧٨١ وقامت بتجربة في ريدوث كورنوال في سنة ١٧٨٤ وهي أول قاطرة سارت بالبخار

placed in front of the engine, and working in a swivel frame, enabling it to run in a circle. Another experiment was made out of doors, on which occasion, small as the engine was, it fairly outran the speed of the inventor. One night, after returning from his duties at the mine at Redruth, Murdock went out with his model locomotive to the avenue leading to the church, about a mile from the town. The walk was narrow, straight and level. Having lit the lamp, the water soon boiled, and off started the engine, with the inventor after it. Shortly after he heard the distant shouts of terror. When he came up to his machine, he found the vicar in great fear, thinking that the hissing, spitting, little demon was no less than Evil One himself."

When James Watt heard of Murdock's experiment, being naturally of a timid disposition, he became much alarmed that Murdock's energies might be distracted from the business of stationary engines, and he requested Boulton to remonstrate gently with Murdock, and get him to drop the subject. Accordingly Murdock did so, never taking up the subject again.

An attentive examination of the model well repays one, and reveals many beautifully simple contrivances, showing Murdock's genius for the adoption of simple means to secure his desired ends.

The model locomotive consists of an oblong board, mounted upon three wheels, two driving wheels being attached to a cranked axle, and one steering wheel in front, under the board, running in a swiveling fork, which can be set by a tiller handle above. Behind the driving wheels is the boiler, constructed of brazed copper. It is a rectangular vessel, $3\frac{3}{8}$ " high, $4\frac{1}{4}$ " long, and $3\frac{1}{8}$ " wide. Through the boiler passes a flue, contracting from a circular chamber forming the fire-box to a small funnel in the top of the boiler, which serves to carry off the products of combustion from a spirit lamp, arranged to burn within the fire-box. The steam cylinder of the engine is mounted on the top of the boiler, and part of it passes into it and is surrounded by steam. The piston rod passes upward, and is attached to the end of a vibrating beam; the beam passes to the front end of the carriage, and is pivoted in an upright pillar. As the piston moves up and down it causes the beam also to move up and down, and a connecting rod attached to it very near the piston rod drives the crank below it, and so causes the driving wheels to revolve.

The steam valve is very ingenious, and it is driven from the beam by a projecting rod, so arranged that the valve is moved in the termination of every up and down stroke by the last portion of movement of the beam upwards or downwards. It is a piston valve, with two pistons ground to work easily, but pressure proof, in the valve cylinder. The space between the pistons is in constant communication with the boiler, and the steam is admitted by two ports, one at the top and one at the bottom of the cylinder, so arranged that when the piston valve is up the steam enters

the upper port and drives down the piston, while the exhaust steam from the under side discharges from the cylinder by the lower port through a tube connecting the two pistons of the valve, and out into the air.

This is probably the earliest slide valve used in a steam engine, as at the date of its construction Boulton and Watt did not use Murdock's D slide in their engines, but still adhered to disc valves, with much driving gear.

Murdock's invention of the slide valve immensely simplified the steam engine by substituting one plain to and from movement for the complex levers and numerous valves of the earlier steam engines. In this model Murdock had certainly the idea of the slide valve.

The safety valve is let into the boiler near the steam cylinder, and it is held down by a little tongue of metal, a very efficient and simple contrivance.

A lead weight is placed above the steering wheel to balance the machine and prevent it tipping over when the water is in the boiler, hung behind the driving wheels.

The wheels are constructed of brass tube brazed together. Every part of the machine is both well designed and well made. It is interesting to observe that at one time the wood under the boiler has been on fire, and it shows still the marks of charring, and is pieced and protected with an iron plate to prevent a similar mishap.

The model was continuously in possession of the Murdock family till 1883, when it was purchased from Murdock's great grandson by Messrs. Richard & George Tangye.

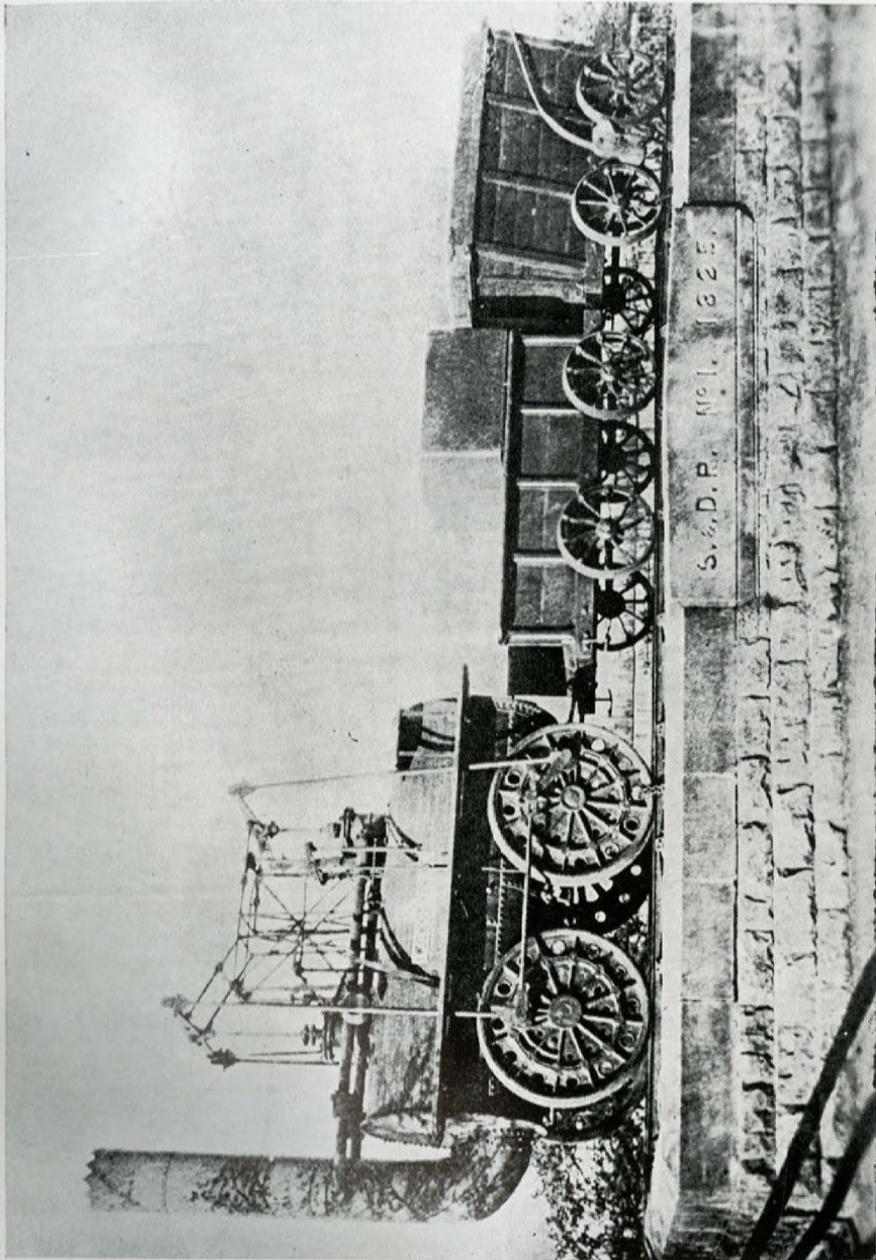
MODEL OF "LOCOMOTION" No. 1. STOCKTON AND DARLINGTON RAILWAY, 1825.

The original of this model was built by R. Stephenson & Co. at Forth Street, Newcastle-on-Tyne in 1825, and in September of that year it opened the Stockton and Darlington Railway, which was the first public steam railway in the world. The engine ceased running in 1846, but is still preserved at Darlington.

The engine has two vertical cylinders 10" diameter (originally 9 1/2") by 24" stroke, each driving by return connecting rods, a pair of driving wheels 48" diameter. The wheels are of cast iron, and are coupled together by external rods and two cranks, so that the driving crank pins of the front and rear wheels are kept at right angles. The wheel base is 5.17 feet. The crossheads are guided by grasshopper parallel motions. The slide valves are driven by rocking shafts which receive their motion from a single loose eccentric on the leading axle, one shaft being rocked directly and the other through a bell crank lever. A platform runs along each side of the boiler, and from these the driver has control of the valve rods, for disengaging and reversing, and the regulator valve. The exhaust steam from both cylinders

SECTION 2. NO. 35.

LENT BY
MESSRS. R.
STEPHENSON
& CO. LIMITED
1932.



“Locomotion” No. 1.

The first locomotive to run on the Stockton and
Darlington Railway in 1825.

قاطرة نمرة ١

اول قاطرة سارت على سكة حديد ستكتن ودارلنجتن

سنة ١٨٢٥

was conveyed by two pipes to the chimney. The feed water was forced into the boiler by a single feed pump 4" diameter driven by a lever from the front crosshead. The boiler is 10'-0" long and 4'-0" diameter, and has a single through flue tube 24" diameter delivering into the chimney which is 15" diameter. The heating surface is about 60 sq. ft., and the grate area about 8 sq. ft. while the steam pressure was 50 lb. per sq. inch. A weighted lever safety valve is provided, and a regulating cock on top of the boiler. As originally built the engine is reputed to have weighed about 7 tons; its weight now is 6.8 tons light.

The tender is built of wood and runs on four cast iron wheels 30" diameter, with a wheel base of 4.75 feet. It holds 15 cwt. of coal and carries an iron tank containing 240 gallons of water; its weight when loaded is about 2.75 tons.

The locomotive is estimated to have been of about 10 H.P., and it hauled a load of 60 to 70 tons at an average speed of 5 miles an hour. The total weight of engine and tender in working order was about 9.75 tons.

MODEL OF PENYDARRON LOCOMOTIVE, 1804.

This model represents the locomotive which was built by Richard Trevithick at the Penydarren Iron Works, near Merthyr Tydvil, Wales, in 1803-4.

At the suggestion of the proprietor, Samuel Homfray, Trevithick undertook to construct a steam locomotive to haul trucks on the tramway from the works to Navigation House, near Abercynon, a distance of about 9 miles. An engine weighing about 5 tons was built, and when first tried on February, 13th, 1804, it hauled a load of about 20 tons at a speed of 5 miles an hour. It made several journeys subsequently, on one occasion being loaded with 25 tons of iron, but the frequent breakage of the cast-iron tram plates soon put an end to the trials. This engine, however, unquestionably proved that a useful load could be hauled solely by the adhesion of the wheels on the track, it also discharged the exhaust steam into the chimney, the effect upon the fire being appreciated at the time.

The cylinder had a diameter of 8.25" and a stroke of 54". The boiler is believed to have been of the return flue type.

MODEL OF MATTHEW MURRAY'S LOCOMOTIVE — 1812.

This model represents the Locomotive designed and built by Matthew Murray of Leeds, in conjunction with John Blenkinsopp (the inventor of the rack rail) for the purpose of substituting the use of steam for horses in the transport of coal from Middleton Colliery to Leeds, a distance of about 4 miles.

SECTION 2. NO. 36.

FIRST FLOOR
BAY C.

SECTION 2. NO. 37.

FIRST FLOOR
BAY F.
LENT BY
MUSEUM, 1932.
LEEDS CITY

This engine remained in service for many years, and as a result of its success many other collieries followed the example. The price of this engine was £380 plus £20 paid to Trevithick for the use of his high pressure steam plant.

It was the first locomotive ever built and used for commercial purposes, and hauled a load of 94 tons of coal at 3.½ miles per hour, or 15 tons up a gradient of in. 18, and when lightly loaded it could travel at a speed of 10 miles per hour.

When working normally the consumption of coal was 21.3, lb and of water 14.3 gallons per train mile, therefore each pound of coal evaporated 6.7 lb. of water.

SECTION 2. NO. 38.

FIRST FLOOR
BAY D.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

MODEL OF 2-2-2 TYPE LOCOMOTIVE "LE BELGE", BELGIAN STATE RAILWAYS.

This model represents the first locomotive constructed in Belgium. The original engine was built by Cockerill, and delivered in December 1835. The inside cylinders were 280 m/ms. (11") diameter × 458 m/ms. (18") stroke, and the driving wheels were 5'-0" diameter.

The engine weighed in working order without tender 11,750 kilogs. (11.5 tons).

Length of model over buffers (Engine and Tender) 900 m/ms. (2'-11 7/16").

Approximate weight of model 12 kgs. (26.44 lbs.).

SECTION 2. NO. 39.

FIRST FLOOR
BAY D.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

MODEL OF 2-4-0 TYPE LOCOMOTIVE "L'ELEPHANT", BELGIAN STATE RAILWAYS.

This model represents the third of an order for five locomotives which were built and delivered by R. Stephenson & Co., Newcastle on Tyne, in July 1835, for the Belgian State Railway. These five locomotives were the first to be used on the Belgian Railway. The engines had inside cylinders 356 m/ms. (14") diameter × 558 m/ms. (22") stroke; and the driving wheels were 5'-0" diameter.

Length of model over buffers (Engine and Tender) 1,010 m/m. (3'-3.¾").

Approximate weight of model 18 kgs. (39.67 lbs.).

SECTION 2. NO. 40.

FIRST FLOOR
BAY C.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

MODEL OF ROYAL COACH—1835, BELGIAN STATE RAILWAYS.

This model represents the 6 wheeled Royal Coach built in 1835 for the Belgian State Railway and is interesting from a historical point of view.

Length of model 620 m/ms. (2'-0.3¾") over buffers.

Approximate weight of model 5 kilogs. (11.02 lbs.).

It is interesting to note that the original on which this model is based formed part of the first stock in use on the Belgian Railways.

MODEL OF HORSE BOX. — BELGIAN STATE RAILWAYS.

This model of a four-wheeled Horse Box shews the style of rolling stock first used on the Belgian State Railways. The original was built about 1835.

Length of model 370 m/ms. ($1'-2\frac{9}{16}"$).

Approximate weight of model 1 kilog. (2.2 lbs.).

MODEL OF BAGGAGE WAGON. BELGIAN STATE RAILWAYS.

The original of this model formed part of the first rolling stock used on the Belgian State Railways. It was a flat truck provided with a tarpaulin cover, and was built about 1835.

Length of model over buffers 350 m/ms. ($1'-1\frac{3}{4}"$).

MODEL OF 5 TON FLAT WAGON. BELGIAN STATE RAILWAYS.

A model of a 5 ton flat wagon built about 1835 for the Belgian State Railways.

The original wagon was part of the first goods stock used on the Belgian railway system.

Length of model over buffers 380 m/ms. ($1'-3"$).

MODEL OF "IRON DUKE" BROAD GAUGE LOCOMOTIVE.

This model represents the "IRON DUKE", one of a series of twenty-two engines built at the Swindon works of the G.W.R. between 1847-1851. These engines were of the broad gauge (7'-0) and ran on eight wheels, the drivers being 8'-0" and the carrying wheels 4'-6" diameter. As originally built the driving wheels had no flanges.

The cylinders were completely closed in and jacketed by the lower part of the smokebox. The slide valves were partially balanced by means of pistons in the common steam chest. The pistons worked inside a small cylinder open at the ends, and were coupled by links to the backs of the valves. The principal objections to this method were the rattling noise, and the danger of the link pins coming out and getting into the cylinders, and the wear of the balance piston rings, which caused leakage and consequent loss of the balancing effect. Subsequently ordinary unbalanced slide valves were substituted. All engines were fitted with Gooch's stationary link motion.

SECTION 2, NO. 41.

FIRST FLOOR
BAY C.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

SECTION 2. NO. 42.

FIRST FLOOR
BAY C.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

SECTION 2 NO. 43.

FIRST FLOOR
BAY C.
SCALE 1/10.
LENT BY THE
BELGIAN STATE
RAILWAYS, 1932.

SECTION 2, NO. 44.

FIRST FLOOR
BAY D.
LENT BY THE
GREAT
WESTERN
RAILWAY, 1932.

The boilers were domeless and steam was taken from a perforated pipe (Hawthorn's 1839 patent) which terminated at a regulator box in the smokebox. The regulator was of the slide valve type with pull-out handle. The wheels, including the 8'-0" drivers, were of wrought iron forged solid with the bosses. The revolving masses were balanced by weights in the rims of the driving wheels. In addition to the outside sandwich frames, there were inside plate frames, between the back of the cylinders and the front of the firebox casing, as well as a fifth frame or "centre stay" of the same length along the centre line of the engine. Each of the five frames had a bearing for the driving axle, but the carrying axles had bearings in the outside frames only. A simple inverted spring on each side carried the weight on the two leading axles.

The type remained with small modifications and higher steam pressures, the standard express engine on the broad gauge down to its abolition in 1892.

Principal Dimensions of Engine.

Gauge	...	...	...	...	...	...	...	...	...	7'-0"
Cylinders (2) diameter	...	...	...	...	...	...	...	...	...	18"
Cylinders—Stroke	...	...	...	...	...	...	...	...	...	24"
Wheels (diameter of driving)	...	...	...	...	...	...	...	...	...	8'-0"
Wheels (diameter of carrying)	...	...	...	...	...	...	...	...	...	4'-6"
Wheelbase total	...	...	...	...	...	...	...	...	...	18'-6"
Heating surface tubes 303—2" dia.	...	...	...	...	...	...	...	...	...	1647.4 sq.feet.
do. Firebox	...	...	...	...	...	...	...	...	...	142.8 "
do. Total	...	...	...	...	...	...	...	...	...	1790.2 "
Working pressure	100 lb. per sq. inch afterwards increased to 120 lb									
Tractive effort (taking 85 % working pressure)	...	...	...	...	...	...	...	...	...	4165 lb.
Weight on driving wheels in working order	...	...	...	...	...	...	...	...	...	12.3 ton.
Total weight in working order	...	...	...	...	...	...	...	...	...	35.5 "

SECTION 2. NO. 45.

FIRST FLOOR
BAY C.
SCALE 1/16.
LENT BY
THE LONDON,
MIDLAND &
SCOTTISH RLY.
CO., 1932.

MODEL OF FOUR-CYLINDER COMPOUND LOCOMOTIVE "DIAMOND JUBILEE" L.N.W.R. — 1897.

This model represents a four-cylinder Compound Express Passenger Locomotive, built at the Crewe Works of the London and North Western Railway, to the designs of Mr. F.W. Webb, in 1897.

The engine is of the 4-4-0 type with all four cylinders in line under the smokebox. The outside high pressure cylinders were 15" diameter by 24" stroke, and the inside low-pressure cylinders 19.1/2" by 24".

The cylinder ratio was 1.69, but the low-pressure cylinders were found to be too small, and were subsequently enlarged to 20.1/2" diameter. The cylinder ratio now became 1.87. The valve gear was Joy's operated from the inside connecting rods only, and one set of motion drove both high pressure and low-pressure valves on each side of the engine. The inside low-pressure valve spindle was carried through the steam chest, and attached to a horizontal rocking lever in front, the other end of which actuated the outside high-pressure valve spindle. The points of cut off in both cylinders were therefore interdependent. Piston valves were used for the high pressure cylinders, and balanced slide valves for the low-pressure cylinders. The boiler had a normal heating surface of 1,401 square feet, the firebox with water bottom, included about 40 square feet of false heating surface. The working pressure in the first engine of this class was 175 lbs. per sq. inch, but in subsequent engines was raised to 200 lbs. per sq. inch.

The coupled wheels were 7'-1", and the truck wheels 3'-9" diameter, wheel base 23'-2". The total weight in working order was 54.4 tons of which 35.5 tons were on the coupled wheels. The inside and outside cranks on the same side were at 180°, so that the reciprocating masses practically balanced each other. The outside revolving masses were balanced in the large wheel bosses, which were cored out, and there were no balance weights in the rims. The inside revolving masses were balanced by extensions of the crank web slabs, the crank axle being of the built up pattern. The inside crank pins were hollow 7.3/4" diameter with a 2" hole drilled through them. The coupling rods, 9'-8" in length, were then the longest in use.

The leading end was carried on a four-wheeled radial truck. A double chimney was fitted to the first engine of the class, but was afterwards discarded. Forty engines similar to the above were built down to the end of 1900.

MODEL OF "FLYING SCOTSMAN" LOCOMOTIVE L.N.E.R.

This model represents the "Flying Scotsman" Express Passenger Locomotive, built to the designs of Mr. H.N. Gresley, and originally introduced by him on the Great Northern Railway in 1922.

At the time those engines were first put into service, they constituted a considerable advance on previous British practice in locomotive design. They are now the standard express passenger engines of the L.N.E.R. and regularly haul trains between Kings' Cross and Waverley Station, Edinburgh, a non-stop run of 392.7 miles, which is the longest run without a stop made by a locomotive in regular service in Great Britain.

SECTION 2. NO. 46.

FIRST FLOOR
BAY F.
SCALE 1/12.
LENT BY THE
LONDON AND
NORTH
EASTERN
RLY. CO., 1932.

The locomotive is of the Pacific (4-6-2) type with three cylinders simple, all driving the second coupled axle. The two outside cylinders are horizontal, and on the driving axle centre line. The inside cylinder is further to the rear, and is inclined at 1 in 8, so that the rod may clear the first coupled axle. The piston valves are 8" diameter, and are horizontal and in the same plane. The outer valves are driven by Walschaerts gear; while the inner valve is operated from them by the Gresley rocking lever system. The earlier engines of this class had 20" cylinders, and worked at 180 lbs. per sq. inch, the total weight of the engine being 92.45 tons. In the later engines of 1928 the cylinder diameter was reduced to 19" and the working pressure increased to 220 lbs. per sq. inch, the weight of the engine being 96.25 tons.

Principal Dimensions of Engine:

Gauge	4'-8.½"
Type	4-6-2
Cylinders (3) diameter	19"
Cylinders—stroke	26"
Wheels (diameter of coupled)	6'-8"
Wheels (diameter of bogie)	3'-2"
Wheels (diameter of pony)	3'-8"
Wheelbase, rigid	14'-6"
Wheelbase, total	35'-9"
Heating surface, tubes 168-2.¼ dia.	1880 sq. feet
Heating surface, superheater flues 32-5.¼" dia.	835 sq. feet
Heating surface, firebox	215 sq. feet
Superheating surface	525 sq. feet
Heating Surface, total	3455 sq. feet
Grate Area	41.25 sq. feet
Working pressure	220 lb. per sq. in.
Tractive effort (taking 85% working pressure)	22,450 lb.
Total weight (in working order)	96.25 tons

Principal Dimensions of Tender:

Water capacity	5000 gallons
Fuel capacity	9 tons
Diameter of wheels	4'-2"
Wheelbase	16'-0"
Total weight (in working order)	62.4 tons
Total wheelbase of Engine and Tender	60'-10.5/8"
Total weight of engine and tender (in working order)	158.65 tons
Overall length of Engine and Tender (over buffers)	70'-5.1/8"

MODEL OF "LORD NELSON" LOCOMOTIVE SOUTHERN RAILWAY.

SECTION 2. NO. 47.

FIRST FLOOR
BAY F.
LENT BY
SOUTHERN
RLY. CO. 1932.

This model represents the "Lord Nelson" Express Passenger Locomotive, built to the designs of Mr. R.E.L. Maunsell, Chief Mechanical Engineer of the Southern Railway, and built at the Eastleigh Works in 1926.

The locomotive is of the 4-6-0 type; with four simple-expansion cylinders. The inside cylinders are placed slightly in advance of the outside ones, and are formed in one casting with their piston valve steam chests above them. These cylinders drive the crank axle of the first coupled wheels, and steam distribution to them is affected by separate inside Walschaerts valve motions actuated by single eccentrics. The outside cylinders are separate castings integral with piston valve steam chests, and these drive the middle pair of coupled wheels, steam distribution in this case being performed by outside Walschaerts gearing having the usual arrangement of return cranks. The engine is capable of handling heavy express passenger trains of 500 tons at an average speed of 55 m.p.h. and at the time it was built (1926) ranked as the most powerful passenger engine in Great Britain.

Principal Dimensions of Engine.

Gauge	... ..	4'-8.1/2"
Type	... ..	4-6-0
Cylinders (4) diameter	... ..	16.1/2"
Cylinders—stroke	... ..	26"
Wheels (diameter of coupled)	... ..	6'-7"
Wheels (diameter of bogie)	... ..	3'-1"
Wheelbase, rigid	... ..	15'-0"
Wheelbase, total	... ..	29'-6"
Heating surface, tubes	... ..	1282 sq. feet
Heating surface, superheater tubes	... ..	513 "
Heating surface, firebox	... ..	194 "
Heating surface, total	... ..	1989 "
Grate area	... ..	33 "
Working pressure	... ..	220 lb. per sq.in.
Tractive effort (taking 85 % working pressure)	... ..	33,500 lbs.
Weight on coupled wheels (in working order)	... ..	61.95 tons
Total weight (in working order)	... ..	83.5 tons

Principal Dimensions of Tender.

Water capacity	... ..	5000 gallons
Fuel capacity	... ..	5 tons
Diameter of wheels	... ..	3'-7"

Wheelbase	19'-0"
Total weight, (in working order)	56.7 tons
Total wheelbase of engine and tender...	60'-9"
Total weight of engine and tender (in working order)	140.2 tons
Overall length of engine and tender (over buffers)	69'-9.¾"

SECTION 2. NO. 48.

FIRST FLOOR
BAY F.

LENT BY
LONDON,
MIDLAND AND
SCOTTISH, RLY.,
1932.

MODEL OF "ROYAL SCOT" LOCOMOTIVE. L.M.S.

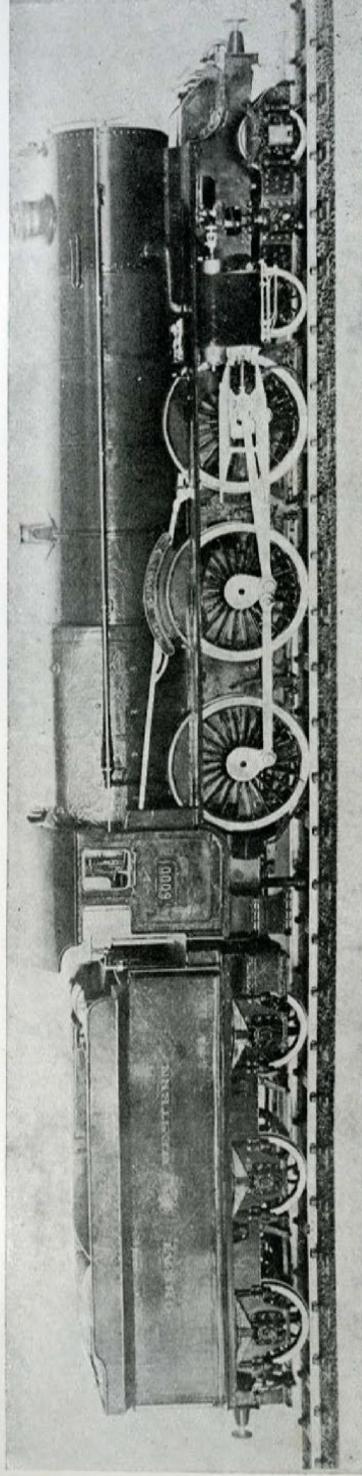
This model represents the "Royal Scot" Express Passenger Locomotive, built to the designs of Sir Henry Fowler, by the North British Locomotive Co. Ltd., Glasgow, in 1927.

The Locomotive is of the 4-6-0 type, with three cylinders, simple. It is capable of hauling, without assistance, heavily loaded trains over the whole line between London and Glasgow.

On the journey between London and Glasgow the engine has hauled a load of 450 tons behind the tender, at an average speed of 53 miles an hour, with a coal consumption of 2.92 lb. and a water consumption of 24 lb. per draw-bar H.P. The outside cylinders drive the second coupled axle, while the inside cylinder drives the first coupled axle. The piston valves are each operated by an independent Walschaerts gear.

Principal Dimensions of Engine.

Gauge	4'-8.½"
Type	4-6-0
Cylinders (3) diameter	18"
Cylinders, stroke	26"
Wheels, (diameter of coupled)	6'-9"
Wheels, (diameter of bogie)	3'-3.½"
Wheelbase, rigid	15'-4"
Wheelbase, total	27'-6"
Heating surface, Tubes 180-2" diam.	1366.5 sq. feet.
Heating Surface—Superheater Tubes, 27-5.¼" diam.	525.5 "
Heating surface, Firebox	189 "
Heating, Total	2081.0 "
Grate Area	31.2 "
Working pressure	250 lb. per sq. in.
Tractive effort, (taking 85% working pressure)	33,150 lb.
Weight on coupled wheels, (in working order)	62.5 tons
Total weight, (in working order)	84.9 tons



Model of 4-6-0 Type Express Passenger Locomotive
"King George V".

Great Western Railway, England.
Built to the designs of C.B. Collett, Esq. When this
engine was built in 1927, it ranked as the most powerful
locomotive in the British Isles.

أموذج قاطرة ركاب اكسبريس نوع ٤/٦-٠
« الملك جورج الخامس »

السكة الحديدية الغربية العظمى بإنجلترا
صنعت طبقاً لتصميم ل. ب. كولت—صنعت هذه القاطرة في سنة ١٩٢٧ كانت
معتبرة أقوى قاطرة في الجزر البريطانية

Principal Dimensions of Tender.

Water capacity... ..	3500 gallons
Fuel capacity	5.5 tons
Diameter of wheels... ..	4'-3"
Wheelbase	13'-0"
Total weight, (in working order)	42.7 tons
Total weight of engine and tender, (in working order)	127.6 tons
Overall length of engine and tender, (over buffers)	63'-2.¾"

MODEL OF "KING GEORGE V" LOCOMOTIVE, G.W.R. 1927.

This model represents the "King George V" an express passenger locomotive of the "KING" class, built to the designs of Mr. C.B. Collett, O.B.E., the company's Chief Mechanical Engineer, at the Swindon works of the G.W.R.

The locomotive is of the 4-6-0 type with four cylinders simple. The engine is capable of hauling unassisted a train weighing 360 tons over the heavy gradients on the South Devon section of the G.W.R. At the time this engine was built (1927) it ranked as the most powerful locomotive in the British Isles, having a tractive effort of 40,300 lbs. at 85 per cent of the boiler pressure. A standard 16-unit Swindon Superheater is fitted and a top feed is attached to the safety valve casing.

The inside pair of cylinders drive the first coupled axle, while the outside pair are placed further back and drive the second coupled axle. The piston valves are 9" diameter, situated above the cylinders, the inside pair being driven by Walschaerts gear, and the outer pair by rocking levers pivoted on the frames. The original engine was exhibited in America, at the Centenary Exhibition of the Baltimore and Ohio Railway, where it excited unusual interest.

Principal Dimensions of Engine.

Gauge	4'-8.½"
Type	4-6-0
Cylinders (4) diameter	16.¼"
Cylinders—Stroke	28"
Wheels (diameter of coupled)	6'-6"
Wheels (diameter of bogie)	3'-0"
Wheelbase, rigid	16'-3"
Wheelbase, Total	29'-5"
Heating surface, Total	2514 sq. feet
Grate area	34.3 sq. feet
Working pressure	250 lb. per sq.in.
Tractive effort (taking 85% working pressure)	40,300 lb.
Weight on coupled wheels (in working order)... ..	67.5 tons
Total weight (in working order)... ..	89 tons

SECTION 2. NO. 49.

FIRST FLOOR
BAY F.
LENT BY
MR. PROTHERO,
1932.

Principal Dimensions of Tender.

Water capacity... ..	4000 gallons
Fuel capacity	6 tons
Diameter of wheels	4'-1.½"
Wheelbase	15'-0"
Total weight of tender (in working order) ...	46.7 tons
Total wheelbase of engine and tender... ..	57'-5.½"
Total weight of engine and tender (in working order)	135.7 tons
Overall length of engine and tender (over buffers)	68'-2"

SECTION 2. NO. 50.

FIRST FLOOR
BAY E.
LENT BY THE
LONDON AND
NORTH EASTERN
RLY. CO., 1932.

MODEL OF "No. 10,000" EXPERIMENTAL HIGH-PRESSURE COMPOUND LOCOMOTIVE. — L.N.E.R.

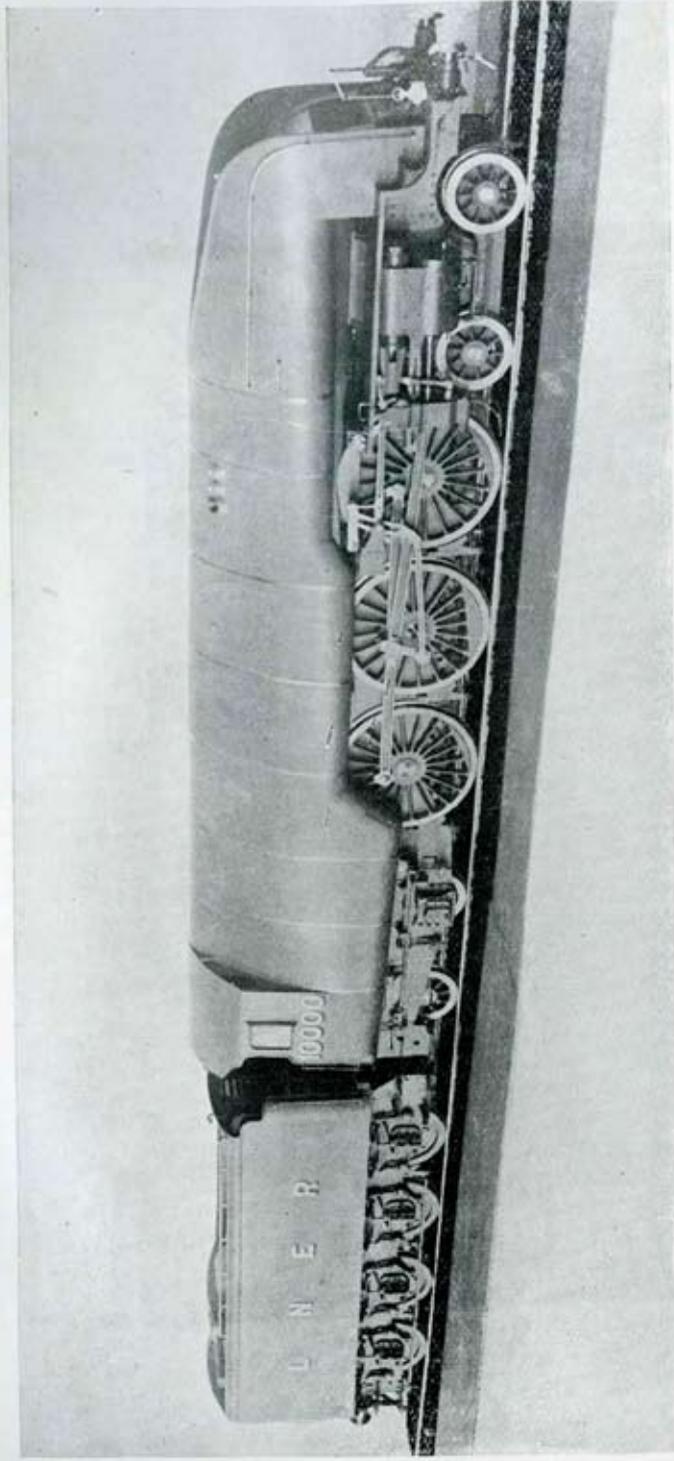
This model represents a 4-6-4, high-pressure compound locomotive, designed by Mr. H.N. Gresley, and built at the Darlington works of the L.N.E.R. in 1929.

The boiler is of the water tube type, and carries a pressure of 450 lb. per sq. inch; it was patented in 1928 by Mr. Gresley, in conjunction with Mr. H.E. Yarrow and was built by Messrs. Yarrow & Co. Ltd., Glasgow.

It has one top steam drum 3'-0" inside diameter by 27'-11.5/8" long, and two water drums on either side of the firebox, each 1'-6" in diameter and 11'-0.5/8" long, and two other drums under the forward part of the boiler each 1'-7" in diameter and 13'-5.3/4" long. The forward drums are connected to the steam drum by 444.-2" tubes and 74-2.5/8" tubes. The drums at the side of fire grate are connected to the steam drum by 238-2.1/2" tubes and there is a back screen of 12-2.1/2" tubes. All the drums are solid forged and machined all over. The Superheater is of a special form supplied by the Superheater Co. Ltd., London, and is fitted in the main flue on the boiler side of the regulator, so that the elements are always under full steam pressure.

The elements are connected to two forward headers located immediately in front of the water tubes.

Air for combustion is pre-heated by being passed from the smokebox end between the outer lagging and the boiler casing, while the front end casing is specially shaped to deflect the smoke and steam well above the cab. The high-pressure inside cylinders are placed well forward and drive the first coupled axle, while the low-pressure outside cylinders drive the second axle. The piston valves of all cylinders are driven by the Walschaerts gear fitted to the outside pair, the inside valves being operated by rocking



Model of High-pressure Compound Locomotive.—No. 10,000.
London and North-Eastern Railway.

Built to the designs of H.N. Gresley, Esq., in 1929.

النموذج قاطرة ذات ضغط عال مركب
سكان حديد لندن والشمال الشرقي
صنعت طبقاً لتصميم ه.ن. جرزلي في سنة ١٩٢٩

shafts, the arms of which are provided with a means of varying the valve travel and cut off independently. At starting, steam limited to 200 lb. pressure can be admitted to the low-pressure cylinder; this is shut off immediately the engine has got away.

Principal Dimensions of Engine:

Gauge	...	...	...	...	...	...	4'-8.1/2"
Type	...	...	...	...	...	...	4-6-4
Cylinders H.P. Ins. (2) diameter	...	...	...	...	...	...	10"
Cylinders L.P. Outs (2) diameter	...	...	...	...	...	...	20"
Cylinders (H.P. and L.P.) stroke	...	...	...	...	...	...	26"
Wheels (diameter of coupled)	...	...	...	...	...	...	6'-8"
Wheels (diameter of pony)	...	...	...	...	...	...	3'-2"
Wheels (diameter of bissell)	...	...	...	...	...	...	3'-2"
Wheelbase, rigid	...	...	...	...	...	...	14'-6"
Wheelbase, total	...	...	...	...	...	...	26'-6"
Working pressure	...	...	...	...	...	...	450 lb. per sq.in.
Tractive effort (taking 85% working pressure)	...	...	...	...	...	...	32,000 lb.
Weight on coupled wheels (in working order)	...	...	...	...	...	...	62.5 tons
Total weight (in working order)	...	...	...	...	...	...	103.6 tons

Principal Dimensions of Tender:

Water capacity	...	...	...	...	...	...	5000 gallons
Fuel capacity	...	...	...	...	...	...	9 tons
Diameter of wheels	...	...	...	...	...	...	4'-2"
Wheelbase	...	...	...	...	...	...	16'-0"
Total weight (in working order)	...	...	...	...	...	...	62.4 tons
Total wheelbase of Engine and Tender	...	...	...	...	...	...	64'-3.1/8"
Total weight of engine and tender (in working order)	...	...	...	...	...	...	166 tons
Overall length of Engine and Tender (over buffers)	...	...	...	...	...	...	75'-3.7/8"

The original engine is the largest passenger locomotive so far constructed for service in Great Britain.

MODEL OF "SENTINEL-CAMMELL" STEAM RAIL CAR.

This model represents a standard "Sentinel-Cammell" gear-driven Steam Rail Coach, for use on suburban lines.

The propelling machinery consists of a vertical boiler fitted in the front driving compartment, which supplies steam to the engine located in the underframe, and the drive is transmitted to the wheels through a cardan shaft and gear-box mounted on the driving axle. The engine is of the 6 cylinder horizontal single acting type, of 6" bore by 7" stroke, arranged for working with superheated steam at 300 lbs. per square inch pressure. It gives 120 B.H.P. at 450 R.P.M. and is suspended in rubber bushings, so that no vibration can reach the passenger space. Control gear is provided at the rear of the coach so that it can be driven in the

SECTION 2. NO. 51.

FIRST FLOOR
BAY F.
SCALE 1/16
LENT BY
METROPOLITAN-
CAMMELL
CARRIAGE,
WAGON AND
FINANCE CO.
LTD., 1932.

reverse direction. There is seating accommodation for 64 passengers, and a luggage compartment. The vehicle is electrically lighted, and is vacuum braked.

KIOSK ENGINE No. 30, EGYPTIAN STATE RAILWAYS, 1862.

This exhibit is a combined engine and saloon, and was built by Messrs. R. Stephenson & Co. (Makers No. 1295). It was delivered in 1862, and was for H.H. Said Pasha's private use.

The outside cylinders are 9" diameter by 14" stroke and are placed behind the leading axle.

The steam chests are also outside the frames, and the slide valves are operated by outside Stephenson valve gear, driven from the axle of the single drivers, which are 5'-0" diameter.

The leading wheels are 3'-6" diameter, and the saloon is carried on a four-wheeled bogie having wheels 3'-6" diameter, the bogie wheelbase is 5'-6". The wheelbase between the leading and driving wheels is 9'-0.1/8", and the total wheelbase of the combination engine and saloon is 22'-6". The boiler barrel is 9'-2.1/2" long by 2'-11" diameter, and there were 98-1.3/4" diameter tubes giving a heating surface of 426.5 sq. feet. The firebox was of the round top type, and had a heating surface of 45.5 sq. feet, giving a total of 472 sq. feet; the grate area was 8 sq. feet, and the working pressure 140 lbs. per sq. inch.

The boiler was fed by a pump driven from the driving axle. A safety valve 3.1/2" diameter of the spring balance type was fitted on the dome. The engine and saloon was originally richly ornamented, much more so than now.

The engine, prior to 1896, stood for many years in the running shed at Boulac, but in that year the then Khedive decided to make use of it to convey him between his summer residence at Montaza and Ras-el-Tin Palace at Alexandria. After 1898 the engine was not so largely used as formerly was the case.

GOODS ENGINE. — 0-6-0 TYPE, No. 986.

This exhibit is one of 42 six-wheeled coupled goods engines supplied by Messrs. R. Stephenson & Co., between 1865 and 1868. The chief feature of these engines as built was the ornamental cast iron dome cover. There were two spring balance safety valves fitted on top of the dome.

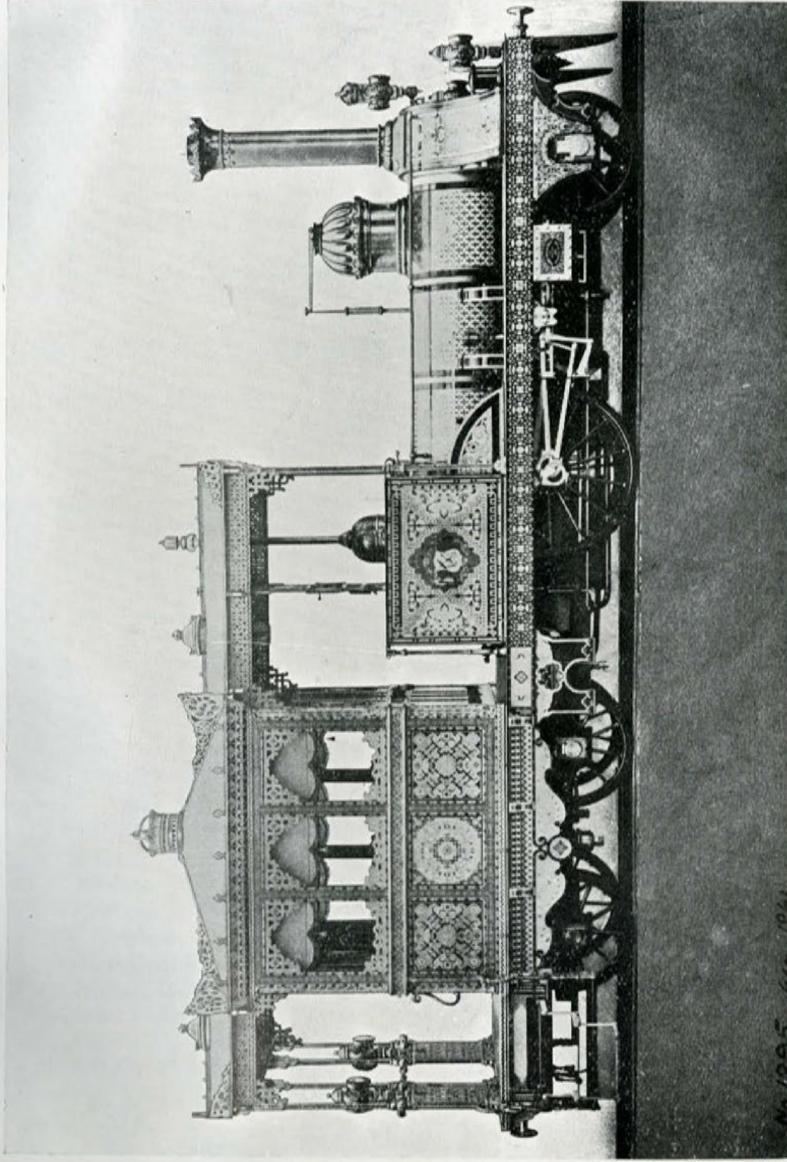
These engines had inside cylinders 16" diameter by 24" stroke, but the engine exhibited was one of many of this class which were almost completely rebuilt by Mr. Trevithick. The cylinders are now 17" diameter by 24" stroke with Stephenson motion. Very little of the original engine is now left, the inside frames, boiler, motion, cranks and coupling rods being entirely new when the engine was rebuilt.

SECTION 2. NO. 52.

GROUND FLOOR
(ANNEX).

SECTION 2. NO. 53.

FIRST FLOOR
(ANNEX).



Kiosk Engine—E.S.R.

Built by Robert Stephenson & Co. and delivered in 1862. This engine was for H.H. Said Pasha's private use.

وابور الكشك — سكك حديد الحكومة المصرية
 بناء الخواجات روبرت ستيفنسن وشركاه وتسلم سنة ١٨٦٢
 وكان هذا الوابور يستعمله الخفور له سعيد باشا
 في تنقلاته الخاصة

The boiler has a round top firebox, on top of which the safety valve is fitted. The total heating surface is 1,047.5 sq. feet, and that of the firebox 95.34, giving a total of 1,142.84 sq. feet.

The firebox grate area is 16.2 sq. feet, and the working pressure 140 lbs. per sq. inch.

The boiler was fed by injectors fitted on the firebox back-plate, delivering feed water through internal pipes.

The coupled wheels are 5'-1.1/4" diameter, and the wheelbase, leading to driving 8'-0", driving to trailing 8'-6", a total of 16'-6".

The frames are double.

The total weight of the engine in working order was 37 tons, of which 14 tons was in the driving axle.

The six-wheeled tender has a water capacity of 1,800 gallons, and a total weight in working order of 27 tons, giving 64 tons as the total weight of engine and tender.

Total wheelbase of engine and tender is 38'-2.1/4", and the overall length over buffers 50'-7.1/2".

MODEL OF FIRST CLASS SLEEPING CAR. — L.N.E.R.

This model represents a first class Corridor Sleeping Car, designed by Mr. H.N. Gresley, Chief Mechanical Engineer, L.N.E.R. and built at the Doncaster Works of the company.

There are ten sleeping compartments, and one shower bath compartment in each vehicle, together with the usual toilet and pantry accommodation.

With the exception of the corridors the whole of the interior decoration of the cars is carried out in "Stipplex" rexine. The material is blue near the floor, fading to cream at the corner, The ceilings and spandrels are also rexine covered.

Each bed consists of a "Vi-Spring" mattress on "Vibase" support, and is provided with blue blanket and bedspread to match the walls. The bed head and foot are of walnut.

The floor of each berth is covered with a blue and fawn carpet.

The interior fittings follow the company's standard practice, all metal fittings being chromium plated. A long mirror is fitted in each corridor door. Pressure ventilation is provided.

The L.N.E.R. was the first railway in Great Britain to fit a shower bath as part of the ordinary equipment of a train. The compartment is 4'-6" long x 6'-7.3/4" wide, and is lined with blue rexine; a shower cabinet 2'-1" square being provided. This is fitted with an overhead douche, a hand operated mixing valve being provided inside the cabinet for controlling the supply and temperature of the water. Stones water-raising apparatus provides the necessary pressure for the spray.

The whole of the hot water for the attendant's pantry, berth wash basins, and shower bath; is heated electrically, no gas being provided. The current is obtained from a 50 volt, axle-driven generator, the batteries being of the traction type.

SECTION 2. NO. 54.

FIRST FLOOR
BAY F.

SCALE 1/12.

LENT BY THE
LONDON AND
NORTH EASTERN
RLY. CO., 1932.

The hot water for the basins and for the shower is provided by separate heaters, auxiliary steam coils being provided for use during the winter.

The cars are carried on two four-wheeled bogies of special design to afford maximum comfort in running. All spaces in the body shell are packed with felt, and sponge rubber is provided under the carpets to eliminate noise.

The body work of the car is varnished teak. Vacuum brake equipment is fitted, two brake blocks acting on each wheel.

Automatic couplers of the standard L.N.E.R. type are fitted to each car.

Principal Dimensions.

Length over body	...	...	...	...	...	...	66'-6"
Width over body	...	...	...	...	...	...	9'-3"
Height overall	...	...	...	...	...	...	12'-10"
Weight	...	...	...	...	...	...	42.½ tons

SECTION 2. NO. 55.

FIRST FLOOR
BAY F.
SCALE 1/12.
LENT BY THE
LONDON AND
NORTH EASTERN
R.L.Y. CO., 1932.

MODEL OF CORRIDOR COMPOSITE FIRST AND THIRD CLASS CARRIAGE, L.N.E.R.

This model represents a Corridor Composite First and Third Class Carriage, built to the designs of Mr. H.N. Gresley, M.I.C.E., Chief Mechanical Engineer, L.N.E.R. These vehicles are units of the main line express trains, which run between Kings Cross, London, and Waverley Station, Edinburgh. There are three first class, and four third class compartments, each with a sliding door on the corridor side. Each compartment is fitted with racks for light luggage, a mirror, and photographs mounted in panels, of typical places of interest on the L.N.E.R. system.

The upholstery in the first class compartments is blue, and in the third class it is red.

A corridor runs along one side of the vehicle, and lavatories are located at each end of the carriage for first and third class passengers.

Each compartment is electrically lighted, a dynamo driven from an axle pulley and batteries supplying the current.

The bodywork of the coach is of varnished teak. The under-frame is of steel construction, the main longitudinal members being of channel section strengthened by round bar trusses, each of which is in three parts, connected together by two adjusting nuts screwed right and left hand. The bogies are of the four wheeled, compound bolster type, the frame being of pressed steel. Laminated bearing springs are fitted, and the wheels are of the solid disc type.

Vacuum brake equipment is fitted, two brake blocks acting on each wheel.

Automatic couplers, of the standard L.N.E.R. type are fitted to each car.

Principal Dimensions :

Length over body	61'-6"
Width over body	9'-0"
Height overall	12'-10"
Seating accommodation... ..	12-1st. class
Seating accommodation... ..	24-3rd. class
Weight	34 tons

MODEL OF BOGIE STEEL THIRD CLASS CARRIAGE, EGYPTIAN STATE RAILWAYS.

This model represents a bogie-third class carriage of all steel construction, built for the Egyptian State Railways by the Birmingham Railway Carriage and Wagon Co. Ltd.

The body of the carriage is of steel construction, built with its underframe to form one complete structure. Insulation is provided between the inner and outer body casings to ensure the vehicles being kept at an even temperature inside in either hot or cold weather. A number of these vehicles are provided with a Guards Brake compartment, in which is fitted a Vacuum Brake Valve and Vacuum Gauge, and a hand brake interconnected with the Vacuum Brake. The main compartment is fitted with the Egyptian State Railways standard design of seats for third class stock i.e. pitch pine strips fixed to steel frames.

The window frames and venetians are of teak, as are the doors. The end sliding doors are in halves and are hung on runners. The lavatory and brake compartment doors are hinged. The interior finishings are of simple style and durable material. The roofs double and fitted with ventilators.

The underframe is composed of longitudinal channels, stayed and braced by cross members and gussets. The headstocks are secured to the main frame by riveted knees and gussets.

Each vehicle is fitted with a dynamo driven from axle pulley, with batteries, for lighting the vehicle electrically.

The bogies are of standard Egyptian State Railway design, the frame plates are of pressed steel, with cast steel hornblocks riveted to the frame, and horn stays bolted thereto. The bolster is of pressed steel plates with cast steel centre and side bearers. The cross girders and the bolster are provided with wearing plates where they come in contact. The bolster side check springs are housed in steel castings, and the suspension links, hangers and rocking bars are of 40—45 ton steel.

The wheel centres are of pressed steel with tyres secured by a retaining ring. The axleboxes are of cast steel, and have journals 9" x 5".

The model has been made chiefly in aluminium, brass and steel, true to scale and complete in every respect, including the electric light equipment.

SECTION 2. NO. 56.

FIRST FLOOR
BAY D.-E.
SCALE 1/12.
PRESENTED BY
THE
BIRMINGHAM
RAILWAY
CARRIAGE &
WAGON CO.LTD.
1932.

The constructional details, pillars, carlines, bogie and under-frame pressings are exact copies of the actual members used for existing carriages on the Egyptian State Railways, and such details as buffers, drawgear, brake equipment are actually working replicas.

The moveable lights, louvres and sliding doors again have been faithfully copied and are complete in every detail.

The lavatory compartment is fitted up complete, also the brake compartment has an actuating wheel which effectively applies the brakeblocks to all wheels.

Principal Dimensions:

Length over buffers	...	...	...	...	...	69'-1.1/4"
Length over body	...	...	...	...	...	60'-3"
Centres of bogies	...	...	...	...	...	45'-0"
Bogie wheelbase	...	...	...	...	...	8'-0"
Diameter of wheels	...	...	...	...	...	3'-9"
Width over sides	...	...	...	...	...	9'-7.7/8"
Height from rail to top of roof	...	...	...	...	...	14'-2"
Seating accommodation...	...	...	...	...	...	104.
Tare	...	...	...	...	...	38 tons.

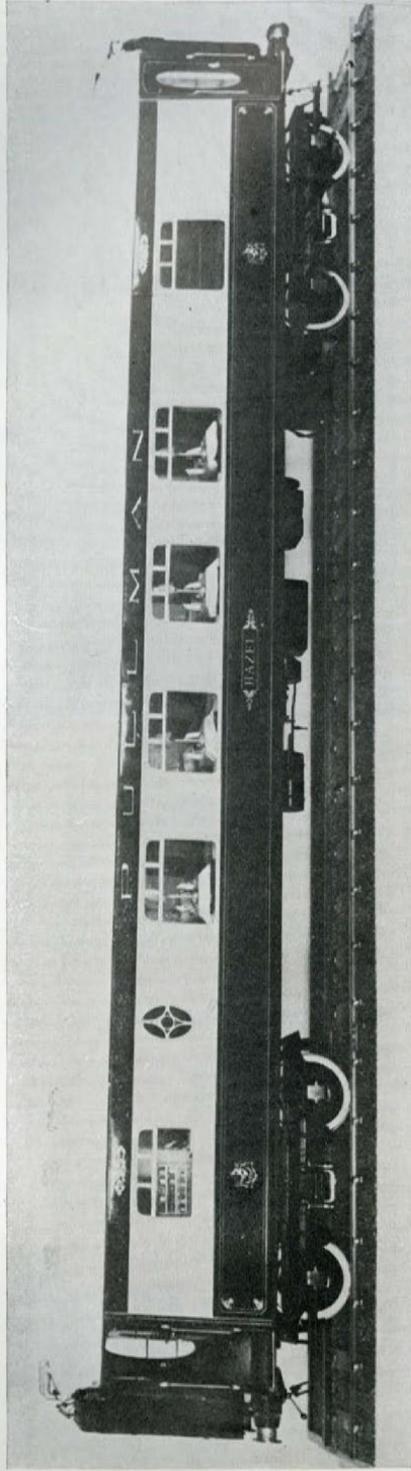
SECTION 2. NO. 57.

FIRST FLOOR
BAY D.-E.
LENT BY THE
METROPOLITAN-
CAMMELL,
CARRIAGE,
WAGON &
FINANCE CO.
LTD., 1932.

MODEL OF FIRST AND THIRD CLASS COMPOSITE PULLMAN CAR. — SOUTHERN RAILWAY.

This model represents the 1st. and 3rd. class composite Pullman Cars which will be used on the express services of the Southern Railway, between London and Brighton and Worthing, when the electrification has been completed.

The coaches are of all-steel construction, and the highest standard of comfort and finish have been adopted. Large side windows operated by patent balances are provided, the frames surrounding the windows on the outside being of Alpac aluminium alloy. The coaches are panelled with "Sundeala" millboard. Each car contains an all-electric kitchen for the provision of meals and light refreshment, and is fitted with a dynamo to supply current at low voltage for cooking, ventilating and other auxiliary purposes. Nickel-iron batteries for emergency lighting are provided. These vehicles have a length over body of 63'-6" and a width of 9'-0.5/8". The height from rail to top of roof is 12'-4.1/2", and the distance between the centres of the bogies is 44'-6" and each bogie has a wheelbase of 9'-0".



Model of First and Third Class Composite Pullman Car.
 "Hazel" — Southern Railway, England.

One of the coaches on the express trains on the newly
 electrified section of the Southern Railway, between
 London, Brighton and Worthing.

انموذج عربة بولمان مشترك درجة أول وثالثة

سكة حديد لندن الجنوبية

احدى عربات ركب قطارات الاكسبريس على القسم الكهربائى من السكة الحديد
 الجنوبية بين لندن وبريجهتون وورثنج

MODEL OF FIRST CLASS CARRIAGE "EXPERIENCE" LIVERPOOL AND MANCHESTER RAILWAY.

This model is representative of the first class passenger stock of the Liverpool and Manchester Railway. This type of vehicle was used in the early days of the history of this railway about 1830-1835. There are three compartments, with seating accommodation for 12 passengers in each. The seats and backs of the compartments are upholstered. All window frames are of mahogany.

The underframe is of wood and iron construction with cross and diagonal bracings.

A draw bar which runs the full length of the vehicle is fitted with screw coupling and a laminated draw spring. The buffer heads are padded and covered with leather.

Footsteps attached to the frame provided means of access of each compartment.

On the ends of the coach footsteps are fitted by means of which the roof was reached, luggage was carried on the roof and was prevented from falling off by the guard rails. The seats which are fixed on the coach ends were used to accommodate a man who acted as observer. The compartments were lighted by oil lamps fitted in the roof. The wheels were of wrought iron built up, as was the practice in those days.

MODEL OF MIXED TRAFFIC LOCOMOTIVE, AUXILIARY RAILWAYS, E.S.R.

This model represents a mixed traffic locomotive built by Beyer, Peacock & Co. Ltd., Gorton Foundry, Manchester. 14 engines of this class Nos. 24-37 entered the service in 1872.

The engine is of the 2-4-0 Tank Type with outside cylinders, which drive the crankaxle of the first coupled wheels. The valves are placed on the sides of the cylinders between the frames, and the valve gear is of the Stephenson Type. The Boiler is of the ordinary round top firebox type, and the engine is fitted with hand brake equipment.

Principal Dimensions of Engine.

Gauge	...	...	...	...	...	...	...	...	4'-8.1/2"
Type	...	...	...	...	...	...	...	...	2-4-0
Cylinders 2 (diameter)	...	...	...	...	...	...	...	...	12"
Cylinders—stroke	...	...	...	...	...	...	...	...	18"
Wheels (Diameter of coupled)	...	...	...	...	...	...	...	...	4'-2"
Wheels (Diameter of Pony)	...	...	...	...	...	...	...	...	2'-4"
Wheelbase, rigid	...	...	...	...	...	...	...	...	6'-9"
Wheelbase, total	...	...	...	...	...	...	...	...	15'-0"
Heating surface, tubes	...	...	...	...	...	...	...	...	475 sq. feet
Heating surface, firebox	...	...	...	...	...	...	...	...	59 sq. feet

SECTION 2. NO. 58.

FIRST FLOOR
BAY E.
LENT BY THE
LONDON,
MIDLAND &
SCOTTISH RLY.
CO., 1932.

SECTION 2. NO. 59.

FIRST FLOOR
BAY J.
SCALE 1/12.

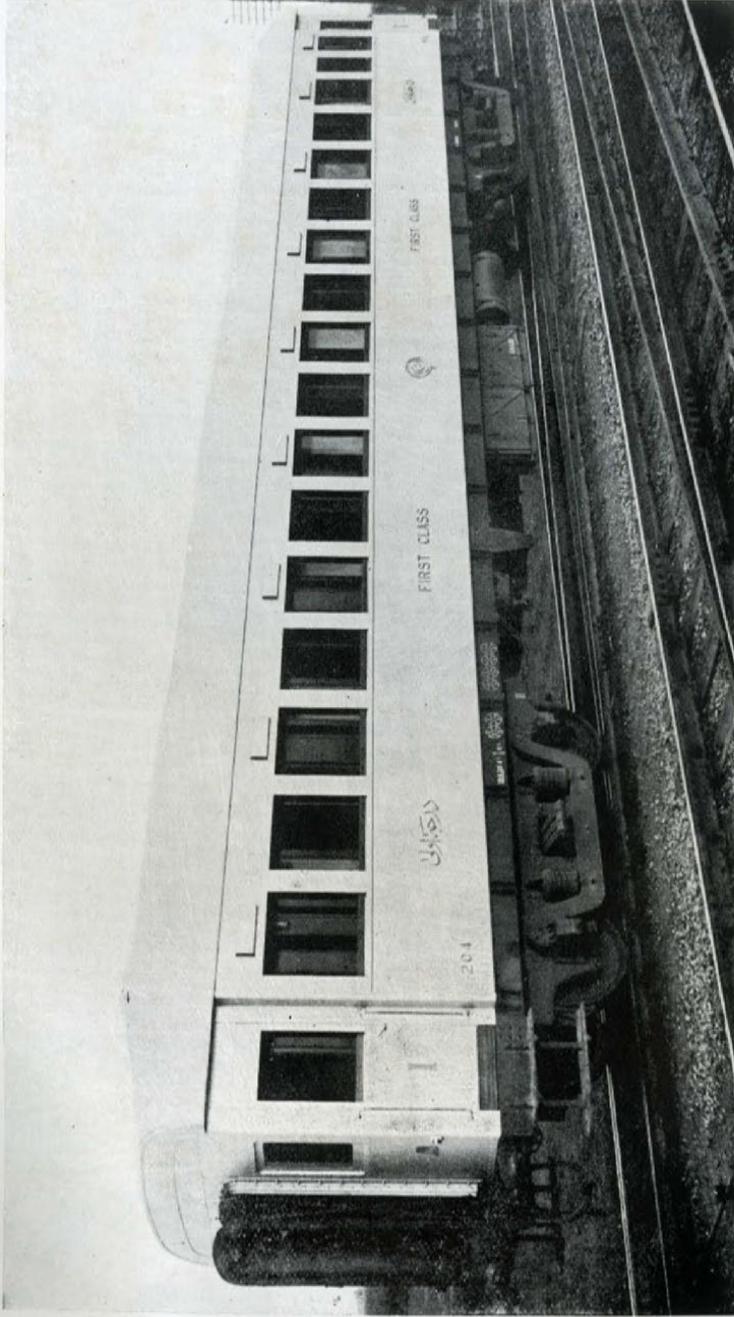
Principal Dimensions of Engine (continued).

Heating surface, total	534 sq. feet
Grate Area	10.8 sq. feet
Working pressure	140 lb. per sq. in.
Tractive effort	6,160 lbs.
Weight on coupled wheels	18 tons
Total weight	24 tons

Principal Dimensions of Tank.

Water capacity	455 gallons
Fuel capacity	$\frac{3}{4}$ ton
Overall length of engine (over buffers)	25'-2"





Bogie All-Steel 1st Class Coach, E.S.R.
The most modern vehicle of this class.

عربة ركاب درجة أولى بوجي من الصلب — سكة حديد الحكومة المصرية
هذا أحدث نوع من هذه العربات

SECTION 3.

LOCOMOTIVE AND ROLLING STOCK DETAILS.

MODELS OF STEEL FLANGED FIREBOX PLATES.

These two models shew typical steel flanged plates, for a locomotive firebox of the Belpaire type.

- (a) Firebox Throatplate.
- (b) Firebox Backplate.

TESTED E.S.R. No. 2, TYPE WAGON AXLEBOX. ORDER E.S.R. MECH. 3128. EGYPTIAN STATE RAILWAYS.

This sample axlebox is one similar in all respects to those supplied under the above order. It is of cast steel, unmachined, but was annealed and sand blasted. It was subjected to twelve blows from a 500 kgs.; (1,102 lbs.) tup falling from a height of 5 metres. It will be observed that the box after this test is in remarkably good condition. The test was made on the box when in the vertical or running position. The centre and back have been reduced in height by $\frac{3}{4}$ ". The sides of the guard grooves have been bulged out at the bottom $2\frac{3}{8}$ " and tilted in at the top $\frac{1}{4}$ ". The face of the front cover has been reduced $\frac{1}{2}$ " in height and bulged $1\frac{1}{8}$ " measured over the ears. The outside of the back of the box has been bulged $\frac{5}{8}$ ", measured across the centre and the inside of the box, at the back, bulged the same amount. The cover has been bent at the press through an angle of 95° without cracking. The bend took place across the cover with the lettering outwards.

STEAM PRESSURE GAUGE. — 6" DIAMETER, TO REGISTER UP TO 200 Lb. per sq. inch.

This exhibit shews a steam pressure gauge, manufactured by the Budenberg Gauge Co. Ltd. The gauge is of the Bourdon type, with all working parts independent of the case. The movement is fitted to a casting which also forms the screwed inlet fixing, thus all stress and risk of distortion when fixing are eliminated. All adjustments can be made from the back.

SECTION 3. NO. 1.

FIRST FLOOR
BAY H.
PRESENTED BY
ATELIERS DE LA
DYLE, 1932.

SECTION 3. NO. 2.

FIRST FLOOR
BAY H.
PRESENTED BY
USINES ET
ACIERIES
ALLARD, 1932.

SECTION 3. NO. 3.

FIRST FLOOR
BAY H.
PRESENTED BY
BUDENBERG
GAUGE CO. LTD.,
1932.

SECTION 3. NO. 4.

FIRST FLOOR
BAY H.
PRESENTED BY
BUDENBERG
GAUGE CO. LTD.,
1932.

STEAM PRESSURE GAUGE. — 6" DIAMETER WITH GLASS BACK TO SHOW INTERNAL PARTS.

This exhibit is fitted with a glass back to show clearly the internal parts. The gauge is of the Bourdon type, in which steam enters the screwed inlet fitting, through which it enters the elliptical section tube. The toothed rack is attached to the inner end of this tube by a link, and the steam pressure causes movement, i.e. the tube tends to become straight. A pinion with pointer attached is thus caused to revolve, and the pointer registers on the graduated dial the steam pressure. The graduations are made while the gauge is under test.

SECTION 3. NO. 5,

FIRST FLOOR,
SCALE 1/2 SIZE
PRESENTED BY
THE NORTH
BRITISH
LOCOMOTIVE
CO. LTD., 1932.

DEMONSTRATION MODEL OF WALSCHAERT VALVE GEAR.

This is a half size model shewing the principle of the Walschaert Valve Gear.

The model includes cylinder, piston, and steam chest and is marked off to show percentage of piston stroke. The crank disc is also marked in degrees whereby the crank angle may be noted for any position of piston or valve.

The valve is of the inside admission and outside exhaust type. The names engraved on the various parts are standard English terms. The inventor of this type of valve gear was Egide Walschaerts, Chief Shop Superintendent of the Brussels. Midi station and shops of the Belgian State Railways. The invention dates from 1844, but a patent could not be taken out in the inventors' name as the regulations of the Belgian State Railways Administration precluded the foreman of a shop from taking such out and deriving royalty from it. The patent therefore was taken out by M. Fischer, and was granted on 30th. November, 1844, and the mechanism described therein resembles the motion which is now so largely used. In Germany claims were put forward that Professor Heusinger von Waldegg had previously invented the gear, but the latter in a letter dated April 3rd. 1875, recognised the right of priority of Walschaert. In this gear the travel of the valve can be varied, whilst the lead remains constant. The motion of the valve is compounded of two distinct movements (1) that produced by the eccentric and curved link, which would give the valve the same motion as would be obtained from an eccentric set without angular advance: and (2) the motion produced by a connection with the crosshead which furnishes the required advance to the valve when the crank is on dead centre. The amount of lead depends solely upon the proportions of the arms of the lever uniting the crosshead to the valve spindle, and remains constant under all circumstances.

The Stephenson gear retained its popularity for a long time, but largely owing to the increase in size and power of locomotives, the Walschaert type which is more accessible, its component parts being outside the engine frames in an outside cylinder engine, came to the fore.

A very great point in its favour is the elimination of the friction of four eccentrics of very large size in modern engines. The return cranks used for outside cylinder engines produce hardly any friction. The steam distribution of the Walschaert gear is almost as good as that given by the Stephenson gear.

The first British locomotive to be fitted with Walschaert gear was an outside cylinder Fairlie tank engine on the Swindon-Marlbrough and Andover Railway 1881, and it remained the one solitary example for many years.

It has now however largely superseded the older Stephenson type all over the world.

ASBESTOS FROM THE RAW MATERIAL TO ITS VARIOUS COMMERCIAL FORMS.

This exhibit shews various commercial forms of asbestos including samples of:—

- (a) Asbestos yarn.
- (b) Asbestos cloth.
- (c) Asbestos metallic cloth.
- (d) Asbestos whitemetal cloth.
- (e) Proofed asbestos sheeting.
- (f) Asbestos packings.
- (g) Compressed asbestos fibre jointings.
- (h) Hydraulic packings.
- (j) Asbestos millboard.
- (k) Asbestos fibre rope.
- (l) Asbestos and India Rubber woven rings.
- (m) Balata belting.

Descriptive cards adjoin the samples.

LOCOMOTIVE BOILER TUBES IN VARIOUS STAGES OF MANUFACTURE.

This exhibit shews the sequence of manufacturing operations in the making of steel tubes for locomotive boilers.

- (a) Pierced tube billet in section.
- (b) Rolling process on billet (section).
- (c) Hot finished tube (as rolled).
- (d) Hot finished tube (pickled).
- (e) 1st. cold drawn pass.
- (f) 2nd. cold drawn pass.
- (g) 3rd cold drawn pass.

SECTION 3. NO. 6,

FIRST FLOOR
BAY H.
PRESENTED BY
MESSRS. LEWIS
HUNTER
& CO. LTD., 1932.

SECTION 3. NO. 7.

FIRST FLOOR,
BAY H.
PRESENTED BY
TUBES LTD.,
ASTON, BIRMIN-
GHAM, 1932.

**SECTION 3.
NO. 8.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
THE UNITED
STEEL
COMPANIES
LTD., 1932.

**SECTION 3.
NO. 9.**

FIRST FLOOR,
BAY H.
PRESENTED BY
VEREINIGTE
DEUTSCHE
METALLWERKE
A.G. (C.
HECKMANN)
1932.

- (h) Piece of 1.3/4" diameter x 12 G tube as drawn.
- (j) Piece of 1.3/4" diameter x 12 G tube as annealed.
- (k) Piece of 1.3/4" diameter x 12 G reduced at end.
- (l) Section piece of 1.3/4" diameter x 12 G tube reduced
- (m) Fractured tube, result of tensile test.
- (n) Crushing test on piece of tube.
- (o) Bulging test on piece of tube.
- (p) Flattening test on piece of tube.
- (q) Flanging test on piece of tube.
- 2 Samples of bush tubing.
- 2 Finished bush bearings.

**TYPICAL SPRINGS USED ON LOCOMOTIVE,
CARRIAGE AND WAGON STOCK.**

This exhibit shews typical springs as used on railway rolling stock, and comprises the following:—

- (a) Laminated Locomotive Bearing Spring, with ribbed and grooved plates, and solid eyes on the top plate.
- (b) Laminated Carriage Bearing Spring, with plain rectangular section plates, and rolled eyes on the top plate.
- (c) Laminated Wagon Bearing Spring, with ribbed and grooved plates, and plain ends.
- (d) Volute spring.
- (e) Spiral Spring, of rectangular section steel.
- (f) Spiral Spring, of round section steel.

**MECHANICAL TESTS ON
VARIOUS COMMERCIAL FORMS OF COPPER AND
MODELS OF COPPER FIREBOX PLATES.**

This exhibit, the samples of which are mounted on a board, shews mechanical tests on commercial copper, in the following forms:—

Tubes:—

- (a) Flattening and doubling over test (cold).
- (b) Flattening and doubling over (at red heat).
- (c) Flanging test.
- (d) Drifting test.
- (e) Tensile test on strip cut from tube.
- (f) Tensile test on piece of tube.

Rods:—

- (a) Tensile test.
- (b) Cold bend test.
- (c) Bend at red heat.
- (d) Hammering or crushing down test.

Hollow Stay Rods:—

- (a) Tensile test.
- (b) Thread test, i.e. screwed bar bent until ends touch.
- (c) Hammering or crushing down test.

Plates:—

- (a) Cold bend test.
- (b) Bend at red heat.

Models of finished copper firebox plates:—

- (a) Firebox wrapper plate.
- (b) Firebox tubeplate.
- (c) Firebox doorplate with dished rectangular firehole.
- (d) Firebox doorplate with flanged round firehole.

SECTIONAL MODEL OF EXHAUST STEAM INJECTOR.

This sectional model represents the class "H" Exhaust Steam Injector, as made by Messrs. Davies & Metcalfe, Ltd.

The Exhaust Steam Injector is a feed water heater which is, in principle, similar to the ordinary live steam injector, except that it utilizes exhaust steam from the cylinders to heat the feed water and also to force it into the boiler.

The class "H" Exhaust Steam Injector represents a considerable improvement on all former types. Automatic control valves are fitted which eliminate the hand controls necessary with previous types.

The injector is started by one operation only, viz: the opening of the valve to admit live steam to the injector. The only other manipulation necessary is the adjustment (when required) of the water regulator to vary the quantity of feed water supplied to the boiler.

The exhaust injector consists of three sections, viz: the injector, the exhaust valve and the automatic valve casings, which are bolted together to form one unit.

The injector casing contains the injector cones, the delivery back pressure valve, water, overflow and delivery connections and automatic overflow and water valves.

The exhaust valve casing contains the automatic exhaust steam valves, supplementary live steam cone, auxiliary live steam nozzle and exhaust steam pipe connection.

The automatic valve casing contains the automatic shuttle valve and the exhaust valve control piston, and live steam pipe connections to steam valve and to engine steam chest. It functions as a feed water heater so long as the locomotive is using steam, and when the engine regulator valve is closed it operates with live

SECTION 3. NO. 10.

FIRST FLOOR.
BAY H.
PRESENTED BY
MESSRS.
DAVIES &
METCALFE LTD.,
1932.

steam, automatically changing from exhaust to live steam working when the regulator is closed and back to exhaust steam working when the regulator is again opened.

The automatic change-over is controlled by the pressure in the steam pipe acting on an automatic valve, which shuts off the auxiliary live steam supply when exhaust steam is available.

Injector working with Exhaust Steam (engine regulator open).

The steam valve on the boiler is open, admitting live steam to the injector.

Steam enters and flows through the supplementary cone into the injector. The steam also passes at the same time to the lower side of the water valve control piston, forces this piston upwards, and so opens the feed water valve.

At the same time steam passes through the auxiliary steam choke into the shuttle valve chamber, and as the shuttle valve is already held on its lower seating, this allows the steam to flow to the upper side of the exhaust steam control piston and so open the exhaust steam valve.

Injector working with Live Steam (engine standing or drifting with closed regulator).

The regulator being shut, there will be no pressure on top of the shuttle valve, and the steam acting on its lower portion forces the shuttle valve on to its upper seating. This cuts off the supply of live steam to the exhaust control piston, allowing the exhaust steam valve to shut. At the same time the live steam passes the lower shuttle valve seating and so into the auxiliary nozzle, thus replacing the exhaust steam.

Live steam still enters the supplementary cone as before and the water valve is also still kept in the open position.

The exhaust steam before entering the injector is purified by passing through a grease separator fixed at any convenient place in the exhaust pipe line, preferably at its lowest point and near the injector.

SECTION 3. NO. 11.

FIRST FLOOR
BAY H.
LENT BY
HOFFMANN
MANUFAC.
TURING
CO. LTD.. 1932.

MODEL OF ROLLER AND BALL BEARING AXLEBOX.

This model shews a type of roller and ball bearing axlebox for Railway Rolling Stock, as manufactured by the Hoffman Manufacturing Co. Ltd.

Reference should be made to the full size coloured drawing of this axlebox, which clearly shews details of construction.

ROLLER BEARING.

This exhibit shews a standard type of Roller Bearing, as manufactured by the Hoffmann Manufacturing Co. Ltd. Roller bearings are now largely used in preference to ordinary journal bearings, principally for the following reasons. There is less loss of power on account of the lower co-efficient of friction, this being independent of the temperature of the bearings, unless the end thrust is excessive. On account of the excellent materials which are now available, and the manufacturing limits used in production, this type of bearing is largely superseding the plain bearing.

BALL BEARING.

This exhibit shews a standard type of Ball Bearing as manufactured by the Hoffman Manufacturing Co. Ltd. Ball bearings are used in preference to plain bearings, principally for the following reasons. There is less loss of power on account of the lower co-efficient of friction, the friction of a ball bearing is independent of the viscosity of the lubricant, or its temperature. The frictional resistance at starting is much less than in a plain bearing, while the wear is practically negligible.

SAMPLES OF SEAMLESS COPPER PIPES.

This exhibit shews samples of seamless solid drawn copper pipes, in 29 different diameters.

TESTED LOCOMOTIVE WHEEL CENTRE.

This exhibit shews the result of a destruction test on a cast steel wheel centre. This test consists of raising the wheel centre, as cast, to heights of 5 and 10 feet, and then allowing it to fall freely, in a running position, on the end of a spoke, on to a solid block of metal of not less than 5 tons weight.

The casting is then turned through 90° and again raised and allowed to fall freely in a running position through distances of 5 feet and 10 feet on the end of a spoke. Any sign of failure under this test renders the wheel centres liable to rejection. If fractures do not result from these tests, the test is continued, the fall being increased 5 feet each time until fracture results or the wheel centre is doubled up.

SECTION 3.

NO. 12.

FIRST FLOOR
BAY H.
LENT BY
HOFFMANN
MANUFACTURING
CO. LTD., 1932.

SECTION 3.

NO. 13.

FIRST FLOOR
BAY H.
LENT BY
HOFFMANN
MANUFACTURING
CO. LTD., 1932.

SECTION 3.

NO. 14.

FIRST FLOOR
BAY G.
PRESENTED BY
VEREINIGTE
DEUTSCHE
METALLWERKE
A.G.
(C. HECKMANN),
1932.

SECTION 3.

NO. 15.

GROUND FLOOR
(ANNEX).
PRESENTED BY
THE COLTNESS
IRON CO. LTD..
1932.

The casting exhibited was subjected to eleven drops as detailed below, and no sign of fracture took place before the 11th.

1st. drop	5 feet
2nd. drop	10 feet

Wheel turned through 90°:—

3rd. drop	5 feet
4th. drop	20 feet

Wheel turned to opposite 1st. position:—

5th. drop	15 feet
6th. drop	20 feet

Wheel turned to within one spoke of 1st. position:—

7th. drop	25 feet
8th. drop	30 feet
9th. drop	35 feet

Wheel turned to within one spoke of 2nd. position:—

10th. drop	35 feet
11th. drop	35 feet

At the 11th. drop the wheel fractured in two positions.

SECTION 3. NO. 16,

FIRST FLOOR
BAY H.
LENT BY THE
VACUUM BRAKE
CO. LTD., 1932.

“DREADNOUGHT” COMBINATION EJECTOR.

This exhibit is the “Dreadnought” Vacuum Brake Combination Ejector. The function of the ejector is to exhaust the air in the train pipe and cylinders. It is a combination of two air withdrawing appliances known as the “large” and “small” ejectors, the one placed within the other. The air as it is withdrawn is passed through an exhaust pipe into the locomotive chimney. The standard Dreadnought Ejector has a small ejector of 20 m/m. and the large of 30 m/m. as practice has proved that this is the largest combination that can be satisfactorily used on a 2 inch train pipe. The small ejector is left at work continuously, whilst the locomotive is attached to a train, to create and maintain a working amount of vacuum. The large ejector is used to quickly restore the vacuum after a stop, or to assist in rapidly creating the desired vacuum in other circumstances, such as just before starting with a train. The “Dreadnought” Ejector will work with pressures from 90 lbs. upwards and possesses the valuable feature of not requiring any fine regulation of the steam.

VACUUM BRAKE CYLINDER.

This is a 10" internal diameter combined cylinder for the Vacuum Automatic Brake. It is in part section to show details of construction.

The details are:—

- (1) Cylinder.
- (2) Piston.
- (3) Casing forming Vacuum Chamber.
- (4) Piston rod with brass sleeve.
- (5) Piston rod packing box.
- (6) Piston rod guide bush.
- (7) Piston rod cap.
- (8) Ball valve.
- (9) Rolling ring.
- (10) Joint ring.

When a vacuum has been created, that is when air to a certain amount has been withdrawn from the chamber (by means of the ejector) the weight of the brake gear causes the piston and rod to fall to the bottom of the cylinder and, by reason of the arrangement of the brake attachments, the blocks are with-held from the wheel tyres.

When by any means air is again admitted to the chamber, the vacuum is preserved on the upper side of the piston, whilst the inrushing air pressing on its under side raises it, in a degree proportionate to the amount of air admitted, the blocks being at the same time applied to the wheels to a corresponding extent.

The ball valve casting forms a junction between the cylinder and the short branch hose pipe which connects the train pipe and the cylinder.

The only moving part of this fitting is a small brass ball which, being free to roll in a horizontal plane, is practically frictionless. The ball is enclosed in a case with perforation to admit of the passage of air, and one end of the case is provided with a turned seating for the ball. When air is being abstracted from the cylinder, that from the top side of the piston, in response to the general sucking out which is going on; forces the ball from its seat and so escapes into the train pipe with that from the underside of the piston.

As soon, however, as air is again admitted to the train pipe, the inrush to the cylinder instantly forces the ball back to its seating, and thus no air passes to the top of the piston. As a consequence the vacuum is maintained above the piston, whilst the air pressing against the bottom side of the piston raises it and so applies the brakes.

SECTION 3. NO. 17.

FIRST FLOOR
BAY H.
LENT BY
VACUUM BRAKE
CO. LTD., 1932.

**SECTION 3.
NO. 18.**

FIRST FLOOR
BAY H.
LENT BY
THE VACUUM
BRAKE CO. LTD.,
1932.

GRADUABLE STEAM BRAKE VALVE.

This valve is designed for use in conjunction with the Automatic Vacuum Brake, when the engine or engine and tender are fitted with a Steam Brake, and its object is to apply the Steam Brake on the engine at the same time as the Vacuum Brake is applied on the train.

The operation of the steam brake valve is dependent on the reduction of a vacuum below a piston working in a cylinder, exactly in the same way as the piston in the vacuum brake cylinders throughout the train. When the driver of a train admits air into the train pipe, and so reduces the vacuum below the pistons, the difference of air pressure below the piston lifts them and pulls the blocks to the wheels of the train, the air is at the same time admitted below the piston of the steam brake valve. This then pulls on a lever which lifts the steam spindle, closing the exhaust and opening the steam valve to the steam brake cylinder which forces the blocks on to the engine wheels.

This valve can be operated by hand, when required or when the vacuum automatic brake is not in use, by means of the hand lever, which pulls on the spiral spring enclosed in the case, attached at one end to the hand lever, and puts pressure at the other on a lever, which through the medium of a 2 to 1 lever, controls the steam valve spindle. In this case the steam pressure on the piston is balanced against the degree of compression placed on the spiral spring.

The piston as it rises closes the exhaust passage which is open to the atmosphere, still rising it opens a small pilot valve, which admits steam to the bottom side of a piston guide beneath it, and so partially balancing the main steam valve, rising still further it lifts the main steam valve off its seat. Steam then passes to the steam brake cylinder.

When the hand lever is pulled out to the full extent and the pawl is in the last notch, the spring is fully compressed, and steam at boiler pressure is admitted to the steam brake cylinder.

**SECTION 3.
NO. 19.**

FIRST FLOOR
BAY H.
LENT BY THE
VACUUM BRAKE
CO. LTD., 1932.

RAPID ACTING VALVE FOR VACUUM BRAKE.

This exhibit shews the rapid acting valve used on the vacuum system of braking trains. The function of this valve is to apply the brakes on long trains, with great rapidity without either causing shocks or the parting of couplings through irregular braking.

The valve is mounted on the train pipe as near as possible to the brake cylinder and is connected to the ball valve by the usual flexible hose.

The valve exhibited is in part section so that the internal parts and construction may be seen.

GUARD'S VAN VALVE.

This sectional exhibit shews the valve which is fitted on the main train pipe in the guards' van.

The guard by pressing down the handle applies the brake. This valve opens automatically when the driver applies the brake suddenly, and admits air until the brake is fully applied.

COMBINATION LOCOMOTIVE INJECTOR.

This is a sectional example of an injector embodying features patented by Mr. J. Gresham in 1884 and 1887. It is a vertical, restarting injector of the self contained type, having all the control valves mounted on it, and is designed to be fitted directly to the boiler backplate by a flange through which both the steam supply and feed-water pipes pass.

The action of an injector depends upon the fact that the velocity of a jet of steam discharging into the combining cone is 20 to 25 times that of a jet of water issuing from a boiler under the same pressure and that the enormous reduction of the volume of the steam, during condensation by the water concentrates the momentum of the jet upon the area of the delivery tube, which is but a small fractional part of the orifice from which it issues, leaving a large margin of available energy. This action may be likened to a pump with a continuous piston equal to the area of the steam nozzle forcing a continuous ram equal to the lesser area of the delivery throat.

The action is as follows, an internal pipe from the dome of the boiler conveys steam to the injector steam valve, which upon being opened admits steam to the steam nozzle by the passage underneath it. The steam issuing from the steam nozzle forces open the combining cone which is free to slide in its guide and passes out freely through this opening to the overflow passage, and on to the overflow pipe of the injector.

In doing so it creates a partial vacuum in the pipe which supplies water from the tank, and the water rises to the injector. The water coming in contact with the steam, travels with it through the lifting cone and rapidly condenses it.

The velocity of the steam being now largely transferred to the water, the latter passes from the lifting cone and through the combining cone, (which moves down on its face, owing to the high vacuum created in the chamber under it, by the passage of the jet) and these two cones become one combining cone, i.e., the cone in which the steam and water combine. After passing through this combining cone the jet flows out at the overflow

SECTION 3. NO. 20.

FIRST FLOOR
BAY H.
LENT BY THE
VACUUM BRAKE
CO. LTD., 1932.

SECTION 3. NO. 21.

FIRST FLOOR
BAY H.
LENT BY MESSRS.
GRESHAM &
CRAVEN LTD.,
1932.

space, and down the passage and overflow pipe, until such time as it attains sufficient velocity to carry itself past this space and enter the delivery cone.

When it reaches this point its velocity is so great that it is sufficiently powerful to pass by the passage communicating with the back pressure valve, and lift this valve, and so enter the boiler.

**SECTION 3.
NO. 22.**

FIRST FLOOR
BAY H.
LENT BY
GRESHAM &
CRAVEN LTD.,
1932.

GRESHAM'S PATENT FEED WATER HEATER.

This exhibit is designed to heat the feed water which is fed into locomotive boilers. The water after passing through the clackbox entrains steam from the steam space, two sets of cones are fitted in which the injector action is repeated by steam from the steam space in the boiler. The steam is entrained through openings in the sides of the delivery casing and combines with the water with the result that the temperature of the water delivered is very little less than that of the saturated steam in the boiler.

**SECTION 3.
NO. 23.**

FIRST FLOOR
BAY H.
PRESENTED BY
ALEX.
FRIEDMANN
VIENNA, 1932

FULL SIZE SECTIONAL HORIZONTAL INJECTOR.

This exhibit, which is partly sectional, is a horizontal non-lifting restarting injector, class B Z with starter, manufactured by Alexander Friedmann. With the older forms of non-lifting injector, by far the greatest proportion of the overflow waste is caused by the fact that there is, as a rule, too long an interval between the opening of the water cock (or overflow valve) and the opening of the injector steam valve on the boiler. By means of the starter embodied in the class B Z injector, this interval, and hence also the overflow waste is reduced to a minimum. The starter consists of a piston and a valve located above it. While the locomotive is in service the water cock and the overflow valve of the injector remain open. The interior space of the injector is, therefore, always filled with water. So long as steam does not enter, the valve attached to the piston spindle prevents any escape of water from the injector. To start the injector it is only necessary to open the steam valve on the boiler. Steam flows through the port communicating with the starting piston and valve causing them to lift, so that the overflow water can escape. At the same time steam passes through two other ports, and the non-return valve, to the steam come. The time required by the steam to travel this distance being immeasurably short, only the superfluous amount of water accumulated in the injector casing will issue at the overflow, whereupon the injector will start immediately.

This class of injector is located under the cab footplate, the control spindles being operated from the cab.

SPECIMENS OF RAILWAY ROLLING STOCK PAINTING.

This exhibit shews three specimen panels of railway rolling stock painting. The left and right hand panels are of steel, and the centre one of wood.

The left hand panel is painted with Docker's Aluminium "Syntholux", and the treatment is:—

Primer,
Filler,
2 Coats of Aluminium "Syntholux".

The middle panel is painted with ordinary aluminium oil paint and varnish, and the treatment is:—

Primer,
Filler,
2 Coats of Aluminium.

The right hand panel is painted with Docker's Aluminium "Cellusol", and the treatment is:—

Primer,
Filler,
2 Coats of Aluminium "Cellusol".

Descriptive matter adjoins each panel.

SECTIONAL METALLIC PACKING.

This exhibit shews a full size United Kingdom Patent. Air Cooled Piston Rod Metallic Packing, for a 4" diameter piston rod.

This type of metallic packing was specially designed to meet the requirements of locomotives working with a high degree of superheat. Complicated castings, which are liable to split, owing to unequal expansion and contraction are avoided in this design.

The packing consists of three anti-friction metal rings, and a bronze cone ring, contained in a sleeve ring which has a conical seating on the stuffing box gland. A bronze neck ring is fitted in the outer end of this sleeve. A baffle ring fitted with a spiral spring is located at the inner end of the packing. This ring transmits the load due to the steam pressure, to the spiral spring which keeps the white metal rings tight against the neck ring. The whole packing is perfectly elastic, and prevents undue wear on the rods.

The main feature of this packing, is such that the air operating on the sleeve which contains the metal rings has double the effective cooling power of other types of packing for Superheated Steam. The whole is extremely simple and cannot be wrongly fitted.

Another important feature is that the complete pressure of the steam is prevented by the spring ring, from entering the stuffing box. By this means, the metal rings in the sleeve, which is air cooled, are less exposed to the full heat of the steam.

SECTION 3. NO. 24.

FIRST FLOOR
BAY H.
PRESENTED BY
DOCKER BROS.,
1932.

SECTION 3. NO. 25.

FIRST FLOOR.
BAY H.
PRESENTED BY
RAILWAY SIGNAL
CO. LTD., 1932.

**SECTION 3.
NO. 26.**

FIRST FLOOR,
BAY H.
PRESENTED BY
THE ARMSTRONG
OILER CO. LTD.,
1932.

"ARMSTRONG OILERS".

This exhibit shews "Armstrong Oilers" which are extensively used in the axleboxes of railway rolling stock.

The "Armstrong Oiler" consists of a specially woven pad attached to a light steel frame, supported by highly-resilient springs. All the pads are woven by the makers on specially designed looms. They are woven in such a manner as to ensure the points only of the pile lightly touching the journal when the oiler is in position. To obtain a sufficient and continuous supply of oil to the pad, cotton feeders are woven into it by a special process, so that after coming through the pad formation they lie between the rows of pile; no amount of top pressure can therefore impede the oil circulation. In order to prevent the possibility of undue top pressure lignum vitae buttons are embedded in the pad surface at intervals, and these, whilst not being sufficiently hard to cut the journal, prevent the pad pile from being flattened out and glazed. In this way the capacity of the pad for supplying oil to the journal surface remains unimpaired throughout. All springs are specially adjusted to give just the right amount of pressure, the design in each case being particularly adapted for the style of axle box, and journal for which the oiler is made. Once the oilers are placed in the axleboxes, with a small supply of oil, no further attention is required, except the addition of a little oil about every three months.

**SECTION 3.
NO. 27.**

FIRST FLOOR
BAY H.
PRESENTED BY
DEWRANCE &
CO. LTD., 1932.

WATER GAUGE.

This exhibit, which is sectioned, to shew details of construction, is Dewrance's Patent Water Gauge, of the type fitted to locomotive boilers.

Should the glass break under pressure the ball in the lower arm rises to its seat and cuts off the rush of water. When the upper arm is also required to be automatic, the patent spring valve shewn is fitted, should the glass tube break the sudden rush of steam closes the valve.

The spring however is strong enough to keep the valve from closing when blowing through; it is made of a special quality of bronze that is not injured by steam up to 300 lbs. pressure.

**SECTION 3.
NO. 28.**

FIRST FLOOR
BAY H.
LENT BY HASLER
TELEGRAPH
WORKS, 1932.

**SPEED INDICATOR AND RECORDER
FOR LOCOMOTIVES.**

This exhibit is an instrument for indicating the speed of a locomotive and the time and distance travelled; while it also makes a continuous record of speed, time, distance, and the duration of stops.

It is fitted with a 24-hours dial clock which indicates the time and records it, through suitable mechanism, by a silver stylus and a pricker on a roll of chrome paper 80 mm. wide,

which is moved by the engine mechanism through a distance of 10 mm. for each kilometre travelled; pricks are made 5 mm. apart along the edges and middle of the paper. The diagram occupies the upper part of the paper and is ruled with horizontal lines 5 minutes apart. The minute-marking stylus travels from bottom to top once every half-hour, drawing a sloping line while the engine is running and a vertical line when it is stationary; the fall of the stylus marks a vertical line every half-hour. The hours are marked by a pricker mounted behind the paper, and this rises once in 24 hours. From the hour pricks and the half hourly vertical lines the time and duration of stops are determined.

The dial speed indicator shows the speed up to 60 kiloms. an hour at intervals of one second, its mechanism being rotated intermittently by an escapement and clutch from the main drive. A second stylus records the speed on the lower part of the paper which is ruled at intervals of 10 kiloms. an hour. All stops are shown by the return of the speed curve to the base line. A counter records the total distance covered and also the length of the last trip.

MODEL OF STEAM RAIL CAR BOILER.

This model represents the patent double locomotive type of boiler, which is fitted to a number of steam rail cars, now running on the Egyptian State Railways.

The boiler is of the Double-Ended Locotype and is a development of a design of small high capacity boiler used for the past 30 years on steam road vehicles. For rail car work the boiler accommodates itself to take the maximum advantage of the space available and has proved itself very economical in maintenance.

The standard specification of the rail car boiler is as follows:—

Working pressure	... ..	275 lbs. per sq. inch.
Test pressure	... ..	375 lbs. per sq. inch.
Heating surface	... ..	134 sq. ft.
Superheater surface	... ..	15 sq. ft.
Grate area	... ..	6.68 sq. ft.

The tubes are 1 3/4" internal diameter and 1'-8 3/4" long. Only 16 stays are required, which are disposed in the firebox roof. The mild steel firebox is circular in section and has no stays in the box sides. The usual mudholes are provided for washing out, and also two inspection covers from the top of the boiler barrel.

The twin superheaters are disposed in the combustion chambers and are tested to 1,000 lbs. per sq. inch. The tubes can be swept without disturbing the superheaters.

It will be noted that from the design of the boiler the hot gases in the firebox divide into two portions and pass through the bottom layer of tubes into the combustion chambers, thence

SECTION 3. NO. 29.

FIRST FLOOR
BAY F.

PRESENTED BY
THE YORKSHIRE
PATENT STEAM
WAGON CO. LTD.,
1932.

past the twin superheaters and return through the top fire tubes to meet in a combustion chamber below the uptake, above which the exhaust jet is fitted.

The boiler normally operates at an evaporation of 2,500 lbs. per hour, but it can supply steam at over 3,000 lbs. per hour without undue forcing.

The firebox as designed operates on ordinary good quality locomotive coal, but modifications can be introduced to enable it to burn low grade coal, wood or oil.

The boiler as described is suitable for the "Yorkshire" 150 H.P., engine, but it can be supplied in other sizes for engines which range from 50 H.P. to 450 H.P.

This boiler has been standardized on the B.Y. Rail Cars manufactured by The Birmingham Railway Carriage and Wagon Co. Ltd., Smethwick, England, in conjunction with the Yorkshire Patent Steam Wagon Co. Ltd., Leeds, England.

SECTION 3. NO. 30.

FIRST FLOOR
BAY H.
PRESENTED BY
MESSRS. C.C.
WAKEFIELD &
CO. LTD., 1932.

MECHANICAL LUBRICATOR FOR LOCOMOTIVES.

This exhibit is a sectioned example of the multiple pump lubricator, patented by Lord Wakefield, for use on locomotives. It delivers oil under pressure to eight points simultaneously, the amount discharged to each point being capable of independent adjustment. The eight single acting pumps are arranged horizontally in two rows, outside the reservoir, four pumps on each side. The driving eccentric shaft is rotated slowly by a ratchet wheel and a lever connected with some reciprocating part of the engine (on Egyptian State Railways engines this lever is attached to the reversing link). When the pump plunger and sleeve valve are at the outer end of the stroke oil flows into the pump barrel through ports in the barrel of the pump. As soon as these ports are covered by the plunger and sleeve valve on the return stroke, the oil in the pump barrel is forced away under pressure to the outlets. If the oil regulating plug is screwed right down, the whole of the oil in the pump barrel will be forced away. By unscrewing this plug partly out, the adjustable plunger will be forced upwards under the oil pressure to the extent of the rise of the plug, and accommodate part of the oil, the remainder being forced away to the outlets. When the plunger and sleeve valve are again on the suction stroke, the adjustable plunger is drawn down by the vacuum in the pump barrel to its normal position, and the above described operation is repeated when the plunger and sleeve valve are on the pressure stroke.

The oil is delivered through the eight outlets to each piston valve head, the centre of each cylinder, and to the two piston rod glands on Egyptian State Railway locomotives.

BRONZE BLOW OFF VALVE.

This is a 1 1/2" bronze blow off valve, fitted with renewable discs and seats made of "Platnam" metal. The valve can be easily opened and closed under steam at high pressure, and is fitted with patent "Oplok" pinion which prevents straining the teeth on the rack and pinion.

It is fitted with an improved locking gland which prevents the key being removed whilst the valve is open.

SET OF BRONZE WATER GAUGES.

This exhibit is a set of bronze water gauges, with 5/8" diameter glass, of the type fitted to locomotive boilers. This water gauge is automatic in the bottom arm only, that is, when the gauge glass bursts, the pressure in the lower arm forces a ball valve on to its seat, thus shutting off the escape of water.

The steam is shut off by closing the cock on the top arm, when fitting a new glass both top and bottom cocks are shut. The try cock at the bottom drains the gauge. Safety plugs are fitted to the gauge cocks, it is impossible for these to be blown from the body in case of accident.

BRONZE GUARDS FOR WATER GAUGES.

These are bronze guards and clips for water gauges, and are applied to the gauges by brackets. The guards can be swung open when it is necessary to adjust the gland nuts, and new gauge glass or packing rings can be inserted, without detaching the guard from the gauge. The glasses are of special manufacture, toughened to withstand the blow caused by the bursting of the gauge glass.

PARALLEL SLIDE VALVE.

This exhibit is a patent parallel slide valve, made by Hopkinson's Ltd. The body is of cast steel, the renewable disc faces and seats are of "Platnam" metal which does not corrode or soften with the high temperature of superheated or high pressure steam. The valve faces are parallel, thus unnecessary and dangerous strains are avoided, and the valve is much easier to open and close than the wedge type. A light spring is fitted between the discs.

The disc is held to the seat by fluid pressure in the valve. The valve spindle has an acme thread, and the sliding crosshead acts as a stop and an indicator to show the position of the valve.

The gland can be repacked when the valve is under pressure. A fullbore uninterrupted passage is provided through the valve.

SECTION 3. NO. 31.

FIRST FLOOR
BAY H.
PERMANENTLY
ON LOAN FROM
HOPKINSON'S
LTD., 1932.

SECTION 3. NO. 32.

FIRST FLOOR
BAY H.
PERMANENTLY
ON LOAN FROM
HOPKINSON'S
LTD., 1932.

SECTION 3. NO. 33.

FIRST FLOOR
BAY H.
PERMANENTLY
ON LOAN FROM
HOPKINSON'S
LTD., 1932.

SECTION 3. NO. 34.

FIRST FLOOR
BAY H.
PERMANENTLY
ON LOAN FROM
HOPKINSON'S
LTD., 1932.

**SECTION 3.
NO. 35.**

FIRST FLOOR
BAY H.
PRESENTED BY
SKEFKO BALL
BEARING CO.
LTD., 1932.

**SECTION 3.
NO. 36.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
BROWN
BAYLEY'S.
STEEL WORKS
LTD., 1932.

**SECTION 3.
NO. 37.**

FIRST FLOOR
BAY H.
PRESENTED BY
S.A. EMILE
HENRICOT
COURT-SAINT
ETIENNE,
BELGIUM, 1932.

**SECTION 3.
NO. 38.**

GROUND FLOOR
BAY R.
SCALE-
FULL SIZE.

SECTIONAL ROLLER BEARING AXLEBOX.

This exhibit shews a roller bearing axlebox, used for railway rolling stock. It is in part section to shew details of construction. This type of axlebox has been successfully employed on leading and trailing bogies, tender bogies, and driving axles on steam, electric and Diesel-Electric locomotives.

Similar axleboxes are now fitted on some of the passenger rolling stock of the Egyptian State Railways.

RAILWAY CARRIAGE AND WAGON TYRES.

This exhibit shows two railway carriage and wagon tyres; one as rolled and the other tested together with test pieces.

The tyre as rolled is $3'-2\frac{1}{4}"$ inside diameter, and the test specified a deflection of $2\frac{7}{16}"$, the test consisted of five blows from a 1 ton tup, falling from a maximum height of 25 feet. The deflection obtained as a result of this test was $2\frac{13}{16}"$.

The tensile test pieces are shown in the unpulled and fractured state, the test results are given on the card adjoining the test pieces.

MODEL OF HENRICOT AUTOMATIC COUPLER.

This exhibit is a scale model of the Henricot Automatic Coupler for railway rolling stock. This coupler consists of a steel jaw, fitted on one side with a knuckle or L shaped lever turning upon a vertical pivot pin.

This knuckle when being swung inwards lifts a key which subsequently becomes lodged on a seat arranged in the interior of the coupler, and permits without further operating the uncoupling of the vehicles.

An identical coupler is fitted to the end of the adjacent vehicles, and so long as both or either of the knuckles are open when the vehicles come into contact, coupling will be affected. The coupler is so arranged that the key is prevented from lifting when in service, the coupler can only be opened by operating the lever.

MODEL OF JOY VALVE GEAR.

This model which was made in the Boulac Workshops of the Egyptian State Railways represents the Joy Valve Gear used on the three cylinder vertical engines of the Birmingham-Yorkshire Steam Rail Cars.

This gear was invented by Mr. David Joy, and has been largely used on locomotives. It is of the radial type, but employs no eccentrics.

The gear is simple in construction, and the points of lead and cut off are exactly equal for both ends of the cylinder, at all grades of expansion.

The valve (in the model this is of the piston type) opens more rapidly than when a link is used, whilst it moves slowly during expansion and exhaust. Motion is derived from a point on the connecting rod, which describes an oval curve, the vertical axis of which is usually rather greater than twice the valve travel. The vibrating link is guided by the rear anchor link, which moves on a pin attached to the top upper part of the engine casing. The lower end of this anchor link moves nearly on a horizontal line, bisecting at right angles the vertical axis of the curve described by the point where the vibrating link is attached to the connecting rod. The intermediate pin joint in the vibrating link also describes an oval curve the horizontal axis of which is the same as that of the curve described by the pin joint on the connecting rod, attached to the vibrating link at this intermediate pin joint is the valve oscillating link, this is guided by a die sliding in a radius guide which is pivoted at a point below the slot in the guide, and is controlled by the reversing rod.

The valve coupling link is attached at its bottom end to the end of the valve oscillating link, and at the top to the valve spindle socket. When the engine is running the die moves along the curved radius guide. By altering the position of the radius guide the valve obtains motions for forward or backward running, or for cutting off at any fraction of the stroke.

By means of the spur reducing gear the model may be operated to show the working of the mechanism.

SUPERHEATER ELEMENTS.— FOR LOCOMOTIVE BOILERS.

This exhibit shows stages in the manufacture of the Patent M.L.S. return bend, which is machine forged integrally with the tubing, giving standard wall thickness and constant maximum area. As a first step in this manufacture the two element tubes are clamped together at fixed centres, the ends after being heated in a furnace are placed in a special machine, where the tube ends are simultaneously split and forged together. The end is reheated and closed in a rotary swaging machine by split dies, in two stages, wherein the end, still hot is shaped and given the proper contour. In the final operation the excess metal in the tip is cut off and the end smoothly finished.

The sectional metal to metal ball joint shows the ball end on the end of the element. This is made integral with the tube itself by means of machinery specially designed for the purpose. The ends of the tubes are "jumped up" or "upset" in a forging press so as to augment the thickness of metal where required to form the ball. They are machined to the correct dimensions and the spherical surfaces at the extreme ends, which make the steam tight joints, are ground to a radius of $1\frac{1}{16}$ " , a cup gauge being

SECTION 3. NO. 39.

FIRST FLOOR
BAY H.
PRESENTED BY
THE
SUPERHEATER
CO. LTD.,
LONDON, 1932.

employed to test the accuracy of the curvature. The gauge itself is checked by a Hoffman steel ball 2 1/8" diameter. Another section shows the method of attaching the ball end of the element to the Superheater Header. The lower spherical surface on the ball ends are formed to the same radius as the upper, and seat in loose washers, which are cupped out to provide spherical seats on the one side and have flat surfaces on the under side which bear against a flange block, made from drop forgings. The element bolts and nuts are manufactured from special steel, having a tensile strength of not less than 50 tons per sq. inch, a yield point of 35 tons per sq. inch, and an elongation of not less than 16 per cent in 2 inches.

Two nuts are employed on each bolt, the second not only acts as a lock nut, but in addition provides protection to the thread of the bolt, preventing its corrosion and ensuring ease of removal when necessary.

SECTION 3. NO. 40.

FIRST FLOOR
BAY H.
PRESENTED BY
SOC. ANON.
UNION DES
ACIERIES,
MARCINELLE/
CHARLEROI,
BELGIUM, 1932.

TESTED AXLEBOX KEEP.

This is a cast steel axlebox keep of the type used on several classes of Egyptian State Railways locomotives.

It has been tested and the results are indicated by the bent in lugs which shew no signs of fracture.

SECTION 3. NO. 41.

GROUND FLOOR
BAY R.

WORKING MODEL OF STEPHENSON VALVE GEAR.

This model represents the form of link motion which for many years was the most popular, owing to its simplicity and the ease with which it permits the point of cut-off of the steam to be varied, so reducing the consumption by allowing the steam to work expansively.

The crank axle carries the two eccentrics, one set in the correct angular position for going forward and the other for going backward.

These are connected by the eccentric rods, one to each end of the curved reversing link.

This link is curved to a radius equal to the eccentric rod length or more strictly, to a radius equal to the distance from the centre of an eccentric to the centre line of the link, measured along the centre line of the eccentric rod. A die block slides in the link and is attached to the rear end of the valve spindle.

To give a definite motion to the valve, one point of the reversing link must be guided.

This is usually done by suspending it from a lifting link, the upper end of which is attached to the reversing shaft lever. In many cases the weight of the reversing link and rods is balanced by a cast iron weight fixed to the reversing shaft, which is operated by a rod and reversing lever in the cab. The reversing lever works on a sector in which notches are provided.

The catch attached to the lever drops into one of these notches and thereby locks the reversing shaft lever in the desired position.

By "linking up" or "notching up" as it is termed the reversing link is moved over the die block, the position of the link over the die determines which eccentric is used to impart motion to the valve, in fact for most positions of the link the combined effect of both eccentrics gives motion to the valve. The cut off is earlier as the link is moved towards the centre of the die block.

The forward eccentric rod is connected to the top of the reversing link and the backward rod to the bottom, thus the die block works in the upper half of link for forward running and in the lower half for backward running.

In the model the steam and exhaust ports are distinctively coloured, and the disc which represents the crank is marked in degrees so that the position of the slide valve may be seen for any position of the crank. As the valve moves from its mid position it uncovers one steam port and admits steam to one end of the cylinder.

At the same time the other steam port is put into communication with the exhaust passage.

The slide valve must be open at the beginning of the stroke on the steam edge by an amount known as the "lead" this is necessary because of the difficulty which would be experienced if this were not allowed, on account of the very gradual opening of the slide valve. Lap is provided on the valve faces, i.e., the valve overlaps the edges of the ports in the cylinder face. The width of the overlap on the steam edge of the valve is called the "outside lap" and that on the exhaust edge of the valve the "inside lap". Generally the former is greater than the latter. Then one port opens sooner or more widely to exhaust than the other to steam, and this diminishes the back pressure, without sensibly diminishing the work done by the steam in the forward stroke.

WORKING MODEL OF WALSCHAERT VALVE GEAR.

This model shews the principle of the Walschaert Valve Gear, it includes cylinder, piston, valve chest and piston valve. The crank disc is marked in degrees whereby the crank angle may be noted for any position of piston or valve.

By means of the reversing lever and sector the effect produced by "notching up" is seen. For a more detailed description of this form of valve gear reference should be made to exhibit No. 5 in this section of the catalogue.

SECTION 3.
NO. 42.
GROUND FLOOR
BAY R.

**SECTION 3.
NO. 43.**

FIRST FLOOR
BAY G.
PRESENTED BY
LIGHTALLOYS
LTD., LONDON.
1932.

ALUMINIUM ALLOY FITTINGS FOR ROLLING STOCK.

This exhibit is a display of "Alpax" fittings for Railway and Tramway Rolling Stock.

Each item is numbered thus:—

Item No. 1.

Lightalloys Patent Aluminium Louvre as supplied to the Rhodesian Railway.

Lightalloys patented Louvre consists essentially of a one-piece die-cast "Alpax" Frame to which the metal slats are secured by cup headed rivets. It is lighter than the wooden louvre it has replaced, and gives an 80 % increase in ventilating area. Being all metal, it is entirely free from warping and twisting trouble, and has the advantage over the usual wooden construction that the metal slats are capable of easy replacement without the necessity of removing the louvre from the coach.

Weight 10 lbs.

Item No. 2.

"Alpax" Louvre Frame with Wooden Slats.

This louvre consists of a die-cast "Alpax" frame in the sides and centre bar of which are cast the slots into which the slats are fitted.

The Louvre as exhibited weights 12 lbs., the same weight as the similar wooden louvre, and has the advantage of being free from warping and twisting troubles, and in addition it will be seen that the design enables the easy replacement of individual slats without the necessity of removing the louvre from the coach.

Item No. 3.

Lightalloys Patent Sliding Light as supplied to the Buenos Aires Great Southern Railway.

This light frame consists of two "Alpax" die castings, the construction of a similar frame being shown in Item No. 4. Its weight, 15 lbs., including glass, is less than the wood frame it replaced and it has the advantage of being free from warping or twisting, inherent in the wooden construction.

It will be seen that the design enables the easy replacement of broken glass.

Item No. 4.

Construction of Lightalloys Patent Sliding Light.

This exhibit shows two castings similar to those used for the sliding light exhibited in item No. 3. The method of glazing the frame will be obvious, as also the ease of replacement of broken glass. The weight of the two castings is 5 lbs. 7 ozs.

Item No. 5.

Fixed Light and Window Moulding as supplied to the Central Argentine Railway.

Large quantities of window mouldings, with or without the fixed light at the top, have been fitted on the whole of the new stock of the Central Argentine Railway and other railways. They afford a substantial saving in weight compared with wood mouldings and do not warp or twist and are free from corrosion troubles.

Weight 7 $\frac{1}{4}$ lbs.

Item No. 6.

"Alpax" Luggage Rack Bracket as supplied to the London and North Eastern Railway (England).

Die cast.

Weight: $\frac{3}{4}$ lb.

Item No. 7.

"Alpax" Parcel Rack Brackets as supplied to the Central Argentine Railway.

Die cast.

Weight: 3 lbs. 10 ozs. (The three castings).

Item No. 8.

Ventilator for Tramcar as supplied to the London County Council Tramways.

This ventilator, constructed of six "Alpax" die castings, is a standard fitment on latest London County Council Trams. Compared with the previous wooden ventilator, it is lighter and does not warp, twist or jam.

Weight: (complete, as shown) 6 lbs. 14 ozs.

Item No. 9.

Omnibus Seat Pedestal.

This light die cast "Alpax" seat pedestal is typical of many varieties of similar design, which have been supplied in many thousands during the course of the last few years. They are replacing steel or wooden constructions for seat pedestals on the majority of new omnibuses being made.

Weight: 1 lb. 14 ozs.

Item No. 10.

Frame for Frameless Droplight as supplied to the London Midland and Scottish Railway.

Large quantities of these frames have been supplied to the above railway. They afford a substantial saving in weight compared with wood moulding, and do not warp or twist and are free from corrosion trouble.

Weight: 6 lbs. 1 oz. (as shown).

This type of frame is fitted to coaches on the Egyptian State Railways.

**SECTION 3.
NO. 44.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
FRIED KRUPP,
A.G., 1932.

TESTED LOCOMOTIVE WHEEL CENTRE.

This Cast Steel Locomotive Wheel Centre was deformed by drop tests in the cold state.

**SECTION 3.
NO. 45.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
FRIED KRUPP,
A.G., 1932.

RAILWAY AXLE. — BENT COLD.

This steel railway axle, the material of which has a tensile strength of 36.8 tons per sq. inch, (58 kilogs. per sq. m.m.) was bent in the cold state.

**SECTION 3.
NO. 46.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
FRIED KRUPP,
A.G., 1932.

TESTED LOCOMOTIVE TYRE.

This locomotive tyre is made of open hearth alloy steel, having a tensile strength of 60.3 tons per sq. inch (95 kgs. per sq. m.m.) and the falling weight test resulted in the deformation shown.

**SECTION 3.
NO. 47.**

GROUND FLOOR
(ANNEX).
PRESENTED BY
FRIED KRUPP,
A.G., 1932.

RAILWAY SPRINGS.

These are springs of various types used on railway rolling stock. Descriptive cards give details of each type, which are as follows:—

Laminated bearing spring-length	... ..	1,200 m.m.
Laminated bearing spring-length	... ..	3'-7 3/8"
Volute buffer spring-height	... ..	8 7/8"
Cup spring—height	... ..	340 m.m.
Helical spring—height	... ..	1,073 m.m.
Cup spring—height	... ..	20 m.m.

**SECTION 4.
MACHINERY AND TOOLS.**

**OPERATIONS IN THE MANUFACTURE OF COACH BOLTS
AND NUTS, AND BLACK WHITWORTH
BOLTS AND NUTS.**

This exhibit illustrates the sequence of operations, in the making of Coach Bolts and Nuts, and Whitworth Black Bolts and Nuts. The operations on each type of bolt are clearly indicated by cards in the case.

**OPERATIONS IN THE MANUFACTURE OF WOOD
SCREWS, AND BOLTS WITH WHITWORTH FORM
OF THREAD.**

This exhibit illustrates the sequence of operations in the making of wood screws, and Whitworth bolts.

The case contains examples of the following types. The operations are clearly indicated by cards in the case.

Wood Screws.

Countersunk head.
Round head.

Whitworth Bolts.

Countersunk head.
Hexagon head.
Square head.
Round head.

STOCKS AND DIES, AND TAPS.

This exhibit shews stocks and dies, and taps as manufactured by Messrs. Arthur Balfour & Co. Ltd.

The tools exhibited are numbered thus.

- 1.—Angular pattern stocks with dies.
- 2.—Round split die with holder.
- 3.—Set of taps for British Standard Whitworth Thread.
- 4.—Set of taps for British Standard Pipe Thread.
- 5.—Ground thread tap for extremely accurate work.

**SECTION 4.
NO. 1.**

FIRST FLOOR
CENTRE CASE
BAY G.-H.
PRESENTED BY
GUEST KEEN &
NETTLEFOLDS
LTD., 1932.

**SECTION 4.
NO. 2.**

FIRST FLOOR
BAY G.
PRESENTED BY
GUEST KEEN &
NETTLEFOLDS
LTD., 1932.

**SECTION 4.
NO. 3.**

FIRST FLOOR
BAY G.
PRESENTED BY
ARTHUR
BALFOUR
& CO. LTD., 1932.

**SECTION 4.
NO. 4.**

FIRST FLOOR
BAY H.
PRESENTED BY
ARTHUR
BALFOUR
& CO. LTD., 1932.

SMALL TOOLS, TOOL STEEL, ETC.

This exhibit shews several types of small tools, and tool steel typical of the manufactures of Messrs. Arthur Balfour & Co. Ltd. The case contains the following:—

- (a) Milling Cutters.
- (b) Slitting Saws.
- (c) Twist Drills.
- (d) Hacksaw Blades.
- (e) Section of miner's drill steel in normal and hardened state.
- (f) Sections of tool steels in normal and hardened state.
- (g) Sample bar of high speed steel.

**SECTION 4.
NO. 5.**

FIRST FLOOR
BAY H.
PRESENTED BY
COLVILLES LTD.,
1932.

**SAMPLE OF "DUCOL" ROUND STEEL BAR TIED
IN A KNOT.**

This exhibit shews a test piece cut from a round bar of "Ducol" steel, and illustrates the extreme ductility of the material. The bar was tied cold and observation will shew that no fractures have resulted from the test.

**SECTION 4.
NO. 6.**

FIRST FLOOR
BAY H.
PRESENTED BY
COLVILLES LTD.,
1932.

**SAMPLE MULTIPLE BEND OF STEEL PLATE
TEST PIECE.**

This exhibit shews a test piece from a steel plate of Colvilles "Ducol" brand steel, which has been submitted to the multiple bend test which consists of bending the piece until the sides touch each other. It will be observed that there are no fractures, illustrating the extreme ductility of the material, which was bent cold.

**SECTION 4.
NO. 7.**

FIRST FLOOR.

PRESENTED BY
MESSRS.
RANSOMES &
RAPIER LTD.,
1932.

MODEL OF PETROL-ELECTRIC MOBILE CRANE.

This model represents a standard Petrol-Electric Mobile Crane, designed and manufactured by Messrs. Ransomes & Rapier Ltd.

These cranes are built in four standard sizes to lift and travel with loads of 1, 2, 3 1/2/5 and 6 tons, and as the name implies, are entirely self contained units. They run on four solid rubber-tired wheels, two of which are mounted in front of the crane on a fixed axle while the other two, which are the driven and also the steered wheels, are mounted on a castor which is pivoted to a post in the tail of the machine. The power required for driving the separate motors of the travel, hoist and derrick motions is derived from a petrol-electric unit which consists of a substantial motor car engine, direct coupled to a specially designed variable-speed electric generator.

The simple but unique and patented method of varying the speed of the generator provides that no current need be generated in excess of that which is actually needed to drive whichever motors may be in use at any given moment. The crane has "three point" support which provides absolute stability when negotiating rough or uneven ground and the fact that it is entirely self contained and does not need rails on which to travel, or trailing cables or batteries from which to obtain its power. These are advantages which result in its being applicable to an almost unlimited number of uses.

This type of mobile crane is suitable for such varied uses as dealing with erection work, heavy machinery, general goods, and stock piles. As an example of its use, the case of loading or unloading railway wagons may be cited, the crane can approach wagons from any position, operate freely in restricted areas, and do all the necessary work without entailing any movement on the part of the train.

MODEL "COCHRAN" STANDARD PATENT VERTICAL MULTITUBULAR BOILER.

This model represents an actual facsimile of the standard type of boiler, made by Cochran & Co., Annan, Ltd.

This type of vertical boiler has horizontal flue tubes. It requires no brickwork setting, only a hard flat surface to stand on. By opening the smokebox doors it will be seen that sweeping the tubes is an easy matter. The tubes absorb all the heat of the flames after they leave the combustion chamber and furnace.

The smokebox is detachable from the boiler, and is usually removed for transit purposes. The "back plate" forms the back of the combustion chamber, the flames and gases, after leaving the furnace, pass into this chamber, where combustion is completed, and then enter the small tubes at a high temperature. During their passage through the tubes all the heat is extracted from them. The back is held in position by clamps and is easily removable; it is lined with firebricks, and the gases, striking the hot brickwork as they come from the furnace, are re-ignited, and smoke is reduced to a minimum.

The uptake through which the gases pass from the furnace, is put in from the combustion chamber side, and its flange is riveted to the tube plate. It is readily removable in case of need.

The spherical top of the boiler makes stays and gussets unnecessary. The space between the tubes and boiler shell allows room for a man to get down this space, and then all round the furnace to clean it. These spaces also act as downtakes for the cool water when steam is rising from the furnace and tubes, perfect circulation is thus obtained. The boiler is self contained,

SECTION 4. NO. 8.

FIRST FLOOR.
PRESENTED BY
COCHRAN & CO.,
ANNAN, LTD.,
1932.

i.e., there is no external firegrate, as this is supported on an angle ring carried by lugs. The space under the firebars constitutes the ashpit, which is formed by an extension of the boiler shell. The furnace is flanged from one plate, and there are no welds. An ogee ring is riveted to the bottom of the furnace connecting it with the boiler shell, thus there are no rivets exposed to flame. The furnace plate is flanged outwards to take the firehole and uptake, in this way the rivets have no flames impinging on them.

The model represents a standard boiler.

7'-0" diameter.

15'-0" high.

600 sq. feet heating surface.

26.75 sq. feet grate area.

SECTION 4. NO. 9.

FIRST FLOOR
BAY G.-H.
PRESENTED BY
GLENFIELD &
KENNEDY LTD.,
1932.

FLANGED SLUICE VALVE.

This model, which is partly cut away to shew details of construction, shews a sluice valve as manufactured by Messrs. Glenfield & Kennedy Ltd. This type of valve is largely used in water mains, and is built in a large range of sizes. The smaller sizes are operated by a handwheel attached direct to the valve spindle, but in the large bore valves used in the more important installations toothed gearing is employed to open and close the valve. The gearing may be one of the following types, spur reducing, worm and wheel, or bevel reducing gear, each type of operating gear is arranged to suit the local conditions.

SECTION 4. NO. 10.

FIRST FLOOR
BAY G.-H.
PRESENTED BY
CONTO-
MICHALOS.
DARKE & CO.
(1929).
LTD., 1932

SECTIONAL "PETTER" PARAFFIN ENGINE.

This exhibit is a Hopper Cooled Universal Paraffin Engine, partly sectioned to shew principle of operation and construction. The engine develops 1 ½ H.P. when running at 750 r.p.m. and is of the two stroke type, in which there is a power stroke in each revolution, this two stroke cycle eliminates the use of valves and their operating mechanism and provides a smooth running engine.

This type of engine is designed to provide motive power as efficient as possible with a minimum of working parts.

The water cooling of the engine is effected by the hopper which is placed on top of the cylinder, and is in direct contact with the water jacket. This method of cooling eliminates separate tanks and piping.

STEREOSCOPE.

This exhibit shows photographs taken in the works of Messrs. H.W. Ward & Co. Ltd. of machine shops, erection bay, test bay, and finished machine tools of various types. This firm are specialists in the design and manufacture of Combination Turret Lathes, Capstan Lathes, Broaching Machines, etc. The eyepiece of the Stereoscope may be focussed to suit individual requirements, and by turning the knob on the right hand of the machine, the photographs are brought into view.

MODEL OF AN ELECTRIC CAPSTAN. — FOR RAILWAY SIDINGS, DOCKYARDS, ETC.

This model represents an electric capstan of the type used in railway sidings, dockyards, etc., for haulage purposes. The motor and operating mechanism are located in a pit below ground level.

SHEET STEEL PILING.

This exhibit shews a section of sheet steel piling and shows the method of locking the sections together.

The diagrams give dimensions of the sections and show how they are arranged.

TOOTHED GEARING.

This exhibit comprises toothed gears of the following types, bevel, spiral, worm and wheel, rack and spur wheel, and clutch.

By turning the handle the gears may be seen in operation, when the action of the various types of gearing may be observed.

GROUND SPUR GEARS.

The ever-growing demand for quietness, efficiency and durability has led to the development of many machines for the final grinding of the tooth profiles, after hardening, of toothed gears. These examples are typical of ground gears on ground spline shafts.

SECTION 4. NO. 11.

FIRST FLOOR
BAY G.-H.
LENT BY
H.W. WARD &
CO. LTD., 1932.

SECTION 4. NO. 12.

FIRST FLOOR
BAY G.
LENT BY
THOMAS BROAD-
BENT & SONS
LTD., 1932.

SECTION 4. NO. 13.

FIRST FLOOR
BAY G.
PRESENTED BY
FRIED KRUPP
A.G., 1932.

SECTION 4. NO. 14.

FIRST FLOOR
BAY G.
PRESENTED BY
J. LANG & SONS
LTD., 1932.

SECTION 4. NO. 15.

FIRST FLOOR
BAY G.
PRESENTED BY
J. LANG & SONS
LTD., 1932.

SECTION 4. NO. 16.

FIRST FLOOR
BAY G.
PRESENTED BY
J. LANG & SONS
LTD., 1932.

THREE STAGES IN THE EVOLUTION OF SPUR GEARING.

When toothed gears were made with moulded teeth, the patterns were cut as nearly as possible to the correct form by hand. Many tooth profiles were produced, depending on the ideas of the makers as to which was the best form.

The next stage was the introduction of gear cutting machines, in which rotary cutters were used, the shape of which were determined by setting out on the drawing board. Then came the system of generating, in which the properties of the involute curve were used. By this method it is possible to design a series of interchangeable gears, every gear of which will mesh correctly with every other.

The grinding of spur gears, after hardening, was the next stage in the evolution of high class gearing.

Many types of machine have been designed for this purpose, the aim of which is to produce gears, which will be silent running, efficient and durable.

The exhibit shews one gear of each type.

- (a) Cast gear, 1880—1895.
- (b) Machine cut gear, 1895—1930.
- (c) Ground gear, 1930.

SECTION 4. NO. 17.

FIRST FLOOR
BAY G.
PRESENTED BY
THE ENGLISH
STEEL CORPORATION LTD., 1932.

SMALL TOOLS.

This exhibit is a selection of small tools of the following types:—

1. Boiler Stay Tap 1 1/4" dia. 11 T.P.I. Used for reamering and tapping out staybolt holes in the boiler plates of locomotives etc.
2. Hand Screwing Chaser, 16 T.P.I. For finish screwing or chasing external threads.
3. Hand Chipping Chisel, 1" wide. These tools are used for hand chipping, and are made with various types of cutting edges.
4. Light Chipping Chisel, 1/2" wide. do. do.
5. Hand Round Nose Chisel. do. do. do.
6. Pneumatic Machine Chipping Chisel. The shanks have been standardised in four types as follows:
 - (a) American hexagonal.
 - (b) American round.
 - (c) British hexagonal.
 - (d) British round.
7. Pneumatic Machine Riveting Snap. For cup or snap head rivets.

- | | |
|--|---|
| 8. Pneumatic Machine Riveting Snap. | For flush or countersunk headed rivets. |
| 9. Broach. | Suitable for the sizing and forming of splined holes. |
| 10. Taper Bridge Reamer. | For reamering holes lineable in plate. |
| 11. Parallel Machine Reamer. | For reamering holes to size and obtaining roundness and finish. |
| 12. Side and Face Milling Cutter, having straight teeth. | For general milling operations. |
| 13. Side and Face Milling Cutter, having spiral teeth. | do. do. do. |
| 14. Single Angle Milling Cutter. | For milling angular faces or recesses. |
| 15. Valve Seating Cutter. | Used for correcting the angle of valve seats, and re-seating. |

BALL BEARINGS.

This exhibit shews two standard types of ball bearings, as manufactured by the Skefko Ball Bearing Co. Ltd.

Ball bearings are now largely used in preference to plain bearings, principally for the following reasons. There is less loss of power on account of the lower co-efficient of friction, the friction of a ball bearing is independent of the viscosity of the lubricant or its temperature. The frictional resistance of starting is much less than in a plain bearing, while wear is practically negligible.

ROLLER BEARINGS.

This exhibit shews three roller bearings of standard types as manufactured by the Skefko Ball Bearing Co. Ltd. Roller bearings are now largely used in preference to ordinary journal bearings, principally for the following reasons. There is less loss of power on account of the lower co-efficient of friction, this being independent of the temperature of the bearings, unless the end thrust is excessive. On account of the excellent materials which are now available, and the manufacturing limits used in production, this type of bearing is largely superseding the plain bearing.

HAND TAPS.

This exhibit shews hand taps for screwing various sizes and forms of threads.

SECTION 4. NO. 18.

FIRST FLOOR
BAY H.
PRESENTED BY
SKEFKO BALL
BEARING CO.
LTD., 1932.

SECTION 4. NO. 19.

FIRST FLOOR
BAY H.
PRESENTED BY
SKEFKO BALL
BEARING CO.
LTD., 1932.

SECTION 4. NO. 20.

FIRST FLOOR
BAY H.
PRESENTED BY
SKEFKO BALL
BEARING CO.
LTD., 1932.

SECTION 4. NO. 21.

FIRST FLOOR
BAY G.
LENT BY
AKTIEBOLAGET
SVENSKA KULLA-
GERFABRIKEN,
GOTEBORG, 1932.

GROUND THREAD STAYBOLT TAP.

This exhibit is a ground thread staybolt tap of the type used for tapping continuous threads in the steel wrapper and copper wrapper of locomotive fireboxes, for the reception of water space stays. As usually made the point of a staybolt tap is tapered, so that the hole is reamed out previous to tapping, the remainder of the tap is threaded, but part of the threaded portion is chamfered or tapered on the top of the thread, leaving only a small portion near the top with the full diameter of the thread.

For copper, soft steel, and other soft materials these taps are made with every alternate thread removed, and with the cutting threads in each adjoining flute staggered. The threads are ground after the tap is hardened, and a guaranteed pitch accuracy of .0002" per inch is obtained.

SECTION 4. NO. 22.

FIRST FLOOR
BAY G.
PRESENTED BY
T.D. ROBINSON &
CO. LTD., 1932.

VARIOUS TYPES OF RIVETS USED IN THE DIFFERENT BRANCHES OF ENGINEERING.

This exhibit shews a representative selection of rivets used in the various branches of engineering. The rivet has been used as a fastening for a great variety of purposes from very ancient times. It is one of the most simple and efficient means of connecting two or more parts together, being permanent, once the parts have been connected, they can only be separated by chipping off the rivet head. Rivets are produced in special machines, from a special quality of round iron or steel bar. The heads of rivets are of many varieties, dependent on the type of structure on which they are to be employed. The types shewn in this exhibit are:—

- (a) Cup head,
- (b) Countersunk head,
- (c) Pan head,
- (d) Ellipsoidal head,
- (e) Raised Countersunk head,
- (f) Conical head.

SECTION 4. NO. 23.

GROUND FLOOR
(ANNEX).
PRESENTED BY
COLVILLE'S LTD.,
1932.

ROLLED STEEL SECTIONS.

This exhibit shews a representative selection of rolled steel sections manufactured by Colville's Ltd.

The samples may be identified by reference to the description which adjoins each section.

FRACTURES OF CARBON TOOL STEELS AND HIGH SPEED STEELS.

This exhibit shews Tool Steels and High Speed Steel as manufactured by Messrs. S. Osborn & Co. Ltd.

The fractures shew the structure of the steel in the annealed and hardened condition, and are as follows:—

Carbon Tool Steels:—

Tempers 2, 3, 4½ and 5, annealed and hardened.

Self tempering Chisel Steel annealed and hardened fractures, also hand chisel.

“C.P.I.” Pneumatic Tool Steel annealed and hardened, also pneumatic chisel.

High Speed Steels.

“Double Mushet” High Speed Steel, “Triple Mushet” High Speed Steel, annealed and hardened fractures, also small drill and saw.

“S.O.B.V.” Cutting Alloy annealed and hardened fractures, also turning tool and small Manganese drill.

RUSTLESS STEELS.

This exhibit shews samples of rustless steels, manufactured by Messrs. S. Osborn & Co. Ltd.

Rustless steels are now in general use for a large variety of engineering parts which are subject to corrosion and acids, and their use is rapidly growing.

The samples are as follows:—

Rustless Steels.

Steel samples, hot rolled, pickled and polished finishes, No. 1, 2, 3, 4, 5 and 6.

Samples of “E.K.” Heat-resisting steel, tested at heat.

Samples of various rustless steels tested in acid.

Samples of articles made from rustless steels (a few rivets, nails, screws, strip and decorative metal).

AUTOMOBILE STEELS.

This exhibit shews samples of steels used in the construction of automobiles, also staybolt steel. As many parts of the modern motor vehicle are subject to high stresses and shocks, alloy steels are now used in their construction.

Fractures of typical carbon and alloy steels are shewn as follows.:

Automobile Steels.

Fractures of Carbon Case-Hardening Steel, 3 % Nickel Case-Hardening Steel, 3 % Nickel Oil Hardening

SECTION 4. NO. 24.

FIRST FLOOR
BAY G.-H.
CENTRE STAND.
PRESENTED BY
MESSRS.
SAMUEL
OSBORN
& CO. LTD.,
1932.

SECTION 4. NO. 25.

FIRST FLOOR
BAY G.-H.
CENTRE STAND.
PRESENTED BY
MESSRS.
SAMUEL
OSBORN
& CO. LTD.,
1932.

SECTION 4. NO. 26.

FIRST FLOOR
BAY G.
PRESENTED BY
MESSRS.
SAMUEL
OSBORN
& CO. LTD.,
1932

Steel, "M.T.R." Oil Hardening Nickel-Chrome Steel,
"D.U." Oil-Hardening, Nickel-Chrome-Molybdenum
Steel.

Staybolt Steel, tensile, bend and Izod tests.

Tensile Test Pieces — Mild Steel 40 % Carbon, tensile
before and after breaking. Also Nickel-Chrome
Molybdenum Oil-Hardening Steel.

SECTION 4. NO. 27.

FIRST FLOOR
BAY G.-H.
CENTRE STAND.
PRESENTED BY
MESSRS.
SAMUEL
OSBORN
& CO. LTD., 1932.

FILES, SHEWING CUTS AND PROCESSES,

This exhibit shews the different cuts of files, which are classi-
fied according to their shape or cross section, and according to the
pitch or spacing of the teeth and the cut. The processes involved
in the manufacture of files are indicated on the board.

SECTION 4. NO. 28.

FIRST FLOOR.
BAY H.
PRESENTED BY
LOWMOOR BEST
YORKSHIRE
IRON
LTD., 1932.

PARTS MADE OF LOWMOOR BEST YORKSHIRE IRON.

This exhibit shews samples of Lowmoor Best Yorkshire
Iron, in various forms. Best Yorkshire Iron is produced from pig
iron of great purity, which is placed in open hearth refineries,
where the remaining silica and sulphur are as far as possible
removed; the resulting product is then puddled in a special way,
and from the puddling furnaces the iron goes to the hammers and
rolls, until it eventually takes its form as Best Yorkshire Iron
bars, plates or forgings. By these various and costly processes
an iron remarkably low in sulphur, and therefore admirably
adapted for welding, is produced, which is largely used for railway
drawgear, and other articles where failure might mean loss of life.
Locomotive and other boiler plates were formerly made of Best
Yorkshire Iron, but owing to the relative cheapness of steel, are
now in almost every case made of the latter material; but iron
is still, in some cases specified where only impure water is avail-
able, the corrosive effect being so much less on the iron that the
life of the plates is often quadrupled.

The samples are numbered thus:—

- 1.—Tensile 1" diameter $\times 13 \frac{7}{8}$ ".
- 2.—Tensile 1" diameter $\times 13 \frac{7}{8}$ " partly pulled.
- 3.—Tensile 1" diameter $\times 13 \frac{7}{8}$ " fully pulled.
- 4.—Double cold bend.
- 5.—Fibre test.
- 6.—Fracture Test.
- 7.— $\frac{5}{8}$ " diameter rivet flattened and hole punched and
drifted to 1 $\frac{1}{4}$ " diameter.

- 8.—Rivet sprayed out.
- 9.—Rivet head flattened.
- 10.—Drift and Ramshorn.
- 11.—Boiler stay threaded and bent cold.
- 12.—Stay screwed down and split.
- 13.—3 link coupling as made.
- 14.—3 link coupling unbroken after 68 tons pull.
- 15.—Part of water stay after 100 years in water.
- 16.—Bar 1 1/2" square. The original section of water stay.
- 17.—Knot tied cold.

TANGENTIAL DIE HEAD.

This exhibit is a Tangential Die Head, patented and manufactured by Joshua Heap and Co. Ltd.

It is the 2" size with Die Holders and Dies for screwing 1 7/8" and 2" diameter. This die head is arranged for Dies, four to a set. All wearing parts are of hardened steel. The holders, to which the dies are solidly clamped, are rigidly supported, the cutting strains being taken on the hardened steel cams, so that perfectly parallel and uniform threads are of necessity obtained. When screwing, there is no tension on the clutch and operating levers.

The dies are adjusted of size by the four-throw cam. An index, which is in full view of the operator, is provided, so that the dies can be set to the required size.

The die holders are of steel, with all wearing parts hardened, and are very powerful. The action of tightening the clamping screws forces the taper face of the clamp into contact with the corresponding taper face of the die holder, and the die to a solid seat. The greater the pressure on the die, the greater is the grip of the clamp.

The dies, which are interchangeable, are of the tangential type, and are made of high speed steel, accurately ground to size. When the dies are dull they can be readily sharpened by grinding the ends; they never require re-cutting or re-tempering.

SCREWED BARS WITH GROUND THREADS.

This exhibit shews samples of screwed bars with ground threads. When extreme accuracy is required in any component, the threads are ground after hardening.

SECTION 4. NO. 29.

FIRST FLOOR,
CENTRE
BAY G.-H.
LENT BY
JOSHUA
HEAP &
CO. LTD., 1932.

SECTION 4. NO. 30.

FIRST FLOOR
BAY G.-H.
PRESENTED BY
JOSHUA HEAP
& CO. LTD.,
1932.

**SECTION 4.
NO. 31.**

FIRST FLOOR
BAY G.
PRESENTED BY
THE CONSOLI-
DATED
PNEUMATIC
TOOL CO. LTD..
1932.

SECTIONAL "BOYER" PNEUMATIC HAMMER.

This exhibit is a pneumatic riveting hammer, sectional, to show internal details. It is fitted with a rivet snap for closing the heads of rivets, and is capable of delivering approximately 1,000 blows per minute, with air at a pressure of 80 lbs. per sq. inch.

The compressed air is admitted through the throttle valve in the handle, this valve is operated by the outside trigger, and exhaust air passes out through a hole in the bottom of the valve chamber.

The air is admitted to the cylinder through the valve in the valve case of the hammer, and causes the piston to deliver a series of blows to the rivet snap. The control is very sensitive, and can be varied at the will of the operator, from a light tap to a heavy blow.

The rivet snap is prevented from being accidentally shot out of the cylinder by the spring clip.

**SECTION 4.
NO. 32.**

FIRST FLOOR
BAY G.
PRESENTED BY
THE
BROUGHTON
COPPER
CO. LTD..
1932.

**TEST PIECES, AND SAMPLES
OF COPPER AND BRASS PRODUCTS.**

This exhibit shows test pieces and samples of copper, brass and yellow metal, typical of the products of a large works. Test pieces are exhibited of copper and brass tubes and plates, with the results given below each, and the analyses of the material. Drift, flattened and doubled, and flanged tests on tube samples are shown, and crush and cold bend tests on rods also. Samples of rods and tubes, rivets, stays and plates are also shown, together with pieces of brass sheet and copper plates.

Each exhibit has a description card adjoining it.

**SECTION 4.
NO. 33.**

FIRST FLOOR
BAY G.
PRESENTED BY
THE ENGLISH
STEEL
CORPORATION LTD..
1932.

"VIKRO" HEAT RESISTING STEEL FIREDOOR.

This is a firedoor for a locomotive boiler, made of "Vikro" heat resisting alloy steel. It is a Nickel Chromium alloy, which has proved very successful in many applications where great mechanical strength, freedom from scaling and non-fragility are required at high temperatures. This material is principally used in the form of castings because it is practically immune from oxidation by furnace gases at temperatures up to 1,100° C.

PACKINGS, FOR STEAM, HYDRAULIC AND AIR PRESSURE.

This exhibit shews a representative collection of packings of various forms for steam, hydraulic, and air pressure. Included among the samples are packing rings for engines and pumps, ammonia compressors, boiler mud door joint rings, asbestos mill-board, etc. Each sample is described on a small card adjoining

SECTION OF CONNECTING ROD, AND TEST PIECES.

This exhibit shows a section of a locomotive connecting rod, made of special Nickel-Chromium Molybdenum steel, and test pieces of this material. This alloy steel is eminently suitable for such locomotive parts as connecting and coupling rods, where it is desirable to keep down the weights of the revolving and reciprocating parts. An alloy steel such as this permits of a much lighter section of rod, than would be required were a plain carbon steel used, on account of the much higher tensile strength of the alloy steel.

SPECIAL TWIST DRILL.

This is a twist drill specially designed for the drilling of Manganese Steel and extra hard materials. It is known as the "Stag Major" super-high speed steel twist drill. This drill was used to drill the holes in the section of Manganese Steel Rail (Section 7, No. 30) and was taken from stock and was not re-ground or touched up in any way during the work. Although Manganese Steel is a hard and difficult material to drill, it will be observed that the lands of the drill have not been worn away at all. The drills can be re-sharpened until the flutes are too short for further service.

SPECIAL STEELS.

This exhibit shows samples and test pieces of special steels.

- (1) Axle steel tensile and Bend Test Pieces.
- (2) "Longstrand" steel Notched and Cold Bent Test Pieces.
- (3) "Longstrand" steel Screwed and Cold Bend Test Pieces.
- (4) Samples of solid and hollow "Longstrand" steel.
- (5) Vacuum Brake Piston Rod in "Two Score stainless steel".
- (6) Stainless Iron Cleading Band.

SECTION 4. NO. 34.

FIRST FLOOR
BAY H.
PRESENTED BY
TUCK & CO. LTD
1932.

SECTION 4. NO. 35.

FIRST FLOOR
BAY G.
PRESENTED BY
THE ENGLISH
STEEL CORPORA-
TION LTD., 1932.

SECTION 4. NO. 36.

FIRST FLOOR
BAY G.
PRESENTED BY
MESSRS. EDGAR
ALLEN & CO.
LTD., 1932.

SECTION 4. NO. 37.

FIRST FLOOR
BAY G.
PRESENTED BY
BROWN
BAYLEY'S
STEEL WORKS,
LTD., 1932.

**SECTION 4.
NO. 38.**

FIRST FLOOR
BAY G.
PRESENTED BY
THE ENGLISH
STEEL CORPORA-
TION LTD., 1932.

SPECIAL STEELS.

This exhibit shows special steel test pieces, the steel represented are:—

- (1) Super Air-Hardening Nickel Chrome.
- (2) Super Medium Nickel Chrome.
- (3) 3 % Nickel.
- (4) Carbon Manganese Molybdenum.
- (5) Carbon Manganese.

Cards adjoin the test pieces giving the results of the mechanical tests, and the uses to which the various classes of steels may be put.

**SECTION 4.
NO. 39.**

FIRST FLOOR
BAY G.
PRESENTED BY
BRUNTON'S
(MUSSELBURGH
LTD., SCOTLAND,
1932.

WIRE ROPES.

This exhibit is a representative selection of wire ropes of various sizes and constructions.

The samples are as follows, reading from the top of the board downwards.

Ungalvanised Wire Rope, Lang's Lay, 6 strands, 7 wires, with one Main Hemp Core.

Galvanised Wire Rope, Ordinary Lay, 6 strands of 24 wires, 7 Hemp Cores.

Ungalvanised Wire Rope, Lang's, Lay, Flattened Strand Construction, 6 strands of 7 wires, over one Triangle wire, with Main Hemp Core.

Ungalvanised Wire Rope in Brunton's "Kilindo" Patent, Non Rotating Ordinary Lay.

Ungalvanised Special Flexible Steel Wire Rope, Ordinary Lay, 6 strands of 37 wires, with Main Hemp Core.

Ungalvanised Special Flexible Steel Wire Rope, Ordinary Lay, 6 strands of 17 wires, with Main Hemp Core.

Galvanised Steel Wire Rope, 6 strands of 12 wires, with 7 Hemp Cores.

**SECTION 4.
NO. 40.**

FIRST FLOOR
BAY G.
PRESENTED BY
BRUNTON'S
(MUSSELBURGH
LTD., SCOTLAND,
1932.

WIRE ROPES AND FITTINGS.

These samples are "Beacon" Tru-Lay Wire Ropes fitted at both ends with Tru-Loc Fittings. One of the samples has been tested to destruction, the result of this test clearly demonstrating that the Tru-Loc Fittings have broken the rope.

"Beacon" Tru-Lay Wire Rope is made of strands and wires, which, by a special process of preforming, have been made permanently to assume the exact shape which they require when in the form of a finished rope.

If a piece of this wire rope be unwound strand by strand, and then each strand be unwound wire by wire, the whole of the constituent parts can be replaced in their correct relative positions.

It is quite impossible to do this with ordinary rope.

This rope has a considerably longer life than ordinary rope of equivalent metal under reversed bending stresses. When outer wires break from long wear, there is no tendency for them to fray out of the rope body, they continue to fit their places, lessening wear on other wires on sheaves and drums.

"Beacon" Tru-Loc Fittings are made in a variety of forms, they permit the use of turnbuckles, shackles etc. A steel sleeve is slipped over the smooth unseized end of this form of wire rope, placed in a press, and by pressure and hammering is made to "flow" down upon the rope until it grips wires and strands tightly.

These sleeves can be threaded, and be furnished with double or single eye ends or hooks.

RIVETS OF VARIOUS TYPES AND SIZES.

This is a representative selection of rivets of various types and sizes, included are rivets with heads of the following types, Ellipsoidal, Countersunk, Semi-Countersunk and Pan.

BLACK AND GALVANISED BOLTS AND NUTS.

This is a selection of bolts and nuts, some of which are black finished, others are galvanised. Among the types exhibited are:

- Hexagon headed bolts and nuts.
- Square headed bolts and nuts.
- Coach headed bolts and nuts.
- Round headed bolts and nuts.
- Tee headed bolts and nuts.
- Railway chair screws.

MEASURING TAPES AND RULES.

This is a selection of metallic measuring tapes, and gauges.

These include:—

- 2 Metallic Measuring Tapes, 20 metres.
- 1 Rustless Steel Measuring Tape, 20 metres.
- 1 Spring Steel Measuring Tape, 2 metres.
- 1 Steel Measuring Band, 1 metres, $\frac{5}{8}$ " wide, with handle.
- 1 Rustless Steel Rule 12".
- 1 Boxwood Rule 2'-0".
- 1 Brass Gauge 3".

The tapes and rules are marked in feet and inches and metric equivalents.

SECTION 4. NO. 41.

FIRST FLOOR
BAY G.
PRESENTED BY
THE RIVET, BOLT
& NUT CO. LTD.,
GLASGOW, 1932.

SECTION 4. NO. 42.

FIRST FLOOR
BAY G.
PRESENTED BY
THE RIVET, BOLT
& NUT CO. LTD.,
GLASGOW, 1932

SECTION 4. NO. 43.

FIRST FLOOR
BAY G.
PRESENTED BY
MESSRS. J.
RABONE &
SONS LTD.,
BIRMINGHAM.
1932

**SECTION 4.
NO. 44.**

FIRST FLOOR
CENTRE TABLE
BAYS G-H
PRESENTED BY
FRIED KRUPP,
A.G., 1932.

**SECTION 4.
NO. 45.**

PRESENTED BY
MESSRS. LUKE
& SPENCER
LTD., 1932.

SPECIAL STEELS.

This exhibit is a representative selection of special steels, for various purposes. Descriptive cards designating the samples give data relating to mechanical tests and other properties of the steels.

GRINDING WHEELS AND RAW MATERIALS.

The grinding wheels exhibited are typical of those used in the Engineering industry today, for various purposes. The pieces exhibited are:—

ROCK SAMPLES.

Emery (quarried).

This is a sample of Turkish Emery known as "Moulah".

Emery (river bed).

This is a sample of Turkish Emery known as "Kuluk".

Boro-Carbone.

This is a sample of Artificial Corundum manufactured by A. Borit of Paris, being a product of the electric furnace, the principal ingredient being Bauxite. The Works are situated in the Pyrenees.

Artificial Corundum is growing in popularity due to the fact that it contains a greater percentage of Alumina, averaging about 90 % as against 60 % to 70 %.

Natural Corundum.

This is a sample of Madagascar Corundum which might be termed a higher grade of emery, containing probably from 80 % to 85 % of Alumina.

It is exceptionally good for the grinding of tools.

Another Grade of Corundum which is now being rapidly brought to the fore is South African which is generally in boulder form.

WHEELS—MANUFACTURED.

Vulcanite Wheels.

Para Rubber masticated after treatment for extracting impurities.

Para Rubber after being blended with abrasive ready for pressing into moulds to form the wheel.

Manufactured vulcanite wheel—as it leaves the kiln.

Manufactured vulcanite wheel—complete ready for use.

Shellac Wheels.

Sample of Shellac.

Cone of Shellac blended with Abrasive ready for pressing into moulds (this sample is of course set, but in process of manufacture it has to be in a plastic state).

Manufactured Shellac wheel—as it leaves the kiln.

Manufactured Shellac wheel—complete-ready for use.

Silicate Wheels.

Sample of Silicate Powder.

Cone of Silicate blended with Abrasive ready for pressing into moulds.

Manufactured Silicate wheel—as it leaves the kiln.

Manufactured Silicate wheel—complete ready for use.

Bakelite Wheels.

These Wheels have been placed on the market in recent years and are especially adapted for high speed grinding, i.e., 9,000 ft. per minute as against the ordinary speed of 5,000 ft.

Sample of Bakelite Resin.

Sample of Bakelite Liquid.

Cone of Bakelite blended with Abrasive ready for pressing into moulds.

Manufactured Bakelite wheel—as it leaves the Kiln.

Manufactured Bakelite wheel—complete-ready for use.

Any class of wheel can be made up of any abrasive according to the nature of the job, e.g.

Emery—Copper and Aluminium.

Corundum—Tools.

Artificial Corundum—High speed steels.

Silicon Carbide—Cast iron.

Artificial Corundum—White (which is extremely cool cutting) for material where the least cracking in grinding would be fatal.

A sample of Silicon—Carbide Grain is shown together with Manufactured wheel—as it leaves the kiln.

Manufactured wheel—complete-ready for use.

Corundum, White,

Sample of Grain.

Manufactured wheel—as it leaves the kiln.

Manufactured wheel—complete-ready for use.

Corundum-Natural.

Sample of Corundum Grain.

Boro Carbone Grain.

In the use of Grinding Wheels it is essential that they should be kept perfectly true so as to obtain uniform running and efficient grinding.

A Hand Dresser complete with Cutters for rough dressing and a Diamond Tool (imitation diamond) for dressing wheels where a fine and accurate finish is required by hand or slide rest.

Descriptive cards are attached to the samples.

SECTION 4. NO. 46.

FIRST FLOOR
BAY H.
PRESENTED BY
THE CHURCHILL
MACHINE TOOL
CO. LTD., 1932.

EXAMPLES OF GROUND LOCOMOTIVE PARTS.

These are typical examples of locomotive parts finished by grinding on specially designed machines. The journal portion and wheel seat of the axle were ground on an Axle Grinder.

The other parts exhibited are an expansion link and die block. The grinding of the inner surfaces of the radiused slot of the link and the hole at the foot was done at one setting on a Radius Link Grinding Machine, and the sides of the link and die block were ground on a Vertical Spindle Surface Grinding Machine.

These grinding machines are manufactured by The Churchill Machine Tool Co. Ltd.



SECTION 5.

STATISTICS.

The importance of accurate statistical information in respect of all branches of railing working cannot be overestimated.

On the careful analysis and interpretation of the figures furnished by the Accounting Department, the operating and commercial offices are best able to frame their policies and methods of handling traffic.

On practically all railways statistics have now assumed a standard form and those here exhibited are amongst the most important.

They deal with the general results of the operation of the Egyptian State Railways, and also the traffic handled by the Passenger and Goods Departments.

The exhibition of the figures in a diagrammatic form is very helpful in enabling the results to be clearly visualised particularly when one set of figures is shown in comparison with another, e.g. receipts versus expenses.

STATISTICAL CHARTS.

This series of block charts illustrates the results of working very clearly. One set of figures is shown in comparison with another, eg. Receipts against Expenses, distinctive colours are used to differentiate, by this means the margin or connection between one set of figures and the other can be seen at a glance.

These Statistical Charts are numbered thus.

No.

1. Coal Tonnage carried and receipts.
2. Timber Tonnage carried and receipts.
3. Building materials carried and receipts.
4. Machinery and metals carried and receipts.
5. Miscellaneous carried and receipts.
6. Straw and Tibn carried and receipts.
7. Manure carried and receipts.

SECTION 5.

NOS. 1-37.

FIRST FLOOR
BAYS O.-P.

- 
8. Tobacco carried and receipts.
 9. Onions carried and receipts.
 10. Cereals carried and receipts.
 11. Rice carried and receipts.
 12. Petroleum, Benzine carried and receipts.
 13. Oil and grease carried and receipts.
 14. Sugar and Molasses carried and receipts.
 15. Unginned Cotton carried and receipts.
 16. Ginned Cotton carried and receipts.
 17. Cotton Seed carried and receipts.
 18. Piece goods, cloth and other stuffs carried and receipts.
 19. Perishable stuffs carried and receipts.
 20. Number of animals carried and receipts.
 21. Train Kilometrage.
 22. Kilos. open for traffic.
 23. Receipts from G.V. traffic.
 24. Percentage of total earnings.
 25. Capital valuation, gross receipts, working expenses and net receipts.
 27. Percentage of working expenses and net earnings to total earnings.
 28. Receipts and expenses per kilometre open.
 29. Receipts and expenses per kilometre.
 30. Tons of goods carried one kilometre.
 31. Tonnage transported by goods trains.
 32. Number of passengers carried.
 33. Number of passengers carried one kilometre.
 34. Coaching receipts.
 35. Goods receipts.
 36. Percentage of expenses to earnings.
 37. Receipts.

**LOCOMOTIVE, CARRIAGE AND WAGON STOCK
IN SERVICE.
EGYPTIAN STATE RAILWAYS, 1852-1931.**

This coloured block chart shows the rolling stock in service each year from the origin of the Egyptian State Railways in 1852 down to the end of 1931.

Distinctive colours are used to indicate the number of each class of stock in service.

**TOTAL EXPENDITURE AND KILOMETRAGE.
EGYPTIAN STATE RAILWAYS, 1878-1930.**

The total yearly expenditure in Egyptian pounds incurred in running the Mechanical Department of the Egyptian State Railways system, from the year 1878 up to and including the year 1930 is shown on this block chart, together with the total yearly kilometrage run. At the bottom of the chart the cost in millimes per kilometre is given.

**COAL AND OIL CONSUMPTION AND KILOMETRAGE.
EGYPTIAN STATE RAILWAYS, 1878-1930.**

The total yearly consumption of coal and oil in the Mechanical Department of the Egyptian State Railways, and the kilometrage from 1878 to 1930 are shown side by side on this block chart. The coal consumption is given in kilogrammes and the quantity of oil used in grammes. At the bottom of the chart the consumption of coal and oil per kilometre is shown.

**E.S.R. PASSENGERS CARRIED, PRIVATE MOTOR CARS
REGISTERED, AND PASSENGER MOTOR BUSES
REGISTERED.**

This block chart shows for each year 1922 to 1931:

- (1) E.S.R. Passengers Carried.
- (2) Private Motor Cars Registered.
- (3) Passenger Motor Buses Registered.

The fluctuations shown on the chart are not to comparative scales

EXPORTS, IMPORTS, AND E.S.R. GOODS RECEIPTS.

This block chart shows for each year 1922 to 1931.

- (1) Exports in Egyptian Pounds.
- (2) Imports in Egyptian Pounds.
- (3) E.S.R. Goods Receipts in Egyptian Pounds.

**SECTION 5.
NO. 38.
FIRST FLOOR**

**SECTION 5.
NO. 39.
FIRST FLOOR**

**SECTION 5.
NO. 40.
FIRST FLOOR**

**SECTION 5.
NO. 41.
ON STAIRS.**

**SECTION 5.
NO. 42.
ON STAIRS.**

**SECTION 5.
NO. 43.**
ON STAIRS.

RAIL, ROAD AND WATER GOODS TRANSPORT.

This block chart shows for each year 1922 to 1931.

- (1) E.S.R. Goods transport in tons.
- (2) Road Vehicle Registered Tonnage-Goods.
- (3) Water Craft Registered Tonnage-Goods.

It should be noted that the fluctuations given on the chart are not to comparative scales.

**SECTION 5.
NO. 44.**

FIRST FLOOR
CENTRE CASE
BETWEEN
BAYS P.-Q.

**SEASON TICKETS AND CARD PASSES.
EGYPTIAN STATE RAILWAYS.**

These are examples of Season Tickets and Card Passes in use from 1908 to date. Sample is exhibited only when a change in the design took effect. All made and printed in the Printing Office of the Egyptian State Railways, Telegraphs and Telephones.

**SECTION 5.
NO. 45.**

FIRST FLOOR
CENTRE CASE
BETWEEN
BAYS P.-Q.

MISCELLANEOUS PRINTING.

These are examples of miscellaneous work produced by the Printing Office of the Egyptian State Railways, Telegraphs and Telephones.

**SECTION 5.
NO. 46.**

FIRST FLOOR

SPECIAL BOOK.

This is a special book, printed by the Printing Office of the Egyptian State Railways, Telegraphs and Telephones on the occasion of His Majesty King Fouad Ist, opening the Automatic Telephone Exchange on October 1st, 1931.

**SECTION 5.
NO. 47.**

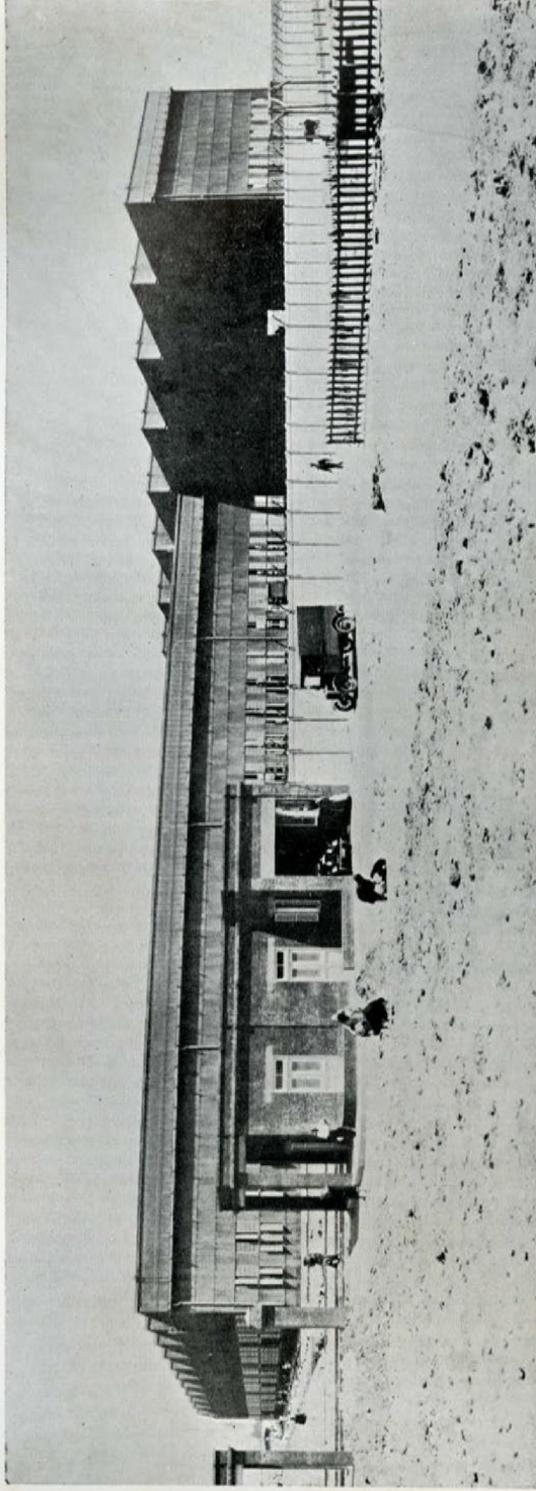
FIRST FLOOR

EXAMPLE OF 3 PROCESS COLOUR PRINTING.

This is an example of 3 colour process printing carried out experimentally by the Printing Office of the Egyptian State Railways, Telegraphs and Telephones.

Exhibit shows:—

1. The yellow block.
2. The red block.
3. The red printed on the yellow.
4. The blue block.
5. The blue printing on the yellow and red producing the finishing picture.



Abu-Zaabal Railway Workshops.

The workshops in their present stage of completion.

A model is exhibited in the Museum.

ورش أبو زعبل

الورش في حالتها الحاضرة

هناك نموذج لها معروض في المتحف

SECTION 6.

NEW RAILWAY WORKSHOPS—ABU ZAABAL. EGYPTIAN STATE RAILWAYS.

The rapid development of the State Railway system, with ever increasing addition to its rolling stock, strained the capacity of the Bulak Shops. Prior to the war it had become increasingly evident that the capacity of the Bulak Shops had been overtaken and that the shops must have capacity largely increased to deal adequately and efficiently with locomotives in particular. The period following the War was one in which extreme difficulty was experienced in maintaining locomotives in service. All indications then pointed to a situation of bad congestion in the near future, with the rapid and progressive development of traffic then promising.

The Bulak site had insufficient area with no possibility of increasing existing area for the requisite expansion of the shops. It became necessary to find a new site and face the problem of eventual removal of the shops from Bulak.

The site as finally acquired is a Abu-Zaabal, situated 28 kilometres from Cairo in a North Eastern direction.

It was not until 1928/29 that all formalities to acquisition of land and sanction to project were completed and work could be started on the new shops.

The ultimate scheme provides for a complete locomotive repair shop which will effect heavy repairs to all the locomotives of the system and a carriage repair shop for dealing with the overhaul of all carriage stock.

For the immediate future, however, in view of the financial stringency and continued depression of traffic, the scheme is limited to a central workshop for locomotive repairs only as replacing existing workshops at Bulak and Gabbary at an estimated cost of L.E.240,000.

The area of 1,100 acres of land as acquired will be sufficient to lay out a model township for the housing of the staff and workmen, together with educational, religious and health institutions when the scheme is completed.

The first section of Locomotive Shops is complete and will be capable of heavily repairing 120 locomotives per annum. The buildings have a total floor area of 196,000 sq. feet, they comprise locomotive shops, machine, production and blacksmith shops. Housing accommodation for about 400 workmen and staff has been already built.

The Workshops are laid out to conform to a regular progressive system of repairs to locomotives and parts in both Erecting Shop and Machine Shop. Every movement and task associated with the work progressing in strict accordance with a preconcerted plan, special purpose Machine Tools being used for specific work and mechanics specializing on particular jobs enables them to become experts on such jobs. This will enable a larger proportion of the spare parts as now purchased from abroad to be manufactured in Egypt in future.

The work is carried out more expeditiously and at less cost than by the original method of repair.

The scheme provides for a central production Machine Shop which will ultimately serve both Carriage and Locomotive Shops and be under one control for direction. It has a floor area of 123,200 square feet and comprises 4 bays of 80 feet x 385 feet length, each having a 10 Ton Overhead Crane for handling larger machine parts. The machines are arranged in groups to enable specific repairs to be carried out with little handling.

The machine tools installed are of the most modern type and capable of high output. Many are individually motor driven but the smaller are driven by lineshafting running on roller bearings, driven by 20 H.P. motors.

The Erecting Shop is 665 feet long and 80 feet wide, 19 pits and 19 spare roads. The Engines are brought into this Erecting shop, by means of an electrically operated 100 Ton Traverser. One 100 Ton Crane running the full length of the Shop having a span of 75 feet, and one 10 Ton Crane of 72 feet span — are installed in the Erecting Shop.

In order to ensure interchangeability of parts a system of limits has been introduced to which tolerance gauges are made. The groups into which the machine shops are divided are:—

(1) **Toolroom.**

Where all gauges, tools, jigs and fixtures are made.

(2) **Manufacturing Bay.**

In this group many of the spares are rough machined prior to finishing in their respective groups.

(3) **Wheel Bay.**

Here all operations in connection with the repair and maintenance of wheels and axles are done in a progressive sequence of operations.

(4) **Motion Bay.**

This group handles the production of all motion details.

(5) **Connecting Rod Bay.**

In this group the machines are concentrated on the production of connecting and coupling rods.

(6) **Piston and Crosshead Bay.**

All operations in the production of these parts are performed in this group.

(7) **Axlebox Bay.**

This group of machines concentrates on the production of axleboxes in a progressive sequence of operations.

(8) **Brass Shop.**

Here all Boiler Mountings etc., are produced and tested.

Compressed air at 80 lbs. pressure is supplied to Shops for portable riveting machines and hycycle mains are laid for portable drilling machines.

The main electric supply is A.C. 420 volts, 50 cycles, 3 phase.

The floors are laid with wooden paving blocks and the traverser roads have concrete surfaces.

Smiths Shop.—This shop has a floor area of 19,600 square feet. There are 12 smith's hearths of the downdraught type, the blast being supplied by a Blower Fan placed inside the Shop.

Two pneumatic hammers of 15 and 10 cwts. capacity respectively, and one steam hammer of 5 cwts. are installed. The furnace equipment comprises one for heating billets, and another for spring plates; both are oil fired. The other machines in this section of the shop are a Hot Saw, and a Punching, Shearing and Cropping Machine. One section of this Shop is devoted to the repair and maintenance of boiler tubes, the plant comprising machines for Tube Scaling, Sawing, Reducing, Expanding, Welding and Testing. Other Sections are reserved for Spring fitting, Coppersmiths, Oxy-Acetylene and Electric Welding. Steam for the hammer and other purposes is produced by two locomotive type boilers laid down outside the Shop.

MODEL OF NEW RAILWAY WORKSHOPS, ABU ZAABAL.

This model represents the workshops in their present stage of completion.

The scale drawing ($1/250$) mounted on the wall panel shows the layout of the various sections of the works, and the machine tools are detailed in tabular form on the same drawing.

SECTION 6.
NO. 1.
FIRST FLOOR
BAY B.

SECTION 6. NO. 2.

FIRST FLOOR
BAY B.

SCALE 1/40

PRESENTED BY

ATELIERS DE

CONSTRUCTIONS

ELECTRIQUES

DE CHARLEROI.

MODEL OF 100 TON ELECTRIC OVERHEAD TRAVELLING CRANE — ABU ZAABAL WORKSHOPS.

This model represents the electric overhead travelling crane which is installed in the Erecting Shop at the new Abu-Zaabal Workshops.

It is used for the purpose of lifting and travelling with locomotives having a maximum weight of 100 tons.

The main cross girders are of the lattice braced type with top and bottom booms parallel; and are stiffened laterally by means of a lattice braced auxiliary girder of similar type, fixed on the outside of each main girder, and connected thereto by horizontal bracing top and bottom.

Platforms are provided on the outside of the main girders running the whole length of the crane; and wrought iron double handrailing is fitted to both platforms. The end carriages are of box section, mounted on cast steel double flanged wheels.

The operating cage is suspended beneath the main girders, and houses all the control gear, it is so designed that the driver has a clear view of the load in all positions.

The crabs are constructed of rolled steel sections and forgings, and each runs on four cast steel wheels on the bridge rails riveted to the top of the main girders.

The rope barrels are of cast iron with right and left hand grooves for the rope.

The crabs are fitted with auxiliary hoisting gear.

All motions of the crane, i.e. longitudinal travel, cross traversing, hoisting and auxiliary hoist are operated by independent motors. Brakes are fitted to each motion, in addition to which the hoisting motion is fitted with an automatic electro-magnetic brake, which is capable of sustaining the full load in the event of the power supply failing.

The steel wire ropes are of extra flexible quality with a minimum factor of safety of 7.

Return blocks are fitted having cast iron sheaves and steel crosshead and side links. The crane hooks are of the "Ramshorn" type fitted with ball bearings to facilitate turning the loads.

The motors are of the enclosed ventilated slip-ring reversible type suitable for an A.C. current supply of 420 volts, 50 cycles, 3 phase.

Principal Dimensions of Crane.

Span : 75'-0".

Speeds.

Hoisting : 50 tons at 5 feet per minute.

Hoisting : 10 tons at 20 feet per minute.

Longitudinal travelling, 200 feet per minute.

Cross Traverse : 80 feet per minute.

SECTION 7.

PERMANENT WAY AND WORKS.

TYPES OF RAILS USED ON EGYPTIAN STATE RAILWAYS—FROM 1852 TO 1932.

The first type of rail on record was a D.H. W.I. rail used in the construction of the Alexandria—Cairo Railway in the reign of the Viceroy Abbas I, and laid on C.I. Pot Sleepers. The weight of this rail is unknown and no examples are extant.

The earliest type of which specimens exist is a 35 kilogs. double head W.I. rail introduced in 1865 (Exhibit 1-A) which was followed by a Belgian rail of 39 kilogs. in 1867 (Exhibit 1-B) and in 1869 by the "Vauthrin" and "Azizi" types both 35 kilogs. (Exhibit 1-C and 1-D).

Up to this date the track was laid on C.I. Pot Sleepers.

In 1873 Flat Bottom Rails first made their appearance with 32.9 and 34.5 kilogs. sections (Exhibit I-E and I-F) laid on wooden sleepers, the use of Pot Sleepers from this year on being definitely abandoned in renewals and construction.

The above rails were all Wrought Iron.

The next order placed was in 1889 when steel first made its appearance with a D.H. section of 35.7 kilogs. (Exhibit I-G), these rails were laid in C.I. Chairs on wooden sleepers.

In 1893 a supply of F.B. Rails 37.4 kilogs. and 42 kilogs. (Exhibits I-H and I-I) was purchased. These have proved wonderfully good rails and many are still in use in running lines giving useful service.

In 1897 a supply of Bull Head rails of 38.6 kilogs. section (Exhibit I-K) was ordered followed in 1902 by a 42 kilogs. rail of the same type (Exhibit I-L). In 1902 it was decided to adopt the flat bottom rail and since this date there have been no further orders for D.H. or B.H. An order was placed in this year for F.B. rails 46 kilogs. (Exhibit I-M) these being laid for the first time on the Ismailia—Port-Said line which was opened in 1904 and replaced the old light railway operated by the Suez Canal Company.

In 1911 it was decided to increase the weight to 47 kilogs. (Exhibit I-N) and this section still remains the standard for main lines and important branches. It is used with either wooden (Exhibit I-O) or steel (Exhibit I-P) sleepers and in the case of the former is laid on steel saddle plates weighing 4.5 kilogs. each. Fifteen hundred sleepers per kilom., with an increase to 1,584 on curves less than 500 metres radius, and 6-hole deep angle fishplates weighing 36.7 kilogs. per pair.

SECTION 7.

NO. 1-A. TO 1-P
GROUND FLOOR
BAYS N-O.

Other rails in use on lines not constructed by the Egyptian State Railways but subsequently absorbed were:—

**SECTION 7.
NO. 2.**

GROUND FLOOR
BAY O.

Steel F.B.	Date
(a) 35 kilogs., Mariout line—B.G. Section.	Unknown
(b) 14 kilogs., Mariout line—N.G. Section.	Unknown
(b) 30 kilogs., Helouan line.	1915
(b) 40 kilogs., Helouan line.	1915
(b) 21 kilogs., Luxor—Assuan.	1895
(b) 25 kilogs., Luxor—Assuan.	1898
(b) 30 kilogs., Luxor—Assuan.	1910
(a) 21 kilogs., Auxiliary Railway of Upper Egypt.	Unknown
(c) 18 kilogs. Western Oasis Railway N.G.	1908
(a) partially replaced by heavier rails.	
(b) entirely replaced by heavier rails.	
(c) Still in use as originally laid.	

**SECTION 7.
NO. 3.**

GROUND FLOOR
BAY O.
PRESENTED BY
MESSRS. G.D.
PETERS
& CO. LTD., 1932.

**RAILS USED ON THE G.W.R. ENGLAND,
ON THE ORIGINAL BROAD GAUGE LINE 1838—1892.**

This exhibit shews two samples of the type of rails which were used by the G.W.R. on the original broad gauge section line between the years 1838 and 1892.

The samples were taken from the sidings of Messrs. D. G. Peters & Co. Ltd. at Slough, Wiltshire, on the G.W.R. system.

**SECTION 7.
NO. 4.**

GROUND FLOOR
PRESENTED BY
COLVILLE'S LTD.,
1932.

**THE SEQUENCE OF OPERATIONS
IN THE MANUFACTURE OF 47 Kilos. FLAT BOTTOM RAIL**

This exhibit shews the sequence of operations in the manufacture of 47 kilos. flat bottom rails.

Sections of steel at different stages of rolling are shewn, these are clearly indicated by cards adjoining the sections, and are as follows:—

- (a) Cross section of ingot.
- (b) Cross section of billet.
- (c) 1st. roughing pass.
- (d) 2nd. roughing pass.
- (e) 3rd. roughing pass.
- (f) 4th. roughing pass.
- (g) 5th. roughing pass.
- (h) 6th. roughing pass.
- (i) 1st. finishing pass.
- (j) 2nd. finishing pass.
- (k) 3rd. finishing pass.
- (l) 4th. finishing pass.
- (m) Cross section of finished rail.

MATERIALS USED IN THE MANUFACTURE OF RAILS AND SLEEPERS.

This exhibit shews samples of the raw materials used in the manufacture of rails and steel sleepers.

The samples comprise:—

- (a) Limestone.
- (b) Coal.
- (c) Coke.

Iron Ores.

- (a) Spathic.
- (b) Campanil.
- (c) Rubio.
- (d) Guillermo.

Pig Iron.

- (a) Sand cast.
- (b) Machine cast.

Sections of Rails.

- (a) 100 lb. per yard flat bottom rail.
- (b) 100 lb. per yard bull head rail.
- (c) 120 lb. per yard bridge rail.
- (d) 72 lb. per yard steel sleeper plate.
- (e) 72 lb. per yard pressed steel sleeper.

STATION BUILDINGS.

When the first railway was constructed in Egypt, dependent buildings, such as stations, shops, sheds and stores were erected in the more important towns. Subsequent development of the State Railways system led to the evolution of buildings to keep pace with the demands of the service, the result being that imposing station buildings, spacious shops and offices, and comfortable and healthy dwellings for the staff were built.

The more important station buildings are briefly described in the following notes:—

Cairo Station Building:

The first station building at Cairo was erected about 1856 and replaced in 1892 by the present station building designed in Arabe style; internal alterations and three subsequent extensions have been carried out, the last extension being the Egyptian State Railways, Museum.

SECTION 7. NO. 5.

GROUND FLOOR
PRESENTED BY
THE BRITISH
(GUEST.KEEN
BALDWIN'S)
IRON
& STEEL CO.
LTD., 1932.

Its total area at present is 5,130 square metres. It is provided with 5 Lower Egypt passenger platforms covered with a 44 metres one span steel shelter and 3 Lower Egypt passenger platforms covered by separate shelters.

A Royal entrance and waiting room, richly decorated in Arabe style, form the central feature of the front elevation.

The 1st. and 2nd. floors accommodate the General Management, Traffic and Audit Offices.

This building is the largest and most important station building on the system.

Alexandria Station Building.

The old station building at Alexandria was erected early in 1856 with the opening of the Cairo—Alexandria line. Fifty years later this station building was insufficient to cope with the traffic which was constantly increasing, and the construction of a new and bigger station building became a matter of necessity.

The new site adopted was that projected in the Municipality's scheme for the remodelling of the station square.

The works were put in hand in 1913, but had to be suspended in 1914 during the Great War.

They were subsequently resumed and completed in 1927, and on the 1st. November of that year Alexandria New Station Building was officially opened to traffic.

The front elevation measures 90.1 m. and the north elevation about 135 metres.

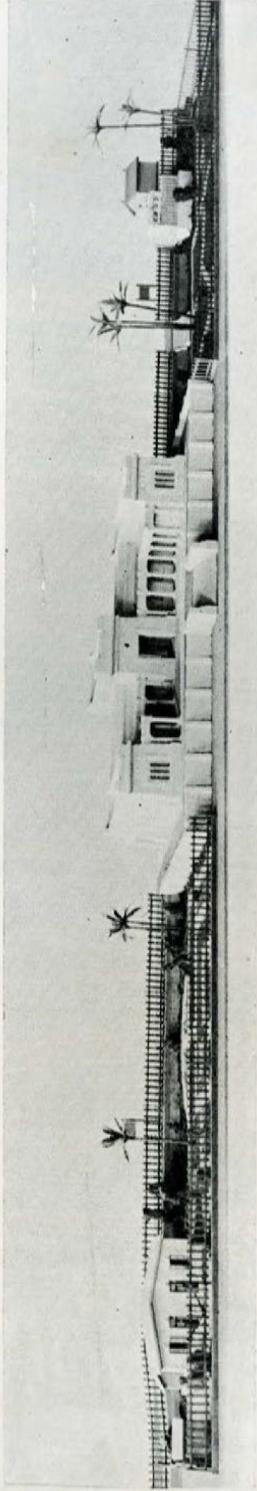
Its covered area is about 4,000 sq. metres. It is provided with 4 passenger platforms covered by one 48 metres span steel shelter, similar with that at Cairo Station.

TANTA NEW STATION.

This building was commenced in 1930 and is now completed.

Advantage was taken in this project of the 4 metres difference in level existing between the station yard and the passenger platform to create passenger subways from the entrance halls, crossing the lines and giving direct access to its 5 different platforms by means of stairs.

The front elevation of the station building which is designed in modern Arabe style measures 110 metres and it covers an area of 1,065 sq. metres. The ground and platform level floors are entirely allocated to the station service. The second floor accommodates the Traffic offices and the 3rd. floor is completely occupied by the New Automatic Telephone Exchange.



Model of Edfou Station.

Designed in ancient Egypt style, this sanction was completed in 1928.

النموذج لخطة ادفو

عمل تصميمها على الطراز المصرى القديم وقد تم بناؤها فى سنة ١٩٢٨

MALLAWI STATION BUILDING.

The Mallawi Station building was erected on 1929. This up to date building is provided with a central Hall and two lateral wings protected by a steel shelter.

The building was planned to deal with the extended goods traffic during the cotton season.

EDFU STATION BUILDING.

The station building at Edfu was completed in 1928. It is designed in the ancient Egyptian style, owing to its importance as a tourist centre and to harmonize with its situation on the Nile bank, in front of the great temple of Edfu. This station building is provided with a patio and with a double roof to protect it from the heat of the sun.

KOM OMBO NEW STATION BUILDING.

This is the most recent station building and was completed early in 1932.

Owing to its situation in a tourist centre, it was designed in ancient Egyptian style. The massing gives the impression of a small ancient temple although the logic inner layout necessary to a station building was not affected.

MODEL OF TANTA NEW STATION. EGYPTIAN STATE RAILWAYS.

This model represents the new station at Tanta, and is cast in Gypsum. It shews in detail the main building, subways, verandahs, etc.

MODEL OF EDFU NEW STATION. EGYPTIAN STATE RAILWAYS.

This model, which is made of Limestone shews details of the buildings, etc.

MODEL OF AN ALL—CONCRETE STATION. EGYPTIAN STATE RAILWAYS.

This model, which was made at the Tanta concrete depôt, shews a standard type of all-concrete station kiosk, of two rooms, with a covered verandah between, with station name board, station petroleum depôt, concrete pale fencing and platform walling.

SECTION 7. NO. 6.

GROUND FLOOR
(ANNEX).
SCALE 1/50.

SECTION 7. NO. 7.

GROUND FLOOR
(ANNEX).
SCALE 1/50.

SECTION 7. NO. 8.

GROUND FLOOR
(ANNEX)
SCALE 1/10.

**SECTION 7.
NO. 9.**

GROUND FLOOR
(ANNEX).
SCALE 1/5.

MODEL OF STANDARD TYPE OF PALE FENCING.

This model represents the standard type of concrete pale fencing, in 3 metre bays.

**SECTION 7.
NO. 10.**

GROUND FLOOR
(ANNEX).
SCALE 1/5

**MODEL OF STANDARD TYPE OF CLOSED
HIGH WALLING.
EGYPTIAN STATE RAILWAYS.**

This model represents the standard type of 2.50 metre closed high walling in 2 metre bays, with back stay at every other column.

**SECTION 7.
NO. 11.**

GROUND FLOOR
(ANNEX).
SCALE 1/5.

**MODEL OF STANDARD TYPE OF SINGLE STATION
NAME BOARD.
EGYPTIAN STATE RAILWAYS.**

This model represents the standard type of single station name board used on the Egyptian State Railways.

**SECTION 7.
NO. 12.**

GROUND FLOOR
(ANNEX).
SCALE 1/5.

MODEL OF SEMAPHORE POST.

Standard Type of 25 feet high Semaphore Post.

**SECTION 7.
NO. 13.**

GROUND FLOOR
BAY N.-O.
REPLICA BY THE
COURTESY OF
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

JESSOP RAIL — 1789.

This is a replica of the edge rail introduced by William Jessop, in 1789, and used on the Nanpanton-Loughborough Railway, England, where it crossed the main road. This rail had an upper parallel, and an elliptical or fish-bellied lower flange, and was 3'-0" long. The head, however, was insufficiently wide, and cut into the tyres of the wheels; another objection to this type was the fact that the wheel required a flange, which at that time meant a revolution in wagon construction.

**SECTION 7.
NO. 14.**

GROUND FLOOR
BAY O.
REPLICA BY THE
COURTESY OF
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

OUTRAM RAIL AND POINTS 1816.

This is a replica of the rail and points made by Benjamin Outram in 1816, at the Butterley Iron works, where he was a partner. He was a great advocate for, and maker of, plate-ways, a term which furnished the origin of "platelayers".

BIRKINSHAW RAIL 1815.

This is a section of the original rail made by John Birkinshaw of the Bedlington Iron Works, England, in 1815.

BIRKINSHAW RAIL, 1816.

This is a section of the actual rail made by John Birkinshaw, of the Bedlington Iron Works; England, in 1816.

LIVERPOOL AND MANCHESTER RAIL, 1829.

This is a replica of the original rail used on the Liverpool and Manchester Railway when it was opened in 1829. These rails were designed by John Birkinshaw, of the Bedlington Iron Works, and were of T section 15'-0" long 2 ¼" wide at the head, with a base in five ellipses, 3½" deep in the middle of the ellipse and 2 ½" deep at the five points where the rail rested in the chairs. The latter had projections on the inner side of each cheek that fitted the web of the rail. The rail weighed 35 lbs. per yard.

DERBY AND BIRMINGHAM RAILWAY, RAIL AND CHAIR, 1839.

This is a reproduction from originals of the rail and chair used on the Derby and Birmingham Railway, England, in 1839.

SECTION 7. NO. 15.

GROUND FLOOR
BAY O.
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

SECTION 7. NO. 16.

GROUND FLOOR
BAY O.
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

SECTION 7. NO. 17.

GROUND FLOOR
BAY O.
REPLICA BY THE
COURTESY OF
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

SECTION 7. NO. 18.

GROUND FLOOR
BAY O.
REPLICA BY THE
COURTESY OF
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

**SECTION 7.
NO. 19.**

GROUND FLOOR
BAY O.
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

BIRMINGHAM AND GLOUCESTER RAIL, 1839.

This is a piece of the original rail used on the Birmingham and Gloucester Railway.

This flat bottomed rail, with which the name of Vignoles has always been associated, was actually designed by Stevens, the Engineer of the Camden and Amboy Railroad, in 1830, but they were made in England.

They became very popular because of being spiked to the sleeper and needing no chairs.

**SECTION 7.
NO. 20.**

GROUND FLOOR
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

MIDLAND COUNTIES RAILWAY RAIL, 1839.

This is a section of the actual rail used on the Midland Counties Railway, England, in 1839.

**SECTION 7.
NO. 21.**

GROUND FLOOR
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

MIDLAND RAILWAY RAIL, 1850.

This is a section of the actual rail used on the Midland Railway, England, in 1850.

**SECTION 7.
NO. 22.**

GROUND FLOOR
PRESENTED BY
THE INSTITUTION
OF MECHANICAL
ENGINEERS,
LONDON.

LEICESTER AND HITCHEN RAILWAY RAIL, 1857.

This is a section of the actual rail used on the Leicester and Hitchen Railway in 1857.

**SECTION 7.
NO. 23.**

GROUND FLOOR
SCALE 1/20.

**MODEL OF TRACK TURNOUT.
EGYPTIAN STATE RAILWAYS.**

This model represents a track turnout, 1 in 8, for Vignoles 47 kilogs. rails, and shows details of fixing and respective timber sleepers.

**MODEL OF "SCISSORS" CROSSING.
EGYPTIAN STATE RAILWAYS.**

This model represents a double through or "Scissors" crossing, 1 in 10, for Vignoles 47 kilogs. rails.

The distance between tracks is 2 metres, and the model shews details of fixing and respective sleepers.

**MODEL OF DOUBLE SLIP ROAD.
EGYPTIAN STATE RAILWAYS.**

This model represents a double slip road, 1 in 10, for Vignoles 47 kilogs. rails, and shews details of fixing and respective sleepers.

PERMANENT WAY MAINTENANCE TOOLS.

This exhibit shews typical permanent way tools of various kinds, comprising Shovels and Hammers, Railway Beaters, Pick Axes, Carpenter's Adze and, a Fase. A descriptive card adjoins each tool.

STOCKTON AND DARLINGTON RAILWAY TRACK, 1825.

These are replicas of the original track used on the Stockton and Darlington Railway when it was opened in 1825. The rail exhibited is in cast iron, but the original rails were of wrought iron, and were designed by John Birkinshaw, of Bedlington Iron Works, Northumberland, and rolled at these works. This rail which was T section had not only a bigger head and base than the cast iron rails previously used, but was lighter in weight. The rails were 12 and 15 feet in length, and 2 1/4" wide at the top, of fish bellied shape, 3 1/4" deep in the middle and 2" deep at the end. The web was 3/4" thick at the top, and 1/2" thick at the bottom. The rails weighed 28 lb. per yard, and were supported on stone sleepers laid 3'-0" apart.

BLINKINSOPP RAILWAY TRACK.

These are replicas of the original track used by John Blinkinsopp on the rack railway which he patented in 1811. Such rails were laid from Middleton Colliery to Leeds in 1812, and from the Kenton and Coxlodge collieries to the Tyne in 1813. In their original form the rails, which were of cast iron, were made with solid cogs, and chairs cast solid with the rail. They were in 6 feet lengths. but before the completion of the original track from Middleton Colliery to Leeds, an improved pattern was

**SECTION 7.
NO. 24.**

GROUND FLOOR
SCALE 1/20.

**SECTION 7.
NO. 25.**

GROUND FLOOR
SCALE 1/20.

**SECTION 7.
NO. 26.**

GROUND FLOOR
BAY P.
PRESENTED BY
HARDY PICK LTD..
1932.

**SECTION 7.
NO. 27.**

GROUND FLOOR
BAYS O.

**SECTION 7.
NO. 28.**

GROUND FLOOR
BAY O.

introduced in which the cogs were cast hollow, and the chairs made separate. The later rails were only made in 3 feet lengths, and the chairs were fixed by driving iron spikes into holes in the stone sleepers, and wedging them with wood. Each chair was fixed to a separate sleeper about 10" long x 17" deep x 9" thick.

The engine used on this rack railway was fitted with a cogged driving wheel, which engaged with the rack cast on the rails on one side of the wagon way. The original rails were cast by the Tyne Iron Works at Lemington-on-Tyne, and were removed from these works at the time they were dismantled by Messrs. John Spencer & Sons Ltd. many years ago. When the works of the latter firm were dismantled a few years ago, the rails were sent to the L.N.E.R. Museum at York.

These replicas were cast at the Boulac Works, of the Egyptian State Railways, from patterns made from the originals.

**SECTION 7.
NO. 29.**

GROUND FLOOR

PEAK FOREST CANAL TRAMWAY TRACK, 1797.

This layout is a reproduction from originals of straight track, points and chairs as laid by Benjamin Outram, of the Butterley Iron Works, in 1797, for the Peak Forest Canal Tramway, England. The rails are of angle section, and were made in 3'-0" lengths. The chairs were fixed to stone sleepers, each chair on a separate sleeper.

**SECTION 7.
NO. 30.**

GROUND FLOOR
BAY O.
PRESENTED BY
MESSRS. EDGAR
ALLEN & CO.
LTD., 1932.

MANGANESE STEEL RAIL.

This exhibit is a section of Manganese steel rail. This material is specially suitable for rails on account of its hardness and wear resisting qualities.

The holes were drilled by a twist drill of special design, made of super-high speed steel.

**SECTION 7.
NO. 31.**

GROUND FLOOR
BAY O.
PRESENTED BY
MESSRS. EDGAR
ALLEN & CO.
LTD., 1932.

DRILLINGS FROM MANGANESE STEEL RAIL.

These drillings are from the section of rail (No. 30) and show the form which should be obtained when the proper type of drill is used.

A drill of special design, made of super-high speed steel was used. This was also made by the maker's of the rail.

MANGANESE STEEL RAIL BENT COLD.

This exhibit is a length of rail of "Imperial" Patent Rolled Manganese Steel.

It was bent in the cold state.

CROSSING VEE, ANGLE 1 IN 8.

This exhibit is a crossing vee, with an angle of 1 in 8, consisting of one splice and point rail notched and gouged, built up in the maker's patent rolled "Imperial" Manganese Steel.

The rails are of British Standard Section 75 lbs., flat bottom.



SECTION 7. NO. 32.

GROUND FLOOR
PRESENTED BY
MESSRS. EDGAR
ALLEN & CO.
LTD., 1932.

SECTION 7. NO. 33.

GROUND FLOOR
PRESENTED BY
MESSRS. EDGAR
ALLEN & CO.
LTD., 1932.

SECTION 8.

BRIDGES.

Bridge Building.

For many centuries wood, stone and fibrous plants were the only materials available for bridge construction.

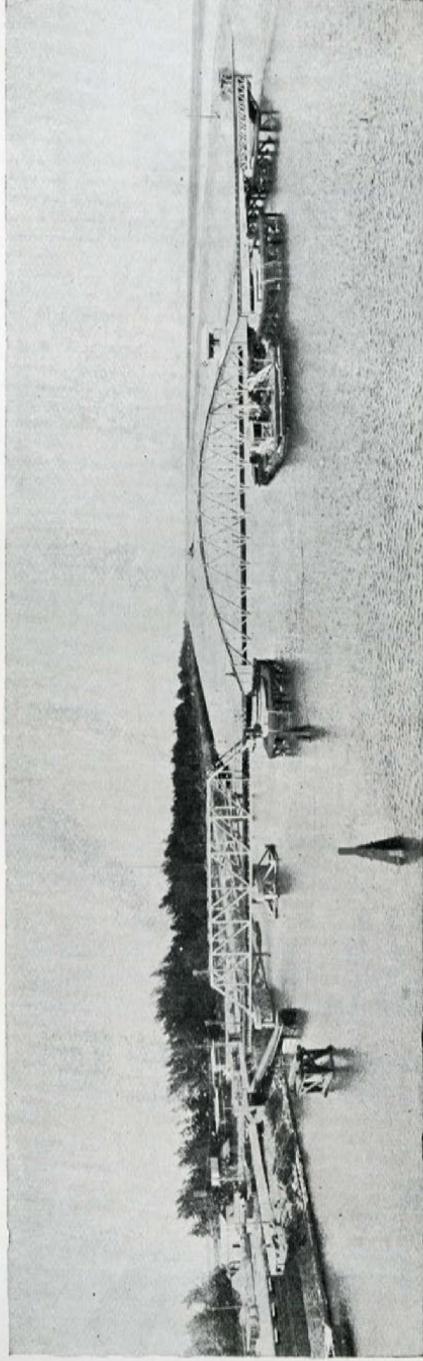
The prototype of our present beam or girder span was the log or tree felled across a stream, while the "Monkey Bridge", or a hanging, looping vine furnished the inspiration for the early suspension bridge. The Romans were the real bridge builders of antiquity: records of their works are fairly well preserved in Italy, Spain and France. Amongst the beam spans the earliest bridge of which we have any exact information was the Pons Sublicius over the Tiber at Rome (620 B.C.), and the most celebrated was Caesar's pile trestle bridge built over the Rhine (55 B.C.).

Corbelled stone arches were used by the Egyptians in the Pyramids of Giza (3,000 to 4,000 years B.C.) and brick arches of crude form are found in the ruins of Thebes; but it was the Romans who really developed the masonry arch. With the fall of Rome, bridge construction in Europe came to a standstill and for many centuries little progress was made. The pioneer bridge builders of the Middle Ages were the Moors in Spain.

At the end of the XVIIth. century when the development of modern science began, the basis for rational engineering theory was laid, leading gradually to the marvellous expansion of the last century. A great impetus was given to scientific design in 1716 when the French Government organized the Department of Roads and Bridges and attached an engineering school (Ecole des Ponts et Chaussées) to it.

The last form of bridge construction to be envolved was the truss invented by Palladio an Italian Architect (XVIth Century), but the invention lapsed until about 1760 when John and Ulrich Grubenmann revived the art in Switzerland and built several truss timber spans on the Limmat at Wittingen, one of 120 metres length being the longest timber span on record. Until the introduction of iron into bridge construction no further improvement was possible.

The first cast iron span was built in 1776 at Coalbrookdale in England over the river Severn. This bridge is an arched structure of 30 metres span and is still in use today. It was followed by a large number of cast iron bridges which were built in various parts of Europe within the following 100 years, nearly all of them being of the arched type.



The Hersh Swing Bridge.

The bridge was built in 1917 over the Suez Canal, for military purposes. It was located 5 kilometres from Kantara, and was removed in 1921.

كبرى الحرش المتحرك

بني هذا الكوبرى في سنة ١٩١٧ على قناة السويس لانراض حربية وكان
موقعه على بعد خمسة كيلومترات من القنطرة وقد ازيل في سنة ١٩٢١

The first railway bridge was constructed in 1823 on the Stockton and Darlington Railway and was the forerunner of the vast array of bridges that have spread over the world as the result of the development of land transport.

In 1847 when the Conway and Britannia bridges were to be designed, Robert Stephenson made a series of experiments on the strength of cast iron and wrought iron which showed the great superiority of the latter material and it was therefore decided to adopt tubular bridges of wrought iron rather than cast iron arches. From that time wrought iron gradually replaced cast iron for bridge construction and was supreme until superseded by steel towards the end of the last century. In 1828 steel of the puddle variety was first utilized in bridge work for a 90 metres suspension span at Vienna, (Austria), but it was another sixty years before steel of a suitable quality for bridge building was manufactured in any quantity. Now simple carbon steel has been replaced in its turn by special alloy steels for large bridges.

Natural cement was applied to bridge construction in the early part of the XIXth. century to the great improvement of masonry work. The development of the Portland cement industry since 1833 provided a more reliable material; and as a result, plain concrete came into very extensive use for arch bridges and for the substructures of other forms of bridge construction.

In order to strengthen concrete structures the practice of embedding old rails and steel bars in the concrete arose naturally. The convenience of this method of construction and the scientific study of stresses in composite structures and the most economical and effective way of employing each material have led to the remarkable growth of the use of reinforced concrete which has been one of the most important features of bridge building in the present century.

MODEL OF LOCO-FERRY AT KANTARA AND SWING BRIDGE AT HERSH ON THE SUEZ CANAL.

The model shows the two following works:— (A) The Loco-Ferry, constructed in 1916 at Kantara on a siding of the Benha—Port-Said line, which serves for the transshipment of goods over the Suez Canal between the Egyptian State Railways (Africa) and the Palestine Railways (Asia).

It is composed of 3-30 metres steel barges connected together and supporting 2-16 metres bridge girders hinged at one of their ends, bearing on hydraulic jacks and worked by steam machinery.

The Ferry can carry four goods trucks per journey and the average number of trucks actually ferried is fifty per day.

The Ferry is shown in its first site with wooden basins excavated into the berms of the canal. In 1930/31 the Ferry was shifted to a new site, south of the Kantara station: new reinforced concrete approach bridges and basins were constructed.

SECTION 8. NO. 1,

**GROUND FLOOR
BAY M.**

SCALE 1/50.

The design and construction were all carried out by the Egyptian State Railways Bridges Department.

(B) The Hersh Swing Bridge constructed in 1917 for military purposes during the Great War, when the output of the Kantara Lcco Ferry was no longer sufficient for the exigencies of the traffic. It was situated near the so-called Hersh locality at a distance of 5 kiloms. from the Ferry and dismantled in 1921.

The superstructure was built up from different spare metallic spans: four fixed and one swing, having a total length of 163 metres with two navigable channels of 42 and 9 metres. The spans were supported on reinforced concrete and on iron screw piles capped with reinforced concrete slabs. Timber fenders and mooring piles were provided to protect the bridge against any impact from the passing boats. The float on which the main swing span rested while in motion resembles the Ferry in structure, being composed of 3 barges connected together and suitably strengthened. When the bridge was closed to navigation and open for railway traffic, the float was entirely separated from the swing span so that variations of tides have no effect on the bridge. To operate the swing span the rails were first disconnected and then the span lifted by means of the 200 tonnes central hydraulic jack operated by a steam pump. Two emergency screw jacks follow the lifting so that if anything should happen to the central jack the bridge would still be supported by them. The float is then put in motion by means of a steam winch and capstan and the bridge is swung round until it has reached one of the rest piers where it is then lowered so as to bear on it. The bridge was designed by the Egyptian State Railways, Bridges Department. The foundation and masonry work as well as the erection of the superstructure were carried out by Messrs. Baume and Marpent, (Belgium).

SECTION 8. NO. 2,

GROUND FLOOR
BAY K.
SCALE 1/25.

MODEL OF A FIXED SPAN OF THE BRIDGE OVER THE NILE AT EDFINA.

The model shows the longest independent span ever built in Egypt up to date (1932).

The main girders are of simple lattice (V) type without end verticals, their lower booms straight, and their upper booms curved, and their total length corresponds to a span of 80 metres between centres of bearings. The height is 12 metres in the central part and 8 metres at the ends of the girders. The distance from centre to centre of the girders is 5.30 metres.

The cross-girders are 8 metres apart from centre to centre and support the rail-bearers which are placed 1.50 metres apart; both rail-bearers and cross girders are plate girders.

The rail-bearers are horizontally braced in the plane of the upper chord. The main girders are braced in the plane of their upper and lower chords. An overhead cross bracing between the struts is also provided. Two side brackets are provided in the

prolongation of the cross-girders carrying a road 2.70 metres wide for lorries up to 8 tonnes loading and a foot-path 0.70 metres wide.

Roadways were not included in the original design — but provision had been made for their addition and they were added before the girders had been built.

The bridge was designed by the Egyptian State Railways Bridges Department, the manufacture and erection of the superstructure was carried out by Messrs. The Cleveland Bridge and Engineering Co. Ltd., Darlington, (England) in 1930/32.

Weight of steel per metre run of bridge: 7 tonnes.

Total weight of the span: 560 tonnes.

Weight of steel castings for bearings: 16 tonnes.

MODEL OF THE REINFORCED CONCRETE OVERHEAD FOOTBRIDGE OVER ZAGAZIG STATION YARD.

This model represents the reinforced concrete overhead footbridge over Zagazig Station Yard.

The bridge crosses 18 tracks and serves as access to the Religious Institute and Technical School, separated from the town by the Marshalling Yard of the Zagazig Station (Benha—Port-Said line).

Main-girders are 1.5 metre deep, 3 metres centre to centre, of cantilever type with 4 hinges and five bays, making a total length of 107 metres. Intermediate column-pairs are provided with top and bottom hinges to allow for temperature changes of lengths.

Maximum loading 4 tonnes per metre run of which live load is assumed to be 400 kg. per sq. metre. Working stresses of 50 kgs./cm² compression in concrete and 1,200 kg./cm² tension in steel are allowed.

The design and construction were carried out by the Egyptian State Railways, Bridges Department.

Total quantity of concrete 320 m³.

Weight of steel reinforcement 40 tonnes.

Cost L.E.1,900.

MODEL OF THE REINFORCED CONCRETE OVERHEAD FOOTBRIDGE AT SHELLAL STATION.

This model represents the reinforced concrete footbridge at Shellal station. It is composed of two Vierendeel girders at 2 metres distance spanning the 13 metres between the inner columns. The top booms serve as hand rails 1.10 metre higher than the foot path.

The stairs are in reinforced concrete carried on four columns with their tops at 3.70 metres above platform level.

Quantity of concrete per girder is 2.8 cubic metres.

SECTION 8. NO. 3.

GROUND FLOOR
BAY L.
SCALE 1/50.

SECTION 8. NO. 4.

GROUND FLOOR
BAY L.
SCALE 1/20.

The wearing surface is made of granite chips in cement (mosaic finish).

Designed and constructed by the Egyptian State Railways, Bridges Department in 1932.

Cost: L.E.400.

SECTION 8. NO. 5.

GROUND FLOOR
BAY L.

SCALE 1/100.

PRESENTED BY
MESSRS. BAUME
& MARPENT.
HAINE-SAINT
PIERRE,
(BELGIUM).
1932.

MODEL OF THE SWING BRIDGE OVER THE NILE AT EMBABA.

This model represents the double track through bridge, situated on the Cairo—Luxor line, North of Cairo. It is the main connection between the Lower and the Upper Egypt Railways over the Nile.

It consists of one independent span 70 metres long (on the eastern side-Cairo), one swing span 69.33 metres and 5 independent spans 70 metres long each, giving a total length of 490 metres. The width of bridge centre to centre of main girders is 9 metres, and the width of the lower roadways provided on both sides of the bridge is 4.2 metres each, for vehicular traffic; the upper foot-paths 3.75 metres wide are provided for pedestrians. The flooring of the lower roadways consists of a reinforced concrete slab with asphalt paving bricks laid over it; the upper foot-paths have a timber flooring.

All piers and abutments are made of rubble masonry with cement moulded facing stones for the shafts, founded on pneumatic caissons of steel and concrete sunk to sand level (from -72 to -20). The machinery for rotating is of the rim bearing type; it can be operated on the model as well as the wedging machinery. At each end of the bridge road-traffic subways 8 and 17 metres wide are provided for the connection of adjoining streets and roads. The bridge was designed by the Egyptian State Railways, Bridges Department, to carry the heaviest engines of the Egyptian State Railways.

The bridge was built by Messrs. Baume et Marpent (Belgium) from 1912 to 1926.

Weight of rolled steel: 8,640 tonnes.

Weight of steel castings etc., for machinery and bearings: 560 tonnes.

29,900 m³ of rubble masonry and concrete for the abutments and piers.

Total cost L.E.540,000.

SECTION 8. NO. 6.

GROUND FLOOR
BAY L.

SCALE 1/50.

MODEL OF THE SWING BRIDGE OVER THE NILE AT BENHA.

The model shows the swing span and one of the fixed spans of Benha bridge, over the Damietta branch of the Nile, 45 kiloms. to the North of Cairo.

The bridge is on the skew (75°) and carries the double railway track of the Cairo—Alexandria line.

The total length of the bridge is 285 metres, it is composed of one swing span 63.40 metres long and two similar fixed parts 112 metres each, one on each side of the swing span. Each of these fixed parts is composed of two continuous equal spans.

The main girders of the swing span are single web bowstring double lattice girders of 4 metres high at centre, 2.10 metres at one end and 2.247 metres at the other end. Distance between centre lines of main girders is 8.30 metres.

The main girders of the fixed part are single web multiple lattice girders with parallel booms 6.65 metres high. Distance between centres of the two main girders is also 8.30 metres.

The original bridge was in wrought iron and built in 1894 by Messrs. Impresa Industriale Italiana. The superstructure was calculated for a train type 66 tonnes and was strengthened in 1906 by the Egyptian State Railways, Bridges Department, without interruption of traffic, to carry the heavy engines of the main lines (train type 118 tonnes).

Original weight of the swing span was 117 tonnes and its weight after strengthening is 335 tonnes.

Original weight of the four fixed spans was 740 tonnes and its weight after strengthening is 1,060 tonnes.

MODEL OF THE OLD RAILWAY SWING BRIDGE OVER THE NILE AT BENHA.

The model shows the swing span and one of the fixed spans of the old railway bridge over the Damietta branch of the Nile at Benha 45 kiloms. to the North of Cairo.

This bridge is the oldest railway bridge in Egypt constructed in 1854 to carry the single main line between Cairo and Alexandria.

The total length of the bridge is 264 metres (865 ft.), it is composed of one swing span 152 ft. long and four continuous fixed spans (87 ft. each) on each side of the swing span.

The bridge is carried on piers made of iron caisson tubes 5 ft. diam.

The swing pier is composed of 6 tubes and each of the two connecting piers is composed of four, while each of the 6 other piers is composed of two tubes.

The metal structure is made of one tubular iron girder 6'-6" wide having a constant height of 6'-6" for the fixed spans and a height of 7'-0" at centre of swing span reduced to 6'-6" at ends.

This bridge was passed to the Main Roads and Bridges Department in 1894 when the existing railway bridge was built.

SECTION 8. NO. 7.

GROUND FLOOR
BAY L.
SCALE 1/48.

**SECTION 8.
NO. 8,**

GROUND FLOOR
BAY L.
SCALE 1/360.
PRESENTED BY
MESSRS.
DORMAN
LONG & CO. LTD.
MIDDLESBO-
ROUGH
1932.

**MODEL OF THE SWING BRIDGE OVER THE NILE
AT DESSUK.**

This model represents the single track through bridge, situated on the Damanhour—Kallin line at the crossing with the Rosetta branch of the Nile.

The bridge consists of two parts, one about 240 metres long over the western channel of the Nile in between Rahmania station and an island, and another about 360 metres long, over the eastern channel in between the island and Dessuk station.

The model shows :—

- (a) the method of removal of the old bridge for the part over the western channel; and
- (b) the method of erection of the new superstructure (independent spans) for parts over the eastern channel.

The old piers and abutments were first strengthened and enlarged to take the new superstructure. A couple of piles were then driven on each side of the pier, the first lower members laid across them and the pier — and on these the first cells of the Warren girders built. When the top member of each adjacent span was in position they were connected together by a temporary tie seen on the model. The third pile trestle provided near the starting point was used to check the reactions as the work progressed, by carrying the load on jacks. The travelling derrick crane mounted on the top booms lifted the material directly from the barges.

The temporary tie between top booms and the packings between ends of spans at the lower booms were removed when erection was completed.

The new bridge was designed to carry the heaviest locomotives of the E.S.R., and roadways and footpaths are provided on each side of the girders for the vehicular and pedestrian traffic.

The old bridge was built from 1894 to 1898 by Messrs. Nouguier, Kessler and Co., Argenteuil, (France).

The detailed designs of the new bridge were submitted by Messrs. Dorman Long & Co. Ltd., revised by the Egyptian State Railways, Bridges Department, and work put in hand in December 1925, and completed in February, 1926.

Weight of rolled steel: 3,350 tons.

Weight of steel castings, etc., for machinery and bearings: 70 tons.

Total cost of bridge: L.E.152,000.

MODEL OF THE BASCULE BRIDGE NEAR ABOU EL AKHDAR.

This model represents the Bascule Bridge, built in 1927 and situated at the crossing of a navigable canal with the Benha—Port Said line near Abou El Akhdar Station at 8 kiloms. from Zagazig.

The clear span for navigation is 7 metres. The bridge is of the deck type with wooden sleepers bearing directly on 4 main plate girders having a total length of $8.65 + 2.55 = 11.20$ metres.

The machinery is of the Bascule type and the model can be worked by a key placed outside.

The design, manufacture and erection of the superstructure were carried out by Messrs. Waagner-Biro A.G. Vienna, (Austria). The masonry work was done by Dr. Ing. W. Stross Alexandria, (Egypt).

Weight of rolled steel 35 tonnes.

Weight of steel castings etc., for machinery and bearings:
12 tonnes.

Cast iron for counter-weight: 52 tonnes.

Total cost: L.E.4,000.

In 1931/32 an additional fixed 8 metres span was constructed on the Benha side of the bridge to increase the water-way.

The existing bridge replaces old fixed superstructures erected in 1885 and in 1905.

MODEL OF THE SWING BRIDGE AT GOHEINA.

This model represents the single track bridge situated on the Abu-Kebir—Salhia line at the crossing with the Bahr El Bagar canal.

The bridge consists of a swing span 19.55 metres long and two reinforced concrete fixed spans 16 metres long each.

The swing span is composed of two main plate girders under rail, spanning two navigable channels 7.30 metres wide each. The piers and abutments are made of reinforced concrete piles and concrete.

The mechanism of the swing span is of the centre-bearing type.

The design and construction of the bridge were carried out by the Egyptian State Railways, Bridges Department. Messrs. Ransome and Rapier supplied the machinery, (1925).

The existing bridge replaces an old fixed one built in 1897.

SECTION 8. NO. 9.

GROUND FLOOR
BAY K.

SCALE 1/25.

PRESENTED BY
MESSRS.

WAAGNER-BIRO
A.G., VIENNA,
1932.

SECTION 8. NO. 10.

GROUND FLOOR
BAY K.

SCALE 1/25.

**SECTION 8.
NO. 11,
GROUND FLOOR
BAY K.
SCALE 1/25.**

MODEL OF THE SWING BRIDGES OVER EL WADI CANAL

This model represents the Swing Bridges situated at the crossing of El Wadi Canal, near Zagazig, with the Benha—Port-Said line.

Double track deck bridges with open floor and two main plate girders for each line, of $4.65+8.98=13.63$ metres total length, which swing in inverse directions over a navigable channel 6 metres wide.

The machinery is of the rim bearing type.

The design, manufacture and erection of the superstructure were carried out by the Egyptian State Railways, Bridges Department (1905). The existing superstructure replaces an old one built in 1885.

**SECTION 8.
NO. 12,**

**GROUND FLOOR
BAY K.
SCALE 1/100.
PRESENTED BY
MESSRS.
WAAGNER-BIRO
A.G., VIENNA,
1932.**

**MODEL OF THE SWING BRIDGE AT GABBARY
(ALEXANDRIA), OVER THE MAHMOUDIA CANAL LOCKS**

This model represents the Swing Bridge, built in 1926 and situated over the Main Locks of the Mahmoudia Canal leading to the Alexandria Harbour, inside the yard of the Customs Warehouses; on the line between Gabbary and Ras-el-Tin. The bridge is of the through type, and carries a double track railway and is designed for the heaviest engines of the Egyptian State Railways. It also carries a main road 9 metres wide.

Apart from the swing span there is also a fixed span over the channel of the locks which is not navigable. The bridge is on the skew and is so designed as to allow the free working of the two main locks, either when the span is opened or closed. The swing span is composed of three main trusses; two outside, of the single webbed section type of a length of 57 and 59 metres and one intermediate, of the box section type with a length of 56 metres and separating the roadway from the railway.

The trusses bear on wheels and rollers transmitting the reaction over the rolling paths and masonry. The floor system is of the open type with wooden sleepers. The floor of the road bridge is made of timber with tarred ropes. The rotation of the swing span can be made by a key placed outside. It takes 3 minutes for unwedging or wedging the real bridge by 4 men at each extremity and 3 minutes for the rotation by 8 men.

The superstructure is partly borne on the walls of the locks and partly on a reinforced concrete piling foundation.

The design, manufacture and erection of the superstructure were made by Messrs. Waagner-Biro A.G. Vienna (Austria). The foundation and masonry works were done by Messrs. Dr. Ing. W. Stross, Alexandria, (Egypt) (1927).

Weight of rolled steel: 470 tonnes.

Weight of steel castings etc., for machinery and bearings: 96 tonnes.

Total cost L.E.34,000.

The existing bridge replaced an old railway bridge constructed in 1892—1893 by Messrs. Brillet & Daydé Pillé, and a road lift bridge laid aside (1895).

MODEL OF THE OVERHEAD ROAD BRIDGE AT MINIA STATION YARD.

This model shows the overhead bridge located at Km.246+700 of the Cairo—Luxor line, about 300 metres to the South of Minia station.

The overhead bridge is constructed in accordance with the established policy of the Egyptian State Railways to suppress the level crossings over the railway lines. It also helps the town of Minia to expand westwards, being enclosed between the Nile on one side and the railway lines as well as the Ibrahimia canal on the other side. The bridge also carries the road traffic from Cairo to Upper Egypt.

This model shows the central part of the overhead bridge over the railway lines and Ibrahimia canal between the approaches.

This central part includes:—

- i) on the south-east approach over the Damaris canal.
 - a. angle with leading stairs.
 - b. two groups of two steel spans of the cantilever type, 42.30 metres long each supported on steel trestles.
- ii) on the south west and north west approaches alongside the Safsafa canal:
 - a. one steel span 12.50 metres long.

Between these lies the three hinged arch 35 metres span over Ibrahimieh canal which is the only steel arch span existing in Egypt.

The road width is 10 metres:—

8 metres for the roadway,
2 metres footpaths, 1 metre each.

The total length of the central part shown by the model is 140 metres.

The bridge was designed by the Egyptian State Railways, Bridges Department. The construction was carried out by Messrs. Etablissements Daydé, Paris (France), for the superstructure and Messrs. Fils, Barthe-Dejean, Cairo (Egypt), for the foundations and concrete works.

Cost of the whole bridge: L.E.67,000.

SECTION 8. NO. 13.

GROUND FLOOR
BAY K.
SCALE 1/100.
PRESENTED BY
MESSRS.
ETABLISSEMENTS
DAYDE, PARIS,
1932.

**SECTION 8.
NO. 14.**

GROUND FLOOR
BAY M.
SCALE 1/100.

**MODEL OF THE SWING BRIDGE OVER THE NILE
AT EDFINA.**

This model shows the single track bridge situated on the proposed Bussili—Sidi Ghazi new line and crossing the Rosetta branch of the Nile at an approximate distance of 200 metres south of Edfina station.

The swing span with two navigable channels 18.45 metres wide each between protection floaters is located on the Edfina side (west). The spans are as follows from west to east:—

One independent open-webbed, through fixed span 80 metres long.

One swing span 60 metres long, and

Two independent open-webbed, through fixed spans of 80 metres long each, giving a total length of 300 metres.

All piers and abutments are made of concrete with cement moulded facing stones for the shafts; the piers resting on pneumatic caissons of steel and concrete sunk to sand level (—30), the abutments being supported on reinforced concrete piles 12 metres long.

The machinery for rotation is of the rim bearing type.

The design of the bridge was made by the Egyptian State Railways, Bridges Department, to carry the heaviest locomotives of the Egyptian State Railways, the construction being carried out by Messrs. The Cleveland Bridge Engineering Co. Ltd., Darlington, (England) in 1930/32.

The model shews the general arrangement of the bridge without the side roadways which were added further for vehicular traffic (see model of the fixed span of the bridge Cat. No. 8/2).

Weight of rolled steel: 1,970 tonnes.

Weight of cast steel for machinery and bearings: 95 tonnes.
6,100 m³ of concrete in the piers and abutments.

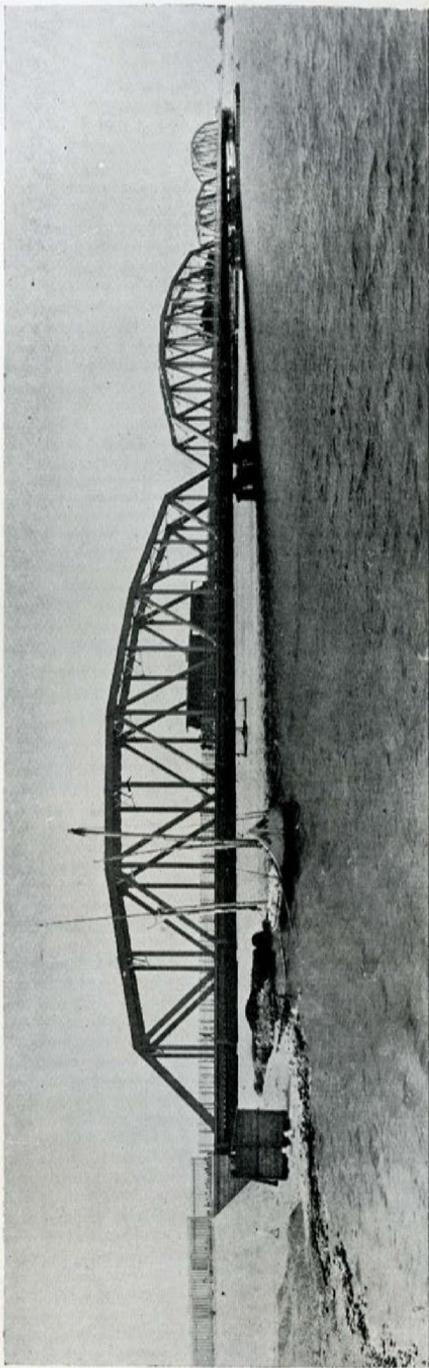
Total cost: L.E.140,000.

**SECTION 8.
NO. 15.**

GROUND FLOOR
(ANNEX)
PRESENTED BY
SIR WILLIAM
ARROL
& CO. LTD., 1932.

ALL-ELECTRIC WELDED GIRDER.

This exhibit is a small all electric welded girder. It was manufactured and tested in the works of the makers in order to obtain data on which to base the design of an all electric welded road bridge.



Edfina Bridge.

This bridge is situated on the proposed Bussili—Sidi-Ghazi new line, and crosses the Rosetta branch of the Nile, approximately 200 metres South of Edfina Station.

كوبرى ادفينا

هذا الكوبرى يقع على الخط الجديد المزمع مده بين البصيل
وسيدى غازى وهو يعبر النيل على فرع رشيد على بعد ٢٠٠ متر
تقريبا جنوب محطة ادفينا

SECTION 9.

SIGNALLING AND LIGHTING.

TRAIN AND STATION LIGHTING ON THE EGYPTIAN STATE RAILWAYS.

In the early days of the Egyptian State Railways the only form of artificial lighting available was oil lighting by means of mineral and vegetable oil lamps. The mineral oil lamps used kerosene with the lamp supported in a glass globe for outdoor lighting and table or suspension lamps for office and indoor use.

The railway carriages at this time either had no lighting at all, or were equipped with vegetable oil lamps with the exception of the State Saloons which employed candle lighting.

In 1901 electric light was installed in Cairo Station and comprised some forty Arc Lamps for the platforms and yards and incandescent lighting for the Offices, the power supply being from a small generating station.

The old station at Alexandria was also equipped with electric light at about the same time and in a similar manner.

Gabbary Marshalling Yard had arc lighting installed about 1903 using Brush system of Arc Lamps and Dynamo.

About 1904 lighting of the more important stations was improved by installing incandescent petroleum lamps of the Lux type. The present lighting for these stations is now carried out by means of pressure vapour incandescent lamps of the Tilley type.

Electric light supplied by accumulators was installed in the Cairo—Alexandria Express trains, the batteries being recharged at each of the terminal stations from the respective power house.

In 1902 a trial was made of electric lighting with the individual system, each coach being equipped, with its own axle driven dynamo, batteries, lamps, etc.

In 1903 a trial was made of the Pintsch Gas Lighting system on the suburban stock on Mataria line. This was extended side by side with electric lighting, 6-wheeled vehicles and 3rd class bogies being lighted by gas and 1st and 2nd class bogie coaches being electrically lighted. The gas lighting was found to be more costly and not so suitable to the conditions in Egypt as electric light was. In 1931 gas lighting was abolished and all stock electrically lighted.

With the extension of electric light in the various towns of Egypt, electric lighting has been installed and many of the stations are now thus equipped.

**SECTION 9.
NO. 1.**

GROUND FLOOR
(ANNEX).

**OIL LAMPS FOR CARRIAGE LIGHTING.
EGYPTIAN STATE RAILWAYS.**

These lamps were the first introduced for carriage lighting, and have been in use for over 40 years. In many of the coaches of the Auxiliary Railway, this type is still in service although the burners have been modified and improved.

**SECTION 9.
NO. 2.**

GROUND FLOOR
(ANNEX).

**GAS LAMPS FOR CARRIAGE LIGHTING.
EGYPTIAN STATE RAILWAYS.**

Gas lighting for railway carriage illumination was introduced in 1903, when the Pintsch system was adopted. The majority of the lamps were fitted as shown with flat-flame vertical burners. In Saloons and First Class coaches the incandescent mantle was fitted. Gas lighting was abolished in 1931.

**SECTION 9.
NO. 3.**

GROUND FLOOR
(ANNEX).

**PLATFORM LAMP.
EGYPTIAN STATE RAILWAYS.**

This lamp, burning paraffin, one of the earliest forms for railway station platform lighting, was introduced over 40 years ago and dispensed with in 1915.

**SECTION 9.
NO. 4.**

GROUND FLOOR
(ANNEX).

**TABLE LAMP.
EGYPTIAN STATE RAILWAYS.**

An early type of lamp used in Stations, offices, etc., and since dispensed with.

**SECTION 9.
NO. 5.**

GROUND FLOOR
(ANNEX).

**WALL LANTERN.
EGYPTIAN STATE RAILWAYS.**

This type was fixed to the walls of station buildings.

**SECTION 9.
NO. 6.**

GROUND FLOOR
(ANNEX).

**PAIR OF TAIL LANTERNS.
EGYPTIAN STATE RAILWAYS.**

This type of lamp was introduced over 40 years ago, and burned a mixture of olive or cotton seed oil and paraffin. They were dispensed with in 1909 and substituted by the present type.

**SECTION 9.
NO. 7.**

GROUND FLOOR
(ANNEX).

**MARIUT LINE LANTERN.
EGYPTIAN STATE RAILWAYS.**

This lamp fitting was removed from the Mariut line about the year 1914. It was introduced about 1908.

**AUTO LUX LAMP.
EGYPTIAN STATE RAILWAYS.**

These incandescent lamps burning paraffin vapour were introduced about 1909. They give a light of approximately 700 c.p. and consume 4.200 kilogs. of petroleum in 12 hours.

**HALF AUTO LAMP.
EGYPTIAN STATE RAILWAYS.**

A similar type to the Auto Lux, but giving approximately 350 C.P. and they consume 2.000 kilogs. of petroleum in 12 hours.

STONES STANDARD "TONUM" ACCUMULATORS.

This is the Standard type of cell used. It has exceptionally strong and substantial positive plates, and the negative plate is of the most modern design. The sections are supported on a bottom block of wood, porcelain or moulded composition. The cell box is of wood and lead-lined and use is made of the block lid.

The bolts for securing the connectors to the lugs are entirely lead covered to protect them from corrosion.

A float is supplied which provides a means of readily ascertaining the level of the electrolyte.

**STANDARD INCANDESCENT LAMP.
EGYPTIAN STATE RAILWAYS.**

An Incandescent lamp burning paraffin vapour introduced about 1910. They give a light of approximately 300 c.p. and consume 1.350 kilogs. of petroleum in 12 hours.

**TILLEY LAMP-TYPE "O.L. 50".
EGYPTIAN STATE RAILWAYS.**

Used principally for Office lighting. Gives a light of 300 c.p. and consumes 1.020 kilogs. of petroleum in 12 hours. These lamps were introduced in 1929.

**TILLEY LAMP-TYPE "O.L. 52".
EGYPTIAN STATE RAILWAYS.**

A similar type to the "O.L. 50" used where a widely dispersed distribution of light is required as in station yards. It gives a light of 300 c.p. and consumes 1.020 kilogs. of petroleum in 12 hours. Lamps were introduced in 1929.

**TILLEY LAMP-TYPE "P.L. 55".
EGYPTIAN STATE RAILWAYS.**

A general utility outdoor lamp. Gives a light of 300 c.p. and consumes 1.020 kilogs. of petroleum in 12 hours. Lamps introduced in 1929.

**SECTION 9.
NO. 8.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 9.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 10.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 11.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 12.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 13.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 14.**

GROUND FLOOR
(ANNEX).

SECTION 9.**NO. 15.**

GROUND FLOOR
(ANNEX).

TILLEY LAMP "CHALLOW" TYPE.

This lamp is intended for use chiefly in platform lighting, and is fitted with a long trough-shaped "Rodalux" reflector. It gives a light of 300 c.p. and consumes 1.020 kilogs. of petroleum in 12 hours. Lamps introduced in 1929.

SECTION 9.**NO. 16.**

GROUND FLOOR
(ANNEX).

**LOCOMOTIVE HEADLAMP.
EGYPTIAN STATE RAILWAYS.**

Supplied in 1911 and fixed to the front of the engine for projecting a beam of light to illuminate the track.

SECTION 9.**NO. 17.**

GROUND FLOOR
BAY J.

**ARC LAMP.
EGYPTIAN STATE RAILWAYS.**

This type of A.C. Flame Arc Lamp was in use at Gabbary in the year 1911.

SECTION 9.**NO. 18.**

GROUND FLOOR
BAY J.

**STONE'S SYSTEM OF TRAIN LIGHTING.
EGYPTIAN STATE RAILWAYS.**

This exhibit shows the arrangement of an axle driven dynamo with batteries and control gear. Current for lighting and charging the batteries is produced when the train is running, by the dynamo. Below a certain speed and when standing in stations etc., current is supplied to the lamps from the batteries, the dynamo being automatically cut out. This system is used on all Egyptian State Railways stock.

SECTION 9.**NO. 19.**

GROUND FLOOR
BAY J.

**STONE'S "C" TYPE TRAIN LIGHTING DYNAMO.
EGYPTIAN STATE RAILWAYS.**

This is one of the earliest types of dynamo fitted to the Egyptian State Railways stock about 27 years ago. Its full output is 40 ampr. at 24 volts, and magnetic lubrication is employed.

SECTION 9.**NO. 20.**

GROUND FLOOR
BAY J.

**STORES "LILIPUT" TRAIN LIGHTING DYNAMO.—
4 X TYPE. EGYPTIAN STATE RAILWAYS.**

This is the latest type of train lighting dynamo introduced on the Egyptian State Railways system. Its full output is 50 ampr. at 24 volts and it is fitted with ball bearings.

SECTION 9.**NO. 21.**

GROUND FLOOR
BAY J.

STONE'S "PEGLOUD" BATTERY CHANGE-OVER SWITCH.

The combination of a "Pegoud" switch with the double-battery system ensures that the two batteries are automatically interchanged every time the train starts after a stop. In this way, both batteries are kept at the highest pitch of efficiency.

STONE'S AUTO CUT-IN-AND-OUT SWITCH.

Is arranged to close the main circuit as soon as the dynamo voltage rises to the proper value for charging the battery.

STONE'S "IMPERISTON" FAN, BRACKET TYPE. EGYPTIAN STATE RAILWAYS.

This adjustable wall bracket type fan is fitted in the First Class Compartments. It has ball bearings and the power consumed is 26 watts.

STONE'S "IMPERISTON" FAN SWITCH.

Used in conjunction with the "Imperiston" fan. The switch has three speeds and an "Off" position.

STONE'S "IMPERISTON" FAN RESISTANCE.

A separate unit, with fuse enclosed in a cast-iron box which may be placed in any out of the way position.

STONE'S MAIN LIGHTING SWITCH.

This switch is fitted in the corridors of the coaches and controls all of the lighting. The lights may be switched on "half" or "full" as desired.

ENCLOSED ROOF FITTING, ONE LIGHT—"DURISTON" No. 6 (PRESSED STEEL). EGYPTIAN STATE RAILWAYS.

This type of fitting is used for 3rd Class Coaches and the corridors and Vestibules of all other vehicles.

ENCLOSED ROOF FITTING, TWO LIGHT, "DURISTON" No. 22 (PRESSED STEEL). EGYPTIAN STATE RAILWAYS.

This type of fitting is used in the Brake, Post, Luggage and Animal Vans only.

ELECTROLIER—TWO LIGHT. EGYPTIAN STATE RAILWAYS.

Fitted to some of the old 1st Class Coaches and all 2nd Class Coaches.

SECTION 9. NO. 22.

GROUND FLOOR
BAY J.

SECTION 9. NO. 23.

GROUND FLOOR
BAY J.

SECTION 9. NO. 24.

GROUND FLOOR
BAY J.

SECTION 9. NO. 25.

GROUND FLOOR
BAY J.

SECTION 9. NO. 26.

GROUND FLOOR
BAY J.

SECTION 9. NO. 27.

GROUND FLOOR
BAY J.

SECTION 9. NO. 28.

GROUND FLOOR
BAY J.

SECTION 9. NO. 29.

GROUND FLOOR
BAY J.

**SECTION 9.
NO. 30.**

GROUND FLOOR
BAY J.

**BRACKET-TWO LIGHT.
EGYPTIAN STATE RAILWAYS.**

This is an old type of roof fitting, which was fitted to the coaches with clerestory roofs.

**SECTION 9.
NO. 31.**

GROUND FLOOR
BAY J.

**BRACKET ONE-LIGHT, OXYDISED BLACK.
EGYPTIAN STATE RAILWAYS.**

This is the old type of bracket fitted in 1st Class compartments only, the globe is fixed in position by means of a screwed locking ring.

**SECTION 9.
NO. 32.**

GROUND FLOOR
BAY J.

**BRACKET ONE-LIGHT, FINISHED MAHOGANY
BRONZE No. 2. — EGYPTIAN STATE RAILWAYS.**

The latest type of bracket introduced for 1st Class compartments. The globe is locked in position by means of split steel collar.

**SECTION 9.
NO. 33.**

GROUND FLOOR
BAY J.

**ENCLOSED ROOF FITTINGS, 2 LIGHT.
EGYPTIAN STATE RAILWAYS.**

Fitted in 1st Class compartments only. It has an opal top reflector, and opal and cut star bowl.

**SECTION 9.
NO. 34.**

GROUND FLOOR
BAY J.

**SERIES-PARALLEL AND "OFF" SWITCH.
EGYPTIAN STATE RAILWAYS.**

Fitted in 1st Class compartments to control the lighting of the enclosed roof fitting. It connects two lights either in parallel, or in series to dim the light.

**SECTION 9.
NO. 35.**

GROUND FLOOR
BAY J.

**TUMBLER SWITCH—5 AMP.
EGYPTIAN STATE RAILWAYS.**

Used to control individual lights principally in Saloons and Service Cars.

SIGNALLING AND INTERLOCKING.

In the earliest days of Railways there were many crude attempts made to protect trains by signals of various forms, such as balls raised and lowered on a mast.

A development of these resulted in the introduction of the Disc Signal on the Great Western Railway in 1841. The cross bar indicated danger, and after an interval of ten minutes the signal was turned and the round disc exposed. The lamp gave a red and white indication at night time.

On the London and South Western Rly. the distinction as to which line a signal applied to was made by the open and closed halves of a circular disc. A "Danger" signal was given by the closed half being on the left; if the right half was seen to be closed the signal applied to the other road. "Clear" signals were given by the edge of the disc being shown to the driver.

The use of the semaphore as a signal was introduced in 1841.

In 1843, signals of this type were fixed at Bricklayers' Arms and operated by a stirrup frame designed by Gregory, which enabled them to be interlocked, this is the first record of Interlocking being introduced.

The Distant Signal as it is known to-day was introduced in 1872 at Norwood Junction, on the London, Brighton and South Coast Railway.

Ground Signals became into use about 1890. The Ground Signal most popular to-day and known as the Dwarf Signal, was introduced by the Great Western Railway in 1914.

The Safety Appliances now fitted on to all Facing Points were introduced as follows:—

The Locking Bar, in 1867.

The Facing Point Lock, in 1870, and

The Detector, in 1886.

In 1856, Saxby interlocked six pairs of points and eight signals at Bricklayers' Arms Junction.

In 1860, Chambers arranged for interlocking between conflicting Points and Signals.

In 1867, Saxby invented his catch-handle locking of which Sir Frederick Bramwell said. "The intention of the Signaller to move the lever, as expressed by the grasp of the spring catch-handle "actuated the locking gear".

The principles existing to-day whereby the interlocking is carried out by means of tappets operating locks in channels was introduced by Stevens in 1870.

Level Crossing Gates have been compulsory since 1836.

In 1863, C.H. Lea, invented the Apparatus whereby all gates could be worked at one operation.

Automatic Signalling with signals operated electrically was introduced on the Liverpool Overhead Railway in 1893.

Track circuits were introduced by Sykes in 1886, when he provided the platform roads at St. Paul's station with this Apparatus.

Power operation of Points and Signals by electricity was carried out in 1893 by Timmis, on the Liverpool Overhead Railway.

The first power operation to be carried out on a large scale, was at Crewe in 1898.

The first three position signal to be fixed in England was at Paddington in 1914

Daylight colour signals were put into use on the Liverpool Overhead Railway, in 1921.

The completion of Interlocking in Egypt has been exceptionally rapid.

Previous to 1900, Stations were controlled by non-interlocked Signals and Points worked by T.O. Levers.

The first Interlocking Apparatus of 7-Levers, was fixed at Nag-Hamadi, in 1902.

Since that date, no less than 380 Signal Cabins, with 10,558, Interlocked Levers, have been brought into use.

Tanta Station which is in course of completion, will be equipped with 7 mechanically worked cabins, the total number of Levers being 440. The largest box will be No. 3, Cabin where 145 Levers will be in operation. Track Circuits will be in use for the Single Line Platforms only.

Power operation of points and signals was brought into use at Cairo Station, in 1905.

The South end of this Station has been fully equipped with Track Circuits — Track Locking — Illuminated Diagram, etc., which brings it up to-date with other similar installations.

The Luxor—Assuan Line is equipped with Long and Short Sectional Staff working, and with this unique advantage it is possible to operate any intermediate cabin by the Long Section Staff.

The number of Swing Bridges in this Country has involved a special system of Staff and Key Control.

Semaphore Type I Wire Block Instruments were introduced in 1906.

The Three Wire Three Indications now in general use were introduced in 1908. Since this date 390 have been fixed.

The first Electric Staff Instrument was fixed in 1900. Since this date 487 have been fixed.

The latest type of Key Token Instrument has just been introduced and is in operation in the Museum.

SECTION 9.
NO. 37.
GROUND FLOOR
(ANNEX).

TURN-OVER LEVER.

A Lever with counterweight at one end, and a crank at the other, connected by a rod to the blades of a pair of points, and is used for moving them from one position to the other by reversing the Lever. The counterweight helps in the action and keeps the blade tight to the stock rail. This type of lever allows the points to be trailed through. Introduced about 1850, and is still in use for non-interlocked points in Yards etc. The latest type of lever can be locked in either position by the insertion of a cottar padlocked.

GROUND LEVER.

When points were required to be grouped in 1860, this type of lever was designed to enable the Pointsman to operate several points from a central position. To avoid the use of counterweights, the levers were made longer and kept in either position by means of a catch rod actuated by a handle attached to the top of the lever. This type does not allow the points to be trailed through.

GRID-IRON LOCKING.

Designed by Saxby in 1870, and is used extensively in America as the pattern frame for Mechanical Interlocking.

The levers in the exhibit have been kindly sent out by the Southern Railway of England, who have just removed them from Brighton Station, where they have been in use since 1881.

SAXBY AND FARMER'S DUPLEX CATCH-HANDLE INTERLOCKING FRAME.

This exhibit shows a two-lever frame embodying the duplex plunger locking motion patented by Messrs. Saxby, Farmer & Reid in 1888. In this development of the interlocking frame, two control plungers in the form of flat section bars, are used together, one above the other in the locking frame through which they slide. One bar is moved by a bell-crank mechanism attached to the spring catch-handle, and the other by the motion of the signal lever. The object of this double movement of the bars is to effect interlocking by raising the spring catch before the movement of the lever. The releasing of the locking between levers is not effected until the lever is completely moved over and its spring catch released, thus, removing any possible risk, of a lever being left with its spring catch not home, and thus capable of falling back into its first position. The bars are notched in a certain fashion according to the requirements of the interlocking. When the bars are moved they actuate locks which effect the necessary interlocking between signals and points.

SAXBY AND FARMER'S IMPROVED DUPLEX TAPPET CATCH-HANDLE INTERLOCKING FRAME (1905 TYPE).

In the 1888 type all the levers are fitted into separate bearings which necessitates a special base being made.

The 1905 type is modified so that all the levers are fixed on a large diameter shaft, supported on standards fixed between every 10 levers. By this arrangement maintenance costs are reduced.

SECTION 9. NO. 38.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 39.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 40.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 41.

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 42.**

GROUND FLOOR
(ANNEX).

**WESTINGHOUSE CO., SINGLE TAPPET CATCH-HANDLE
INTERLOCKING FRAME. 1924.**

The general principle involved is the same as in the previous types of frames except that single tappets are here used. Half the motion of the tappet is achieved by pressing the catch handle. The pulling over of the lever does not move the tappet, but when the catch handle is released, the second half of the stroke of the tappet is performed.

This action is arrived at by means of the introduction of a link in the specially designed catch-handle operating mechanism. The locking box is made inclined in front of and below the fulcrum of the signal levers.

**SECTION 9.
NO. 43.**

GROUND FLOOR
(ANNEX).

BLACK'S APPARATUS.

This apparatus is utilized for operating facing points and their locking bars simultaneously with one lever.

The rodding from the Signal Cabin actuates the locking bar through a system of cranks, the locking bar actuates the Apparatus, which in its turn, moves the blades of the points to one direction or the other. The apparatus is in the form of a double cam operating on a central pin and eccentrically connected to the locking bar. The cams are in contact with two rollers supported on pins fixed in the stretcher rod connecting the two blades,

The movement of the stretcher rod is effected by the cam operating against the above rollers whilst it is being revolved upon its centre. The completion of the stroke locks the stretcher rods in position.

**SECTION 9.
NO. 44.**

GROUND FLOOR
(ANNEX).

FACING POINT PLUNGER LOCK.

To guarantee that facing points have been properly set in a required position and that they will remain in such position, the facing point plunger lock was invented. The principle involved is the provision of a plunger bolt working through a slot in a Cast Iron Casing.

Split Stretcher Rods connected to the Blades of the points, slide through the casting at right angles to the Plunger Bolt. In the Stretcher Rods, elongated holes of the same dimensions as the bolt are made, through which the bolt passes. Thus if the blade is not fitting right up to the stock rail, the Lever operating, the plunger bolt cannot be worked.

**SECTION 9.
NO. 45.**

GROUND FLOOR
(ANNEX).

FACING POINT PLUNGER LOCK—DETECTED.

This is a modified Type of Facing Point Plunger Lock. The difference is that the plunger is detected in either position by virtue of a specially shaped slot made in it.

Inside this slot is a loose pin fixed from top and bottom to a sort of cross-head connected by a rod to the detector fixed outside the track. The movement of the plunger from one position to the other moves the cross-head and, eventually, the detector rod a certain distance. So if the plunger has not performed its full stroke either to the "In" or "Out" positions, the detector will not allow the signal wire to be pulled. The advantage of this type is that if something goes wrong with the plunger lock mechanism the signals will not function and the failure could at once be discovered.

WIRE WORKED POINT APPARATUS—MARIUT LINE.

Each point is connected separately to a rod operated by a Cam plate revolved by a chain wheel connected by wire to a lever in the Cabin.

Originally in use on Mariut line at Amria Station.

DISTANT SIGNAL ARM. — OLD TYPE.

This is the type of signal arm that was in use about 1870. It is made up of flat iron pieces spaced apart and fixed inside an iron frame.

The visibility of same is not satisfactory, and it was replaced later by the rolled steel arm, or wooden arm.

SIGNAL ARM. — NEW TYPE (DISTANT). (MOUNTED ON CAST CONCRETE POST).

This is a 5 ft. steel plate enamelled with corrugations running the length of the arm to stiffen same. It is coloured yellow for distinction from stop signals. When at danger at night, it exhibits an orange light.

All new type distant signals on the Egyptian State Railways are repeated in the signal cabin. The exhibit shows the method of repeating the signal into the cabin.

SIGNAL ARM. — NEW TYPE (HOME). FIXED ON STEEL LATTICE POST.

This is a 5 ft. corrugated steel enamelled plate as now used on the Egyptian State Railways.

The arm is fixed on a sample 7 ft. steel lattice post together with all other fittings of an ordinary home signal post.

**SECTION 9.
NO. 46.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 47.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 48.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 49.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 50.**

GROUND FLOOR
(ANNEX).

**DIFFERENT TYPES OF SIGNAL LAMPS,
OLD AND NEW.**

This collection of signal lamps shows all the different patterns of lamps with their interiors that have or are now used for the different signalling purposes.

- (1) The Welsh Lamp.
- (2) The Adlake 7 day burning lamp.
- (3) The Signalite 7 day burning lamp.
- (4) E.S.R. Old Type Signal Lamp and interior, 8" lens.
- (5) E.S.R. Old Type Signal Lamp and interior, 6" double lens.
- (6) New Type Signalling 5" single lens.
- (7) E.S.R. Old type signal lamp for repeater.
- (8) E.S.R. New type signal lamp for repeater.
- (9) Shunting Arm Signal Lamp.
- (10) Point Indicator Lamp.
- (11) Disc Lamp-Old Type.
- (12) Disc Lamp-New Type.
- (13) Single Dwarf-signal lamp.
- (14) Double Dwarf-signal lamp.
- (15) Staff Exchanger Lamp Mirror Type.
- (16) Staff Exchanger Lamp, 4" lens.
- (17) Staff Exchanger Lamp, 5" lens.
- (18) Staff Exchanger glass front lamp.
- (19) Level Crossing Barrier Lamp—old type.
- (20) Level Crossing Barrier Lamp—new type.
- (21) Level Crossing Gates Lamp—old type.
- (22) Level Crossing Gates Lamp—new type.

**SECTION 9.
NO. 51.**

GROUND FLOOR
(ANNEX).

POINT INDICATOR SIGNAL.

Originally provided to indicate the position of Trap Points on Sidings. Now obsolete.

**SECTION 9.
NO. 52.**

GROUND FLOOR
(ANNEX).

DISC SIGNAL.

Introduced with interlocking in 1900, now replaced by Dwarf Signal.

**SECTION 9.
NO. 53.**

GROUND FLOOR
(ANNEX).

**DWARF SIGNAL (NEW TYPE) E.S.R. DESIGN.
ONE ARM.**

A Dwarf Signal is used to give signals for shunting operations over interlocked points.

It is in the form of a white disc with a broad red stripe across the middle, and pivoted at the centre. The disc has two circular openings with red and green glasses fitted to them.

The operating wire is connected to a system of levers which turn the disc through 45° to exhibit the "clear" signal.

The green glass also comes opposite the lamp which is fixed to the standard, and gives a green light for night indication.

When the wire is released, the disc goes back to its normal position by virtue of a counterweight.

DWARF SIGNAL (NEW TYPE) E.S.R. DESIGN, TWO ARMS.

Similar to the Dwarf Signal with one arm, but has two arms with one above the other. It is used when space between trucks is limited.

POINT DETECTOR. — OLD TYPE.

This appliance operates with a single slide connected to a beam fixed to the switches. The objection to this type is that it has to be fixed behind the stretcher rod operating the points, consequently fine detection cannot be provided.

POINT DETECTOR USED WITH ORDINARY F.P. LOCK.

This detector is an improved design of the previous one. It has two slides connected to one blade behind the stretcher rod.

POINT DETECTOR USED WITH DETECTED F.P. LOCK.

This is the latest type of detector and is used in conjunction with the detected F.P. Lock. It has three slides, two connected to the blades by extension pieces for fine detection, and one connected to the crosshead working on the special slot in the lock plunger.

VERTICAL COMPENSATORS (OLD TYPE).

Compensators are provided to counteract the effects of contraction and expansion.

This type has been superseded by the horizontal one, because it does not allow of sufficient stroke being made in the transmission; further, owing to requirements of the loading gauge, it has to be fixed at a greater distance from the track.

HORIZONTAL COMPENSATORS (NEW TYPE).

This is the only type which gives the same stroke as it receives. The majority of Compensators, owing to their peculiar design, have this disadvantage that they lose stroke during operation.

This new type has been in operation on the Egyptian State Railways since 1926.

SECTION 9. NO. 54.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 55.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 56.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 57.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 58.

GROUND FLOOR
(ANNEX).

SECTION 9. NO. 59.

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 60.**
GROUND FLOOR
(ANNEX).

RAIL CLIPS.

Used for supporting F. P. locking bar, various types.

**SECTION 9.
NO. 61.**
GROUND FLOOR
(ANNEX).

**SAMPLES OF CAST CONCRETE FRAME BASES
FOR SIGNALLING FITTINGS.**

Various frames utilized for supporting Rod Rollers, Wheels, Cranks, Compensators and Detectors. Used in the transmission for operating Signals and Points.

**SECTION 9.
NO. 62.**
GROUND FLOOR
(ANNEX).

OLD TYPE PULL OVER LEVER.

This lever was used for working distant Signals. It has a balance weight adjustment.

**SECTION 9.
NO. 63.**
GROUND FLOOR
(ANNEX).

OLD TYPE WIRE COMPENSATOR.

To overcome the effects of expansion and contraction of Signal wires, this apparatus was designed. It has been superseded by the wire adjuster.

**SECTION 9.
NO. 64.**
GROUND FLOOR
(ANNEX).

WIRE ADJUSTER.

It achieves the same results as the wire compensator, but is much smaller in size and is installed inside the Signal Cabin and worked by the Signaller.

**SECTION 9.
NO. 65.**
GROUND FLOOR
(ANNEX).

POINT RODDING JOINTS.

Plug and Cottar Joint.
Screwed Coupling Joint.
Coupling—New Type.

**SECTION 9.
NO. 66.**
GROUND FLOOR
(ANNEX).

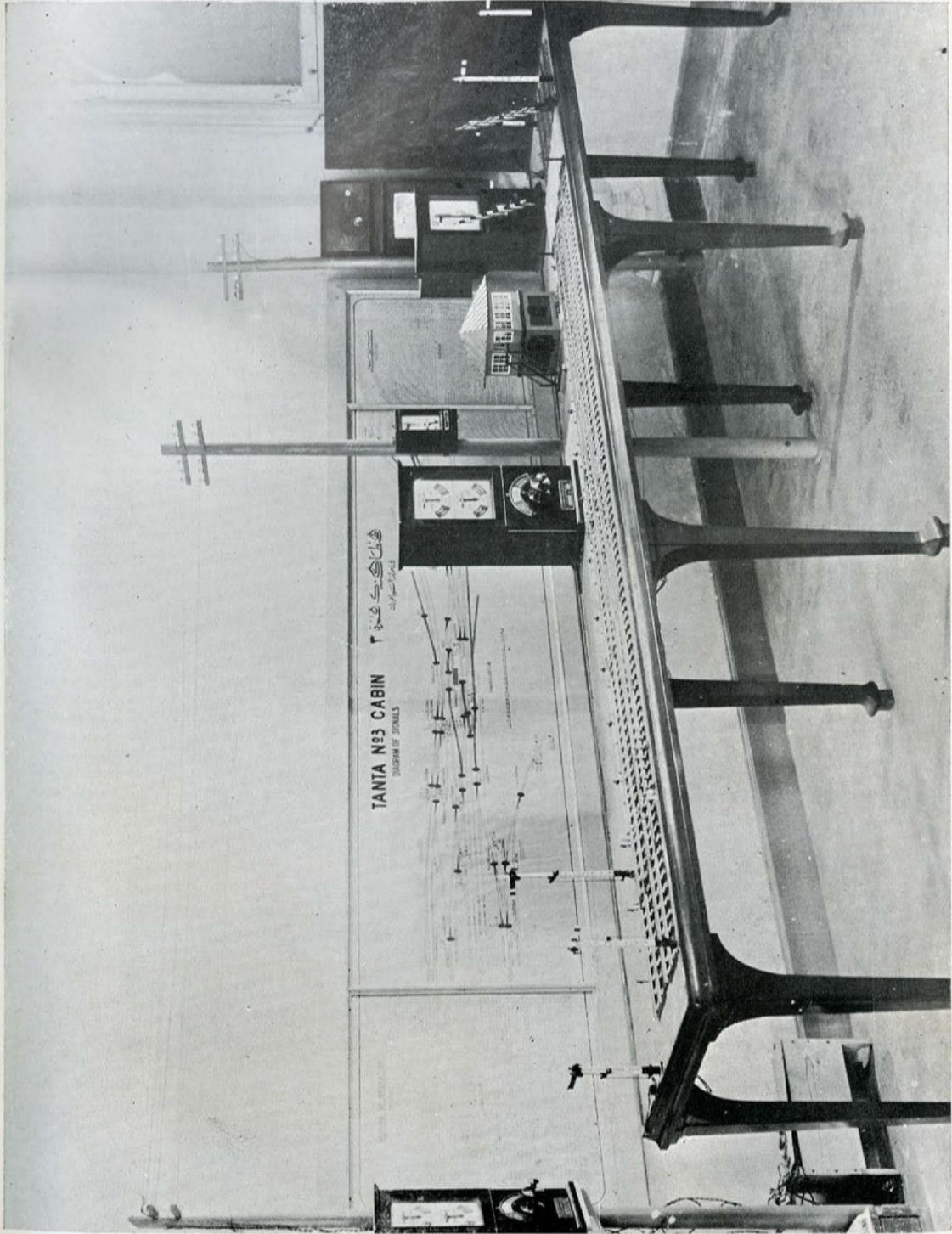
TYPES OF ROD ROLLERS.

Charringtons and Egyptian State Railways Types.

**SECTION 9.
NO. 67.**
GROUND FLOOR
(ANNEX).

TYPES OF JOINTS.

Old Type of 1 1/4" Joint to weld.
New Type of 1 1/4" Joint with coupling.



Model of Signal Layout. — The Cabin contains a 12 lever apparatus interlocked in accordance with E.S.R. requirements.

نموذج لتركيب اشارات — في الكشك جهاز يحتوي على اثني عشر رافعة مرتبطة حسب الحاجة بمصلحة سكة حديد الحكومة المصرية

MODEL OF CHAMBERS' STIRRUP FRAME.

As traffic increased, it was observed that the points and signals should be mechanically connected so as to work in harmony and prevent conflicting signals being given and avoid accidents. This model represents the interlocking frame patented by Mr. A. Chambers in 1860, which was the first frame to be designed, wherein each lever moves independently, but is controlled by the previous movement of the point or conflicting signal lever. The signal wires are led to vertical rods mounted in a frame, each rod having a stirrup formed in it, which is pressed down by the foot of the Signaller when the signal is to be lowered, and is held in that position by a pin on one side engaging with the turned-up end of a groove cut in the adjacent frame pillar. The point levers are mounted on horizontal shafts and the point rods connected to their lower ends. The signal stirrups are guided by their stems passing through holes in cross bars at the middle and bottom of the frame. Slots are cut in the lower part of the frame through which pass bars attached to the horizontal shaft connected with the point levers. These bars when moved under the stirrups prevent them from being lowered, but when they are withdrawn, or present a hole under the stirrups, then the signal can be lowered.

MODELS OF VARIOUS OLD SIGNALS.

- (a) First form of signal fixed on Liverpool and Manchester Railway 1834.
- (b) Fixed on Liverpool and Manchester Railway 1836.
- (c) Fixed on Grand Junction Railway 1838.
- (d) Fixed on London and South Western Railway 1840.
- (e) Gregory's Semaphore Signal 1841.
- (f) Fixed on Great Western Railway 1841—for Up line.
- (g) Fixed on Great Western Railway 1841—for Down line.

MODEL LAYOUT OF A BLOCK POST.

This model was designed and manufactured in the Signalling Workshops, Cairo.

It includes a double track, crossover road and level crossing.

The cabin contains a 12-lever Apparatus interlocked in accordance with Egyptian State Railways requirements.

Lever Nos.

- 1.—Up Distant.
- 2.—Up Home.
- 3.—Starter.
- 4.—Spare.
- 5.—Dwarf Signal.
- 6.—Crossover.

SECTION 9. NO. 68.

GROUND FLOOR
BAY J.

SECTION 9. NO. 69.

GROUND FLOOR
BAY J.

SECTION 9. NOS. 70-73.

GROUND FLOOR
BAY J.
SCALE 1/20.

- 7.—Spare.
- 8.—Down Starter.
- 9.—Down Home.
- 10.—Down Distant.
- 11.—Barrier Lock.
- 12.—Spare.

The Level Crossing is controlled by Guillotine Barriers operated by a ground lever. Barriers are locked from the Cabin.

The Block Instruments show the old type Semaphore Block Instruments with the new type 3 Wire 3 Indication Instruments.

SECTION 9.
NOS. 74-79.
GROUND FLOOR
BAY J.

**ELECTRICAL STAFF INSTRUMENTS
FOR SINGLE LINE WORKING.**

In single line working the protection of obstruction in a section is guaranteed by the above. The possession of the Staff by the Driver is an assurance that he can proceed with safety to the next station.

Each Block Section is provided with 2 Instruments, operated electrically. In each Instrument, a certain number of staff rods are fixed, which can only be released by the consent of the signalman of the opposite end of the section. As soon as a staff is withdrawn the instruments are considered out of phase and until the staff is returned to its original Instrument, or the Instrument at the other end of the section, further staffs cannot be withdrawn, therefore, it is impossible for two trains to be in the section simultaneously.

Magnetos are used to generate the electrical current necessary to relieve the staffs.

The first pair of large staff Instruments were supplied to this Railway in 1900.

The "M" Type, referred to as the miniature type; is an improvement on the large type. The staff is only 23 cm. long and weighs 0.42 kilos, whereas the large staff is 61 cm. and weighs 1.73 kilos.

The releasing of the staff is effected by an armature attached to four magnets which attracts a pole piece attached to an interlocking lever. Two of the magnets are energised by a local circuit.

The "S" Type instrument is the latest development. The coils are replaced by a rotary armature which is operated by the line circuit, consequently, the local battery is economised.

The Key Token Instrument is a further development as it enables the key to be utilized for releasing levers operating any siding which may be fixed in mid section.

METHOD OF OPERATION FOR WORKING THE KHASA RAILWAY.

- 1.—Khasa Crossing rings to Bussili and Edfina.
- 2.—If section clear, Bussili and Edfina send current which is indicated on the twin galvanometer.
- 3.—Khasa Crossing presses tapper key on Control Apparatus, and withdraws slide releasing key.
- 4.—Key is placed in special lock on lever which allows the lever to work the points of the Khasa Crossing.
- 5.—After the train has passed over the points, the lever is restored to its normal position when key is released.
- 6.—Key on being returned to the control allows slide to be pushed in the key and the slide becoming automatically locked and the Token Instrument line wire again connected.

STAFF EXCHANGER. — MIRROR TYPE.

Original type introduced with large type staff presumed to be economical owing to one lamp being used, its disadvantage is that at night the light thrown down on receiving arm is very poor, consequently, staffs invariably missed the receiving arm and were damaged.

STAFF EXCHANGER. — OLD TYPE.

A modification of the Mirror Type brought about by the introduction of the miniature staff, this was very expensive in manufacture and had the same fault as the Mirror Type—poor illumination of the receiving arm and staff at night time.

STAFF EXCHANGER. — NEW TYPE.

An attempt at an improvement on the old type. Spot lighting of the aluminium knob of the receiver and the staff, is arranged for.

The spring clip for the Staff Hoop has been made lighter.

The receiving arm and lamp bracket have been designed to give a permanent alignment, and incidentally an opportunity to take the staff at greater speed than allowed in the two previous types.

WHITAKER'S AUTOMATIC EXCHANGER.

This is a patented exchanger and is used extensively in all parts of the world.

It has one distinct advantage on the hand exchangers, the exchange of staffs can be made at any speed up to 90-kilometres per hour.

It is obvious that the absence of braking at each station results in economies being effected upon the maintenance of the rolling stock by the use of this apparatus.

**SECTION 9.
NOS. 80-81.**
GROUND FLOOR
BAY J.

**SECTION 9.
NO. 82.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 83.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 84.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 85.**
GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 86.**

GROUND FLOOR
BAY J.
PRESENTED BY
MESSRS. W.R.
SYKES, INTER-
LOCKING SIGNAL
CO. LTD., 1932.

**SECTION 9.
NO. 87.**

GROUND FLOOR
BAY J.
PRESENTED BY
MESSRS. W.R.
SYKES INTER-
LOCKING SIGNAL
CO. LTD., 1932.

**SECTION 9.
NO. 88.**

GROUND FLOOR
(ANNEX).

**SECTION 9.
NO. 89.**

GROUND FLOOR
(ANNEX).

MODEL OF INTERLOCKING APPARATUS.

This is a model of Interlocking Apparatus.

ELECTRICALLY OPERATED SIGNAL — 1875.

This is an electrically operated signal manufactured in 1875 by Messrs. W.R. Sykes.

E.P. FACING POINT LAYOUT.

E.P. Facing Point Layout including C. Valves-Track circuit control of Points and Signals and 2 Position Colour Light Signal.

BRIDGE LOCKING GEAR.

This apparatus is to the design and manufacture of the Signalling Department, Egyptian State Railways. It is intended to lock swing bridges; so that before opening the bridge a key must be obtained from the Signal Cabin. Once this key has been taken out of the locking apparatus, no signals can be lowered. The key cannot be withdrawn from the bridge locking gear until the bridge is in its right alignment and its wedge properly set.



SECTION 10.

TELEGRAPHS, TELEPHONES AND WIRELESS COMMUNICATIONS.

Brief history of the Invention of the Electric Telephone and Telegraph.

Telephone.

The first knowledge of electro-magnetism on which the telephone and most other electrical apparatus depend was discovered by Hans Christian Oersted of Copenhagen in 1820, who found that a voltaic current exerted an influence upon a magnetic needle.

Michael Faraday, an Englishman, extended the knowledge of the subject by discovering that electrical currents might be induced in a closed circuit by the motion of a magnet in its immediate vicinity and conversely by moving the circuit across the magnetic field.

In 1861 Philip Reis, a German, succeeded in transmitting by electrical means musical and other sounds by the aid of a loose contact.

The earliest type of magnetic receiver was devised by R.E. House of New York, who in 1868 invented and patented a receiver employing an electro magnet and a diaphragm. This was used as both a receiver and a transmitter.

A number of inventions somewhat similar to those of Reis, were made but the first real contribution was the production of the telephone made by Graham Bell in 1875, who as a result of a happy accident in his search for the production of the speaking telephone, was able to produce a telephone transmitter in which the voice impinging on a diaphragm of gold beaters skin varied the current of an electromagnet. (A model of this will be found in exhibit No. 11).

Almost coincident with this discovery was one of a similar nature by Elisha Grey of Chicago.

The first commercial form of transmitter was the Bell box telephone produced in 1877 and was used as receiver and transmitter.

The first telephone exchange was established in America in 1878 and was later followed by one in London in 1879. Signals to the operators were effected by magneto drop indicators.

A considerable improvement in the transmission of telephonic speech was achieved in 1877 by the invention by Edison of the variable resistance carbon transmitter with which he used a transformer.

Further improvements in the carbon transmitter were effected by Hughes in 1878 and by Blakein in 1879. A number of exchanges in the United Kingdom were installed during this period with gradually improved methods of switchboard connection, etc.

Until 1882 the speech current was provided from separate batteries at the subscribers' premises, but in this year a system of Central Battery working was patented by G.L. Anders of London. Later improvements were effected in this system by the Western Electric Company of America in 1890, and by Stone by 1893. In 1898, automatic signalling was also introduced whereby both call and clearing signals were given by the actuation of the subscriber's switchhook. The current for Central Battery working is provided by accumulators and a bijou system is shown working in the Museum.

Considerable improvement was effected in the design of exchange switchboard equipment and exchanges of 10,000 lines are now common.

Manual telephone exchanges, however, necessitated the employment of large staffs, generally of female operators and supervisors and many attempts were made to eliminate these by machine switching. The first practical apparatus was produced in America in 1889. Considerable progress was made in ensuing years, and in 1912 the first public automatic exchange was opened in England. The number of automatic exchanges in most countries has since attained considerable proportions, and they are generally rapidly replacing manually operated switchboards.

There are now two main systems: the Step-by-Step (Strowger) and the Rotary (Standard). Both are in use in Egypt and working models of each system are exhibited in the Museum.

Progress in apparatus has been accompanied by improvements in line construction. The early telephone wires were made of galvanized iron or copper wire with earth return. In 1893, however, metallic circuits were introduced in England. The present practice is to employ hard drawn copper or bronze wire. Overhead wires have generally given way to underground cables in most towns as generally there are objections on the part of local authorities to the erection of overhead wires. Cables for junction and trunk circuits have the advantage of avoiding breakdowns due to storms. The construction of cables composed of wires insulated with gutta percha, however, had the disadvantage of introducing inductive capacity and reduced speech efficiency but this has been largely counteracted and eliminated by the introduction of induction loading and of insulating the wires by means of paper wrapping and filling the cable with dry air.

It has been computed that 60 % to 70 % of the capital cost of a telephone system lies in the line plant. The introduction of the thermionic valve as telephone speech relay has, therefore, resulted in considerable saving enabling smaller conductors to be

used and it has also permitted speech to be transmitted over very much greater distances than was formerly possible.

A system of multiplex telephony exists by means of which additional speech channels may be obtained by combining existing circuits with the aid of transformers. This is known as superimposition, the additional channels obtained being called "phantoms."

Wireless Telephony has made tremendous strides of recent years and overseas telephone conversations between subscribers in different Continents are now possible.

TELEGRAPHS.

Frictional Electricity.

From the standpoint of engineering, the problem of signaling from one place to another is one of power transmission on a scale sufficient to affect either directly or indirectly one of the five senses — usually that of sight or sound — of the recipient of the message. It is in the earliest considered attempts at the electrical transmission of power, therefore, that the rudiments of the electric telegraph will be found.

In August, 1730, Stephen Gray, a pensioner of the Charterhouse, working in conjunction with his friend Mr. Wheeler, found that by means of frictional electricity transmitted along an insulated wire, motion could be imparted to a down feather at a distance of 886 ft. In the course of their experiments, these two also discovered accidentally the distinction between conductors and insulators. Their experiments were independently repeated by M. Dufay, a French officer who afterwards became celebrated as the originator of the two-fluid theory of electricity, and by Desaguliers, whose "Dissertation Concerning Electricity," published in 1742, was the first book on the subject in the English language.

Up to this time the possibilities of the transmission of electricity to a distance excited no attention outside a very narrow circle of scientific men, but the invention of the Leyden Jar in 1745 was a very different matter, and highly sensational accounts were published of the physiological effects produced by the discharge from this "prodigy of nature and philosophy."

In 1748 Dr. Watson, an Englishman discharged a jar through two miles of wires supported on insulating posts on Shooter's Hill, but neither he nor any of his contemporaries appear to have seen the applicability of these experiments to telegraphy, and the first distinct proposal to employ electricity for this purpose is that contained in a letter signed with the initials "C.M." in the Scots Magazine for 17th. February, 1753.



In 1774, a system of 24 wires, one for each letter of the French alphabet, was erected at Geneva by Le Sage, and worked by means of frictional electricity, a separate pith-ball electroscope being connected to each wire at the receiving end. In 1816, Sir Francis Ronalds in England constructed a successful single-wire telegraph worked by frictional electricity, but further developments of such telegraphs were totally stopped by the introduction of magnetic instruments.

Voltaic Systems.

Volta, in 1800 discovered the current or low-tension electricity resulting from chemical action, and in 1819 Oersted deflected a magnetic needle by such a current; Ampere's observation, in 1820, of the magnetic properties of a helix, and Sturgeon's discovery in 1824 of the electro-magnet, completed the preliminary researches that rendered magnetic receiving instruments possible. The first needle telegraph was made by Baron P.L. Schilling at St. Petersburg between 1825-32. Prof. K.A. Steinheil, in 1837, produced a working magneto-electric telegraph in which the sounds produced by needles striking bells of different tones were observed; in a subsequent telegraph, symbols were indicated by a code of dots variously arranged in two parallel lines, these being marked on a paper strip by a tube pen fixed to the needle. Steinheil in 1838 erected a line of about six miles of galvanised iron wire between Munich and Bogenhausen; he was the first to employ the earth as the return conductor for low-tension currents.

Sir. C. Wheatstone and Sir W.F. Cooke took out their first patent in 1837 for "giving signals and sounding alarms at distant places" by "means of electric currents transmitted through metallic circuits." The first actual working telegraph was erected between Paddington & West Drayton (13 miles) in 1838-9; the wires were at first carried in a tube either buried or supported a few inches above the ground, but this method soon proved unsatisfactory and an open line was erected. The instruments were simplified so far as to require only two wires, and the telegraph line from Paddington was extended to Slough (18.5 miles). Cooke and Wheatstone subsequently introduced a single-needle instrument which is still used by railway companies, etc., in places where the work is light and the operator not highly skilled.

In America as early as 1832 Prof. S.F.B. Morse had turned his attention to the subject of telegraphy, and by 1835 had devised a working model, in which he used cast type set up in a line in the transmitter; by the regular travel of the type the circuit was closed at the necessary intervals of time. Prof. Morse constructed a line between Washington and Baltimore in 1843-4 with funds granted by Congress. He found it possible to make the signals by hand with a simple key. The armature on the receiving instrument had a to-and-fro motion which printed zig-zag lines on a moving slip of paper.

This instrument was superseded by a receiver which, by means of a stylo, embossed dots and dashes on the paper tape. It was subsequently found very fatiguing to the eye to read this slip so the instrument was supplanted by an inkwriter.

Herr Th. John, an Austrian engineer, in 1854 brought out as a substitute for the stylo a disc revolving in ink. Other inventors then turned their attention to this instrument, amongst the most successful being Messrs. Siemens and Halske. Another outcome of the Morse embosser was the "sounder," as the operator on the Morse embosser found it easier to listen to the click of the armature against the upper and lower stops than to read the slip. The sounder is perhaps the simplest of all telegraphic instruments; it can be read faster than the operator can write, i.e., at the rate of 35 to 40 words per minute.

In Messrs. Cooke and Wheatstone's patent of 1840 is described a step-by-step revolving disc telegraph, in which the letters or symbols are successively visible through an opening in the dial, the particular one it is desired to signal being allowed to remain visible for a longer period than the others. This was modified later to an instrument with an open dial on which the symbols were indicated by a pointer; many forms of these have been developed. Known as A B C instruments, they were employed on private and rural lines, as they required no battery and could be worked by an unskilled person. Their use has not been so extensive since the telephone became common.

Type-Printing Telegraphs.

Early type-printing telegraphs were introduced by Messrs. Wheatstone, P.A.J. Dujardin, J.W. Brett and D.E. Hughes. This last is the only one which has been extensively employed in Europe in the past. It still survives, but there are now a number of improved machine telegraphs in use. Some of these are able to print the message in page form, ready for delivery; others make use of paper tape, which is cut up and gummed on to the form.

Multiplex System.

By means of the duplex system of telegraphy two messages, one in each direction, can be sent simultaneously over one line, while quadruplex telegraphy, suggested by Stark and Bosscha in 1855 and made practicable by T.A. Edison in 1874, permits of two messages in each direction. In the multiplex system, which was proposed by Meyer in 1873 and depends upon the synchronous motion of rotating arms at distant stations, several messages can be sent over one wire at the same time. The first successful system based on this principle was that invented by J.M.E. Baudot in 1875. The duplexing of this system was effected by

Col. A.C. Booth, of the British Post Office. By this means it became possible to transmit and receive 12 simultaneous messages on one line. Several other very successful multiplex telegraphs are now used; among these may be mentioned the Murray and Western Electric systems.

The Murray multiplex in its latest form embodies many of the advantages of the automatic system with those of a multiplex, and the combination marks a distinct phase in the progress of multiple way telegraphs.

The latest development of multiplex telegraphy makes use of thermionic valves. The Siemens and Halske system, which is one of the best known, is designed to work through telephone cables, the frequencies adopted for alternating current telegraph working are therefore of the same order as the speech frequencies. Any existing method of direct current operation can be dealt with, and six separate channels may be accommodated on a single pair of wires. So far as the sending and receiving apparatus is concerned, little change is necessary. Instead, however, of the operator's instrument being connected direct to a line, the outgoing signals pass through the coils of a relay to earth. The tongue of the relay, on making contact with the marking stop, closes an oscillatory circuit tuned to the particular frequency adopted for that channel. Alternating currents are thus generated and passed to line.

At the receiving station, each separate frequency is filtered out, amplified and conveyed to its proper relay, the telegraph set being operated from the local contacts of the relay.

Another example of the use of thermionic valves in telegraphic and telephonic communication is found in carrier current systems, by the use of which the capacity of the lines can be multiplied enormously. The method developed by the Western Electric Company is extensively used in America.

Start-Stop Printers.

Other forms of type-printing telegraphs worked on the start-stop principle have been introduced during recent years. These are applicable to fairly busy lines, where duplex conditions are necessary, and also to less heavily worked circuits, such as those rented by large business companies, for private communication between their branches in various parts of the country. The receiving instrument is automatically started and stopped by the operation of the keyboard at the sending end. Continuous attendance at the instrument is therefore unnecessary.

RADIO COMMUNICATION.

Radio.

“Signalling across space without connecting wires” was conceived in the knowledge that electric oscillations produce electric waves which in their turn travel out into space in all directions, and that electric waves could be detected by a conductor which converted their energy back into oscillatory currents and electro-motive forces.

In 1867, Professor James Clerk-Maxwell, predicted the propagation of electric waves during the oscillatory discharge of a condenser. He also predicted the properties of these waves and foretold the velocity of propagation to be the same as that of all other ether waves. Further, he declared all ether waves to be electro-magnetic, the only differences in their behaviour being due to their differing frequencies of vibration.

In 1883, Henri Rudolf Hertz, a German physicist, began the study of Clerk-Maxwell’s electro-magnetic theory which was to have a profound effect on “communication without connecting wires.”

By 1889, Hertz had converted the theories of Maxwell into experimental fact. He showed how electro-magnetic waves were propagated through space, and measured their length and velocity, as well as shewed their exact correspondence with the waves of light and heat. Hertz produced waves by electric oscillations and “received” them by means of a conductor remote from the electric vibrator. His receiving conductor — a metal ring with a micrometer spark-gap introduced at some point in its circumference — was so dimensioned that its natural period of oscillations was the same as, or in resonance with, the frequency of the electro-magnetic waves propagated by his oscillator. The researches of Hertz laid the foundations for modern radio in all its forms, and to him and Clerk-Maxwell are due all the pioneer work which has enabled the science to advance so rapidly.

As the oscillatory currents received by a resonated “receiving” system are at frequencies much above the audible limit, and are, moreover, of very small values, a means of detecting and making visible or audible the presence of the feeble electric currents had to be provided. Devices to effect this — termed “detectors” — were subsequently evolved.

Sir Oliver Lodge in 1895 received Hertzian waves over a distance of about 40 yards using as a “detector” a tube of metal filings (coherer) and a galvanometer.

Sig. Guglielmo Marconi, an Irish-Italian, was, from his earliest years, keenly interested in communication by means of Hertzian waves. He began his brilliantly successful series of experiments in June 1895. Marconi found that the Hertzian form

of resonator gave only feeble signals at a distance, and he substituted a vertical wire, with the result that in 1895 he was able to transmit signals to a distance of one and a half miles.

The early receiving apparatus of Marconi consisted of an insulated vertical wire, a coherer, a relay, a decoherer, and a Morse printing instrument; the transmitting apparatus consisted of a large spark-gap to which the antenna and earth wires were connected. The high tension current for the spark was provided through an induction coil from batteries.

Marconi was the first to realise the commercial possibilities of radio-communication. He came to England in 1896, and took out the first patent ever granted for a practical system of Wireless Telegraphy. The patent covered "Improvements in Transmitting Electric Impulses and Signals, and in Apparatus therefor." In 1897 he signalled between two Italian warships 12 miles apart.

In 1899 the first proof of the advantages of wireless over other forms of communication came with the saving of the lives on board the ship "R.F. Mathews" which struck a lightship. The latter was equipped with a Marconi transmitting set, and was able to summon assistance.

On December 12th. 1901, the Atlantic was bridged by wireless for the first time. Marconi received signals in Newfoundland from his Poldhu Station in Cornwall.

Improvement followed improvement in rapid succession so that the stage was reached where not only wireless telegraphy but telephony without connecting wires became possible.

In 1904, Professor J.A. Fleming invented the two-electrode thermionic valve, which, as a detector and rectifier of Hertzian waves, proved itself to be one of the greatest steps forward in the science of radio communication. It led to and inspired the subsequent invention of the three-electrode valve amplifier and generator, without which modern radio telegraphy and telephony as we know it would hardly exist.

Later, the American Radio pioneer, Dr. Lee de Forest, added a third electrode or Grid to the thermionic valve, which revolutionised radio telegraphy and telephony.

The applications of thermionic valves in modern radio-communication may be classified as follows:—

- (1) Amplification—Radio and audio frequency.
- (2) Detection of damped-wave (spark) signals.
- (3) Generation of continuous oscillations.
- (4) Heterodyne reception — reception of continuous wave signals.

Spark or damped wave telegraphy has been condemned by International Convention and the induction coil and spark-gap, the coherer and the magnetic detector have now been entirely superseded by the thermionic valve.

TELEGRAPH AND TELEPHONE PROGRESS IN EGYPT.

Telephones.

Telephone history in Egypt commences in 1881 when a concession was given by the Egyptian Government to establish the first telephone line between Cairo and Alexandria. Two years later, communication was extended to several other large towns.

In 1918, the Egyptian Government took over all telephones and a special Department in connection with the State Railways was formed to carry out the necessary work.

The progress of the telephone service has been very marked both as regards the growth of lines, traffic and exchanges and in the design of the apparatus.

Automatic telephony was first introduced into Egypt in 1926 when an exchange in Cairo named Ataba was installed capable of serving 2,000 subscribers. In 1930 an Automatic Exchange was installed at Mansourah with a capacity of 1,000 lines and since then the whole of Cairo City has been converted to Automatic working on the "Rotary System." The capacity of this automatic exchange is 16,000 subscribers' lines. The work of converting other large towns to the Automatic System including Alexandria, Port-Said, Tanta, Heliopolis and Giza is in hand and early completion of this is anticipated.

Egypt possesses an extensive and good grade trunk line system connecting all towns and most villages and communication can be obtained even in the busiest parts of the day with little or no delay.

An underground cable connects Cairo and Alexandria.

Speech on the longer routes is augmented by thermionic valves and a repeater station is being erected at Tanta near the centre of the Delta which will materially improve general speech conditions.

The service given to subscribers in Egypt compares very favourably with European countries in spite of the fact that in the manual exchanges the variety of languages spoken by subscribers at many places increases the operating difficulties.

A Radio Telephone Service has recently been opened in Cairo with direct links to London, Paris, Berlin and Rome. Calls to most countries of Europe, North and South America, South Africa, Australia and certain ships on the Atlantic routes can now be made. This service has widened the scope of the Egyptian subscribers to cover 30 millions of telephone users throughout the world and it is confidently expected that it will prove of great value for commercial and social calls.

Telegraphs.

The telegraph service is very efficiently organised and all towns and villages of any size possess at least one telegraph office.

In common with most other countries the telegraph service of late years is experiencing the depression consequent upon the development and growth of the telephone service.

Wireless Telegraphy.

Egypt is a country which is peculiarly suitable for the employment of Radio Telegraphy as by this means, communication with the remote oases can be maintained, and a number of stations have been erected at these places.

The following wireless telegraph stations also exist:—

A "Lloyds" radio station erected by the Government at Port Said for communication with ships.

An Egyptian Government station at Alexandria for ship service. This station has a very extensive range.

A high power and speed station was erected at Abu-Zaabal near Cairo for communication with European stations with onward service to the rest of the world. This station was afterwards transferred to the Marconi Company.

A station at Kosseir — an important mining town on the Red Sea — for communication with ships in the Red Sea and with the inland telegraph system civil aircraft on the Indian and African air-routes.

Egyptian Government ships performing Coast-guard and Red Sea patrol work have been fitted with wireless installations.

Mobile wireless stations have been provided for desert communication.

SECTION 10 NO. 1.

GROUND FLOOR
BAY C.

PRESENTED BY
THE STANDARD
TELEPHONES
& CABLES
CO. LTD., 1932.

AN AUTOMATIC TELEPHONE DEMONSTRATION SET.

This is an Automatic Telephone demonstration set illustrating the principles of the rotary system now in use at Cairo City. (This system is being extended to Heliopolis, Alexandria, Giza and other Cairo sub-exchanges.

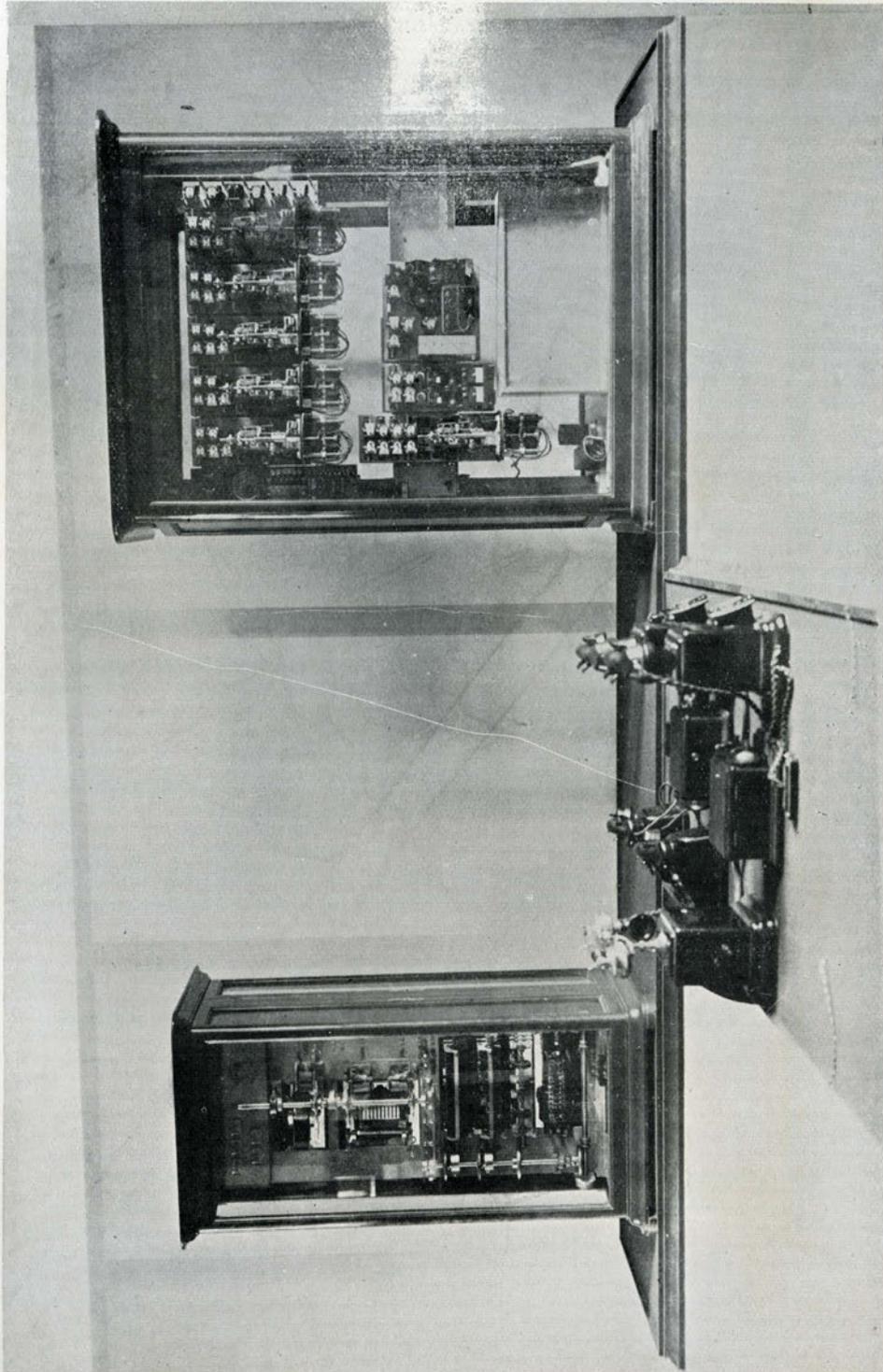
SECTION 10. NO. 2.

GROUND FLOOR
BAY C.

AN AUTOMATIC TELEPHONE DEMONSTRATION SET.

This is an Automatic Telephone demonstration set illustrating the principles of the Strowger system (step by step) now in use at Mansoura.

An additional set of switches also illustrates the dialling of 5 digits on an illuminated board. This system is being extended to serve Port-Said and Tanta.



Automatic Telephone Demonstration Set.

مجموعة ايضاحية للتليفون الاتوماتيكي

A PRIVATE BRANCH EXCHANGE (P.B.X.).

This is a private Branch Exchange (P.B.X.) used in connection with an Automatic Exchange. Its capacity is 3 exchange lines and 10 extensions. It is fitted with a dial and cords.

A LARGER PRIVATE BRANCH EXCHANGE.

Used in connection with an Auto Exchange. Its total capacity is 10 exchange lines and 50 extensions. It is fitted with a dial for obtaining calls on the main auto exchange.

A CORDLESS "PRIVATE BRANCH EXCHANGE".

This is a cordless "Private Branch Exchange" for 3 exchange lines and 9 extensions. Self restoring eyeball indicators are used, 4 simultaneous connections may be established by raising or lowering the key.

AUTOMATIC TELEPHONE INSTRUMENTS.

This shows Automatic Telephone Instruments of the types used in connection with Automatic Exchanges.

COMMON BATTERY TELEPHONE INSTRUMENTS.

These are Telephone Instruments of the types used in connection with "Common Battery" exchanges.

A SECTION (3 POSITIONS) "COMMON BATTERY" TELEPHONE SWITCHBOARD.

This is a section (3 positions) "Common Battery" Telephone Switchboard previously in use at Medina Exchange, Cairo. It has now been reduced in size and modified for use in the Provinces.

RELAY RACK.

A rack carrying the subscribers' lines and cut-off relays.

MAIN DISTRIBUTING FRAME.

A frame which provides cross connection facilities for subscribers lines and accommodates the protective apparatus of every line.

SECTION 10. NO. 3.

GROUND FLOOR
BAY C.

SECTION 10. NO. 4.

GROUND FLOOR
BAY C.

SECTION 10. NO 5,

GROUND FLOOR
BAY C.

SECTION 10. NO. 6.

GROUND FLOOR
BAY C.

SECTION 10. NO. 7.

GROUND FLOOR
BAY C.

SECTION 10. NO. 8.

GROUND FLOOR
BAY D.

SECTION 10. NO. 9.

GROUND FLOOR
BAY D.

SECTION 10. NO. 10.

GROUND FLOOR
BAY D.

**SECTION 10.
NO. 11.**

GROUND FLOOR
BAY E.
PRESENTED BY
THE STANDARD
TELEPHONES
& CABLES
CO. LTD., 1932.

MODEL OF GRAHAM BELL'S TELEPHONE.

This is the first practical type of telephone and was the fore-runner of the modern instrument.

**SECTION 10.
NO. 12.**

GROUND FLOOR
BAY E.

**100 SUBSCRIBERS' LINES MAGNETO TELEPHONE
SWITCHBOARD.**

This is a 100 subscribers' line magneto telephone switchboard with hand restoring indicators and cords to make 15 calls simultaneously.

**SECTION 10.
NO. 13.**

GROUND FLOOR
BAY E.

MAGNETO TELEPHONE SWITCHBOARD.

This shows a magneto telephone switchboard with self-restoring indicators and cords to make 15 calls simultaneously. This exhibit is wired to accommodate 40 exchange lines but it is capable of considerable extension.

**SECTION 10.
NO. 14.**

GROUND FLOOR
BAY E.

MAGNETO CORDLESS TELEPHONE SWITCHBOARD.

This is a magneto cordless telephone switchboard for 50 subscribers' lines, 8 calls may be made simultaneously. Suitable for use in a small town. Connections are established by inserting metal pegs in the jack allocated to the calling and called subscribers.

**SECTION 10.
NO. 15.**

GROUND FLOOR
BAY G.

POWER PLANT.

This power plant with transformer rectifier and accumulators is used for supplying current to telephone and telegraph exhibits.

**SECTION 10.
NO. 17.**

GROUND FLOOR
BAY F.

MORSE TELEGRAPH INSTALLATION.

This illustrates a complete Morse telegraph installation on the duplex principle. The instruments shown would be staffed by 4 telegraphists at each end and is capable of transmitting 4 messages simultaneously (2 from each end). For this purpose, only one wire to the distant station with an earth return is necessary. The present exhibit however indicates how, by means of "superimposition" this telegraph installation and a telephone circuit can be provided on a single pair of connecting wires.

MORSE PRINTER.

This is an instrument on which the signals sent by a Morse key are received at the distant station on a paper tape which records in dots and dashes the signals sent. The exhibit is for long distance work and includes a relay with local battery.

WHEATSTONE TELEGRAPH INSTRUMENT.

This is a telegraph instrument for transmitting messages at a high speed. The signals are transmitted by means of a perforated tape and are recorded at the distant station on an "inker" which records the messages on a paper tape in dots and dashes. The messages are "punched" on the sending tape by means of a hand operated machine. A speed of 300 words or more per minute can be obtained. The present exhibit is working at a very slow speed and is actuating a Morse sounder but may be transferred to the "inker" by moving switch "A".

WHEATSTONE HAND PERFORATOR.

The hand punching machine mentioned in No. 19.

WHEATSTONE BRIDGE.

A wheatstone bridge comprises three sets of resistance coils, a battery and a galvanometer. With this apparatus the resistance of any line, instrument or other system of conductors can readily be measured. The apparatus is joined up and the resistance to be measured being connected, the three resistances are varied until the galvanometer needle is deflected. Having obtained a balance, the 4 resistances bear the correct relation to each other and the unknown resistance can then be calculated.

REFLECTING GALVANOMETER.

This instrument, by utilising a reflected ray of light can measure very small currents of electricity. A beam of light is directed by a lens on to the mirror, which in its normal position reflects a circular beam of light on the scale. When the mirror is deflected by even a small current, the spot of light moves along the scale.

The beam of light is practically a pointer of indefinite length, and by increasing the distance from the mirror to the scale, the sensitiveness of the arrangement may be greatly enhanced. The usual distance employed is a metre.

SECTION 10. NO. 18.

GROUND FLOOR
BAY F.

SECTION 10. NO. 19.

GROUND FLOOR
BAY F.

SECTION 10. NO. 20.

GROUND FLOOR
BAY F.

SECTION 10. NO. 21.

GROUND FLOOR
BAY F.

SECTION 10 NO. 22.

GROUND FLOOR
BAY F.

**SECTION 10.
NO. 23.**
GROUND FLOOR
BAY F.

Q. AND I. GALVANOMETER.

This is used as a rough and ready testing instrument by line-men and faultsmen.

**SECTION 10.
NO. 24.**
GROUND FLOOR
BAY F.

PORTABLE TESTING SET (OHMMETER).

This is an obsolete type of Evershed Ohmmeter. It has now been replaced by modern types of the Megger.

**SECTION 10.
NO. 25.**
GROUND FLOOR
BAY F.

THE POST OFFICE TANGENT GALVANOMETER.

This consists of a magnetic needle pivoted upon a steel point in the centre of the box. The light aluminium pointer is fixed at right angles to the needle and a mirror to ensure accurate reading is fixed adjacent to the scale.

**SECTION 10.
NO. 26.**
GROUND FLOOR
BAY F.

RELAY — AMERICAN.

A non-polarised relay, American type, for use on "B" side of quadruplex.

**SECTION 10.
NO. 27.**
GROUND FLOOR
BAY F.

SOUNDER INSTRUMENT, 250 OHMS. TRANSLATING "FOR NILE SERVICE".

This is used in offices open at night during the Nile flood season for special service.

**SECTION 10.
NO. 28.**
GROUND FLOOR
BAY F.

SOUNDER, 250 OHMS. WITHOUT SHUNT.

This instrument is extensively used between all stations in Egypt for open and closed circuits. It is used on closed circuits composed of from 2 up to 8 stations with batteries at both ends.

Gravity batteries are used in every case of closed circuit. Also used on open circuits with battery at each station. In this case Léclanché cells are used in place of gravity.

**SECTION 10.
NO. 29.**
GROUND FLOOR
BAY F.

TELEGRAPH SOUNDER (TRANSLATING) 40 OHMS. 5 TERMINALS.

Three terminals, besides the two to which the ends of the coils are brought, are fixed on the base of the instrument. These are marked "S", "T", "M" and connected to top contact, lever and lower contact respectively for use as a "Relaying Sounder".

SINGLE CURRENT KEY.

This is employed to send Morse signals by hand. Pressure of the handle closes the circuit and operates the distant instrument.

SINGLE CURRENT KEY WITH COMMUTATOR.

This prepares the circuit for simplex or duplex working for switching to different circuits.

SINGLE CURRENT KEY WITH SWITCH.

Morse key used for double current working. The switch disconnects the battery when messages are not being sent. It is also used for duplex working.

VIBRATOR.

The vibrator system is used on lines of very high resistance, and comparatively poor insulation. It is also used as a military telegraph instrument. Signals are received in the form of a buzz in a telephone handset.

SWITCH, 6 TERMINALS "2 WAY".

This prepares the circuit for simplex or duplex working.

"ERICSSON" TYPE OF GALVANOMETER WITH SHUNT

This type of instrument is now obsolete.

INDIAN STATE RAILWAY SOUNDER, DOUGLAS PATTERN KEY.

This is obsolete; it has now been replaced by modern types.

POLE CHANGER. — NON POLARISED.

This instrument is used as quadruplex pole changing repeater in connection with Wheatstone working.

SECTION 10. NO. 30.

GROUND FLOOR
BAY F.

SECTION 10. NO. 31.

GROUND FLOOR
BAY F.

SECTION 10. NO. 32.

GROUND FLOOR
BAY F.

SECTION 10. NO. 33.

GROUND FLOOR
BAY F.

SECTION 10. NO. 34.

GROUND FLOOR
BAY F.

SECTION 10. NO. 35.

GROUND FLOOR
BAY F.

SECTION 10. NO. 36.

GROUND FLOOR
BAY F.

SECTION 10. NO. 37.

GROUND FLOOR
BAY F.

**SECTION 10.
NO. 38.**

GROUND FLOOR
BAY F.

POLARISED SOUNDER.

This consists of an electromagnet with an armature centrally pivoted between the armature poles. It is inductively magnetized by a permanent magnet. Signals are given by sound according to the direction of the transmitted current. Morse signals are employed; dots and dashes being distinguished by different sounds.

**SECTION 10.
NO. 39.**

GROUND FLOOR
BAY F.

GALVANOMETER, MILITARY-SINGLE AND DUPLEX.

This is a galvanometer employed in securing a "balance" on duplex and quadruplex circuits. The coils have a double winding of 50° each.

NO. 40.

GROUND FLOOR
BAY F.

SINGLE CURRENT GALVANOMETER.

This is the single current type employed on simple circuits to indicate the presence of current upon the line.

NO. 41.

GROUND FLOOR
BAY F.

"SIEMENS" TYPE OF SINGLE NEEDLE GALVANOMETER

This type of instrument is now obsolete.

NO. 42.

GROUND FLOOR
BAY F.

SOUNDER WITH 6 TERMINALS, OLD PATTERN.

This is an obsolete type of Indian Sounder.

NO. 43.

GROUND FLOOR
BAY F.

SOUNDER 900 OHMS., WITH SHUNT.

For local circuits using secondary cells.

NO. 44.

GROUND FLOOR
BAY F.

SOUNDER 250 OHMS., WITH SHUNT.

For open and closed circuits using primary cells.

SECTION 10.

NO. 45.

GROUND FLOOR
BAY F.

SOUNDER POLARIZED, 500+500 OHMS.

For use as a relaying sounder on short lines.

SECTION 10.

NO. 46.

GROUND FLOOR
BAY F.

ACCUMULATOR—SMALL.

This is used to store electricity. It is formed of positive and negative plates immersed in dilute sulphuric acid. It is charged by being connected to a suitable source of direct current when a chemical action takes place in the plates. It is then capable of discharging a current by a reverse of the chemical action.

THE AGGLOMERATE CELL.

The agglomerate cell is composed of an oblong jar 6 inches high into which is placed a carbon rod or plate in the centre. Two flat agglomerate blocks are added, one at each side, separated from the carbon plate by two oblong insulators. The blocks are of manganese dioxide mixed with an equal weight of crushed carbon, the jar is filled with dilute salamoniac.

THE LECLANCHE CELL.

The containing vessel of this cell consists of a square glass jar, ending in an almost circular collar, shaped to admit the zinc rod which forms the positive element. The rod is cast on to a copper wire which is usually insulated where it emerges from the zinc and forms one terminal of the cell. Inside the jar is placed a circular porous pot containing the negative element, a carbon plate and the depolarizer manganese dioxide. Water with Salamoniac are added (15 % by weight) in the cell around the porous pot.

Its electromotive force is 1.33 volts.

Internal resistance 2 ohms.

THE DANIELL CELL.

The Daniell Cell is composed of a jar at the bottom of which is sulphate of copper. Around this is a copper flat plate with a zinc rod at the other end.

The zinc is placed in a porous pot filled with water.

The water in the porous pot becomes saturated with sulphate of zinc produced by the chemical action which takes place when the two plates are connected.

Its electromotive force is 1.08 volts.

Its internal resistance is 4 ohms.

THE GRAVITY CELL.

The gravity cell is composed of a jar, at the bottom of which is a copper plate. The copper plate is connected by insulated wire. Above the copper plate is placed the sulphate of copper. Water is added. Above the water a zinc plate is suspended by wooden supports on the surface of the water.

The electromotive force is 1 volt.

The internal resistance is 7 ohms.

DRY CELL.

This cell consists of a zinc cylinder with a connection wire attached to the inside of the cylinder. The latter contains a carbon rod, surrounded by a depolarizer composed of a mixture of powdered peroxide of manganese and carbon.

SECTION 10. NO. 47.

GROUND FLOOR
BAY F.

SECTION 10. NO. 48.

GROUND FLOOR
BAY F.

SECTION 10. NO. 49.

GROUND FLOOR
BAY F.

SECTION 10. NO. 50.

GROUND FLOOR
BAY F.

SECTION 10. NO. 51.

GROUND FLOOR
BAY F.

**SECTION 10.
NO. 52.**

GROUND FLOOR
BAY F.

BICHROMATE CELL.

The elements of the bichromate cell are: zinc (amalgamated) and carbon, with chromic acid as the depolarizing agent.

The zinc stands in a porous pot with a small quantity of mercury and a weak solution of sulphuric acid.

The carbon is in the outer earthenware jar, in which a similar but stronger solution of sulphuric acid and a quantity of bichromate of potash is placed.

The electromotive force is 1.8 volts.

The internal resistance is 2 ohms.

**SECTION 10.
NO. 53.**

GROUND FLOOR
BAY G.

UNDERGROUND CABLE CHAMBER.

Model of underground cable chamber showing method of joining lines.

**SECTION 10.
NO. 54.**

GROUND FLOOR
BAY G.

PHANTOM LOADING POT. — 15 UNITS.

This is employed to increase the efficiency of transmission on long underground lines, and similar pots are inserted at regular intervals.

**SECTION 10.
NO. 55.**

GROUND FLOOR
BAY G.

PORTABLE SET "ERICSSON TYPE".

This is used by linesmen and faultsmen for outdoor testing.

**SECTION 10.
NO. 57.**

GROUND FLOOR
BAY E.

DAMAGED CABLES.

Specimen of lead sheaths of damaged telephone cables due to Electrolysis.

**SECTION 10.
NO. 58.**

GROUND FLOOR
BAY E.

CABLES.

These are specimens of cables of various sizes.

**SECTION 10.
NO. 60.**

GROUND FLOOR
BAY G.

TELEPHONE CORDS.

These are telephone cords shewing components and stages of manufacture.

JUNCTION BOX.

A junction box for cable to air line distribution.

RADIO TRANSMITTING SET.

This is a model of a Radio Telegraph transmitter of medium power with attachment for Telephony. The three sections contain the apparatus for:—

- (a) The transformation and rectification of the power supply.
- (b) The generation of radio-frequency oscillations.
- (c) The modulation of the latter at audio frequencies.

RADIO VALVES.

Specimens of transmitting and receiving valves used in wireless telegraphy and telephony.

TELEPHONE INSTRUMENTS.

These are specimens and sections of Telephone Instruments, and specimens of telephone relays and switchboard keys.

INDICATORS, KEYS, ETC.

These are specimens of indicators, keys, protectors, generators, distribution blocks, jacks, induction coils and condensers.

MAGNETO HAND GENERATOR.

A magneto hand generator for actuating bell lamp and indicator. (Working).

MAGNETO TELEPHONE INSTRUMENTS.

These are type of subscribers' magneto telephone instruments. (Wall sets).

SECTION 10. NO. 61.

GROUND FLOOR
BAY G.

SECTION 10. NO. 62.

GROUND FLOOR
BAY G.

SECTION 10. NO. 63.

GROUND FLOOR
BAY G.

SECTION 10. NO. 64.

GROUND FLOOR
BAY D.

SECTION 10. NO. 65.

GROUND FLOOR
BAY E.

SECTION 10. NO. 66.

GROUND FLOOR
BAY F.

SECTION 10. NO. 67.

GROUND FLOOR
BAY E.

SECTION 10.

NO. 68.

GROUND FLOOR
BAY E.

MAGNETO TELEPHONE INSTRUMENTS.

These are types of subscribers' magneto telephone instruments.
(Table sets).

SECTION 10.

NO. 69.

GROUND FLOOR
BAY C.

AUTOMATIC SWITCHING APPARATUS.

These are specimens of Automatic Switching apparatus.

SECTION 10.

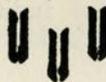
NO. 70.

GROUND FLOOR
BAY G.

PRESENTED BY
TUDOR
ACCUMULATOR
CO. LTD. AND
CHLORIDE
ELECTRICAL
STORAGE
CO. LTD.

ACCUMULATOR MANUFACTURE.

This is an exhibit illustrating the processes in the manufacture
of modern accumulators.



SECTION 11.

PHOTOGRAPHS, PAINTINGS AND MAPS.

These are photographs, taken about 1870 of typical scenes on the Nile.

These are views of the modern Automatic Telephone Exchange in Cairo (Medina).

A selection of photographs of the Medina Manual and Automatic Telephone Exchange, Cairo, the Ministries Automatic Exchange, and The Mansura Automatic Exchange.

These are views of the Cairo and Alexandria Telegraph Offices and Mansura Automatic Exchange.

A selection of historical telephone and telegraph details is depicted in this series of photographs.

These are views of the Wireless Stations at Ras El Tin and Alexandria.

These are photographs of typical Signal Cabins and Signal Installations on the Egyptian State Railways system.

The Power Stations—old and new, at Gabbary are depicted in the series of photographs.

A selection of photographs of various bridges on the Egyptian State Railways system is displayed on this column.

These are views of various designs of bridges on the Egyptian State Railways system.

SECTION 11.

FIRST FLOOR
COLUMN 1.

SECTION 11.

GROUND FLOOR
COLUMN 2.

SECTION 11.

GROUND FLOOR
COLUMN 3.

SECTION 11.

GROUND FLOOR
COLUMN 4.

SECTION 11.

GROUND FLOOR
COLUMN 5.

SECTION 11.

GROUND FLOOR
COLUMN 6.

SECTION 11.

GROUND FLOOR
COLUMN 7.

SECTION 11.

GROUND FLOOR
COLUMN 8.

SECTION 11.

GROUND FLOOR
COLUMN 9.

SECTION 11.

GROUND FLOOR
COLUMN 10.

SECTION 11.
GROUND FLOOR
COLUMN 11.

Included in this series of photographs is a locomotive ferry.

SECTION 11.
GROUND FLOOR
COLUMN 12.

These are views of the Egyptian State Railways Hospital in Sharia Malaka Nazli, Cairo.

SECTION 11.
GROUND FLOOR
COLUMN 13.

This is a series of photographs of typical Stations on the Egyptian State Railways system.

SECTION 11.
GROUND FLOOR
COLUMN 14.

These are typical views on the Main Line of the Egyptian State Railways.

SECTION 11.
GROUND FLOOR
COLUMN 15.

This is a series of photographs of stations on the Egyptian State Railways system.

SECTION 11.
GROUND FLOOR
COLUMN 16.

These are views of shunting operations in various yards of the Egyptian State Railways.

SECTION 11.
GROUND FLOOR
COLUMN 17.

This is a series of views of the old Gabbary Workshops of the Egyptian State Railways.

SECTION 11.
GROUND FLOOR
COLUMN 18.

These are photographs of various Locomotive Running Sheds on the Egyptian State Railways.

PROGRESS OF SIGNALLING 1861 TO 1932.

This illuminated panel displays photographs and drawings of some of the first signalling installations in England, and also views of one of the latest types of all electric locking frames.

The views show :—

1. Victoria Station, London.
"Hole in the Wall" Signal Cabin.
Opened 1861.
2. Victoria Station, London.
"Hole in the Wall" Cabin and Signals.
Opened 1861.

3. Cannon Street Station, London.
General View showing Cabin and Signals as installed 1865
4. Cannon Street Station, London.
Interior of Signal Cabin. Opened 1865.
Locking Frame 67 levers.
5. Cannon Street Station, London.
General View showing Tracks and Signal Cabin, June 5th. 1926.
6. Cannon Street Station, London.
General view showing re-modelled Layout.
June 23rd. 1926.
7. Cannon Street Station, London.
Interior of New Cabin showing Interlocking Frame of 143 levers — Opened 1926.
8. Cannon Street Station, London.
General View of Station showing New Light Signals and and Route Indicators — Opened 1926.
9. Charing Cross Station, London.
General View showing Cabin and Signals, as installed in 1865.
10. Charing Cross Station, London.
New Signal Cabin — Opened 1926.
11. Charing Cross Station, London.
Interior of New Signal Cabin, showing new power interlocking frame of 107 levers — Opened 1926.
12. London Bridge Station, London.
North Cabin and Signals as installed 1878.
13. London Bridge Station, London.
Interior of North Cabin, opened 1878.
Locking Frame 280 levers.
14. London Bridge Station, London.
New Signal Cabin — Opened 1928.
15. London Bridge Station, London.
Power Interlocking Frame of 311 levers — Opened 1928.
16. Brighton Station, England.
General View showing Cabins and Signals as installed 1865.

17. Brighton Station, England.
Diagram of Signalling installation, as installed 1881
18. Brighton Station, England.
General View showing Starting Signals with South and West Signal Cabins — Opened 1881.
20. Brighton Station, England.
South Cabin Interior showing locking frame of 240 levers, —Opened 1881.
21. Brighton Station, England.
South Cairo Interior showing Interlocking between levers — Opened 1881.
24. Brighton Station, England.
Interior of the New Signal Cabin showing portion of the all electric interlocking frame of 225 levers — Opened 1932.
25. Southern Railway, England.
North Kent East Junction Locking Frame of 85 levers. The first all electric interlocking frame installed in England — Opened 1929.
26. Diagram of early Signalling Installation manufactured in England for the East Newark Junction, Pennsylvania Railroad, U.S.A. Supplied 1875.
27. Early Mechanical Interlocking Frame produced in 1859.

Nos. 1 and 2.—“Hole in the Wall” Cabin, Victoria Station—London.

This was one of the earliest signalling installations in England. It was manufactured and erected by Messrs. Saxby and Farmer, Limited in the year 1861, in accordance with letters patent granted to Mr. John Saxby in the year 1860, and was very highly commended by Col. Tolland, Chief Government Inspecting Officer for Railways at his official inspection.

Nos. 3, 4, 5, 6, 7 and 8.—Cannon Street Station, London.

Was first equipped with signalling in the year 1865. The first installation was equipped and erected by Messrs. Saxby and Farmer, Ltd. The electric power Signalling installation now in use was installed by the Southern Railway Coy. in the year 1926, the apparatus being supplied by The Westinghouse Brake and Saxby Signal Co. Limited.

Nos. 9, 10 and 11.—Charing Cross Station.

Was first equipped with signalling in the year 1865, and, as at Cannon Street, was supplied and erected by Messrs. Saxby and Farmer, Limited. As at a Cannon Street, an electric power signalling installation is now in use, installed by the Southern Railway Company in the year 1926, the apparatus being supplied by The Westinghouse Brake and Saxby Signal Company Limited.

Nos. 12, 13, 14 and 15.—London Bridge Station.

London was originally operated by two Railway Companies, viz. London, Brighton and South Coast Railway, and the London and South Eastern Railway. The former Company installed the first signalling installation in the year 1878, the materials being supplied and erected by Messrs. Saxby and Farmer, Ltd.

It contained, in the North Cabin, the largest locking frame in the world at the time of its erection, the levers being placed in two rows, back to back, the number being 280. An additional feature was the employment for the first time of Route Indicators. This locking frame, and also the 98 lever interlocking frame in the South Cabin were in continual use until 1928, when the two stations were operated from one Cabin containing a power interlocking frame of 311 levers operating points by electric motors and colour light signals. This new power frame, was supplied and erected by The Westinghouse Brake & Saxby Signal Co. Ltd., who supplied also the whole of the other materials to the order of the Southern Railway Co. by whom the work was installed.

Nos. 16, 17, 18, 20, 21 and 24.—Brighton Station, England.

Was first equipped with signalling in the year 1861. The interlocking frames were of the same type as supplied for "Hole in the Wall" Cabin at Victoria Station, London, and Messrs. Saxby & Farmer, Ltd., supplied and erected them.

In the year 1880 the Station was largely increased in size and Messrs. Saxby & Farmer were again entrusted with the manufacture and installation of the necessary signalling. This necessitated six signal cabins, the chief of which, the South Cabin, contained a locking frame of 240 levers in one row, the largest so constructed at the time of its erection, other cabins being the West Cabin with 120 levers and the North Cabin with 96 levers. In all 592 levers were required. It was also equipped with Route Indicators. A special feature was the construction of a subway under the lines to carry the operating rods and wires from one side of the line to the other. This installation was in continual use until October, 1932, when a new All-Electric interlocking frame of 225 levers was supplied and erected by the Westinghouse Brake & Saxby Signal Co. Ltd., together with a power installation supplied by the same contractors and installed by the Southern

Railway Company. This new power installation enables one Cabin to do the work of no less than seven mechanically operated cabins, and controls an area of over two miles on the main lines from London, as well as the routes to Portsmouth and Hastings. A special feature of the locking frame is that it is built in 3 sections, each section being at an angle of 150° to the adjoining section. It is also provided with two complete illuminated diagrams, each diagram being in two sections, the whole equipment being of the most modern type. Thus, in 70 years three installations have been provided by the same contractors.

No. 25.—North Kent East Junction, Southern Railway, England.

The first interlocking frame ever installed in which the interlocking between the levers was carried out electrically. Previously to this frame, such interlocking was always done mechanically.

No. 26.—East Newark Junction, Pennsylvania Railroad.

This diagram shows an early Railway signalling plant, manufactured by Messrs. Saxby & Farmer Ltd., for a railway in the United States of America, and the locking frame which was of the Saxby "Rocker" type, patented in 1871, was for years the standard type on American Railways.

No. 27.—Model of an early British Interlocking Frame.

Manufactured in the year 1859. The catch for retaining the lever in the "Normal" or "Reverse" position was the quadrant plate. The interlocking was carried out by hooks and bevels through spring loaded locking rods.

SECTION 11.
FIRST FLOOR
COLUMN 1.

GRAECO-ROMAN AND ARAB PERIOD. — TRANSPORT.

Typical transport scenes in the Graeco-Roman and Arab periods are depicted in this series of eight illuminated photographs.

SECTION 11.
FIRST FLOOR
COLUMN 2.

NEW RAILWAY WORKSHOPS — ABU ZAABAL.

This series of photographs are interior and exterior views of the works in their present stage of completion.

SECTION 11.
FIRST FLOOR
COLUMN 3.

DEVELOPMENT OF FOREIGN LOCOMOTIVES.

The development of foreign steam locomotives is depicted in this series of eight illuminated photographs; these include a photograph of the original Murdock locomotive, the first ever run in England.

Descriptive cards are displayed under each photograph.

DEVELOPMENT OF FOREIGN LOCOMOTIVES.

The evolution of foreign locomotives is illustrated in this series of illuminated photographs.

PULLMAN CARS.

This series of photographs depicts Pullman Cars and views of the interiors of these vehicles.

MACHINE TOOLS.

This series of illuminated photographs shows typical machine tools used in the production of locomotives.

LOCOMOTIVE INVENTIONS.

These illuminated photographs depict some historical locomotive inventions.

E.S.R. CARRIAGE AND WAGON STOCK.

This is a series of photographs of typical Egyptian State Railways Carriage and Wagon Stock.

LOCOMOTIVES OF THE EGYPTIAN STATE RAILWAYS.

These photographs show representative types of Egyptian State Railways locomotives, with various wheel arrangements and for different duties.

EARLY LOCOMOTIVES OF THE EGYPTIAN STATE RAILWAYS.

Some of the earliest locomotives of the Egyptian State Railways are depicted here, including the 8'-2" Single Driver, built by Neilson & Co. in 1862.

EGYPTIAN STATE RAILWAYS, PRINTING OFFICE.

These are photographs of different sections of the Egyptian State Railways, Printing Office.

MODES OF TRANSPORT.

This series of illuminated photographs depicts conveyances and methods of transport used in different parts of the world.

SECTION 11.

FIRST FLOOR
COLUMN 4.

SECTION 11.

FIRST FLOOR
COLUMN 5.

SECTION 11.

FIRST FLOOR
COLUMN 6.

SECTION 11.

FIRST FLOOR
COLUMN 7.

SECTION 11.

FIRST FLOOR
COLUMN 8.

SECTION 11.

FIRST FLOOR
COLUMN 9.

SECTION 11.

FIRST FLOOR
COLUMN 10.

SECTION 11.

FIRST FLOOR
COLUMN 11.

SECTION 11.

FIRST FLOOR
COLUMN 12.

SECTION 11.FIRST FLOOR
COLUMN 13.**EARLY TYPES OF MOTOR VEHICLES.**

This display of illuminated photographs shows some of the early types of motor vehicles.

SECTION 11.FIRST FLOOR
COLUMN 14**THE ALEXANDRIA—RAMLEH RAILWAY STATIONS.**

Some of the stations on this railway are shown in this series of illuminated photographs, some of which were taken during the years 1890-1900 and the modern in 1932.

SECTION 11.FIRST FLOOR
COLUMN 15.**CANAL TRANSPORT.**

Typical scenes of canal transport of goods is depicted in this series of photographs.

SECTION 11.FIRST FLOOR
COLUMN 16.**SEASONABLE TRAFFIC.**

These are typical scenes of transport taken during the onion and cotton seasons.

SECTION 11.FIRST FLOOR
COLUMN 17.**THE ALEXANDRIA-RAMLEH RAILWAY. —
ROLLING STOCK.**

The rolling stock in service on this railway from 1904 to 1931 is depicted in this series of illuminated photographs.

SECTION 11.FIRST FLOOR
COLUMN 18.**TRANSPORT IN CAIRO.**

This series of photographs shows various means of conveyance as used in Cairo today.

SECTION 11.FIRST FLOOR
BAY B.**NEW LOCOMOTIVE WORKSHOPS OF THE EGYPTIAN
STATE RAILWAYS, ABU-ZAABAL.**

The new workshops at Abu-Zaabal in their present stage of completion are shown in this panel, which includes line drawings of the general layout of the works, and a tabular list of the machine tools which are laid down.

Other drawings show the layout of the erecting shop, and bays for the production of connecting and coupling rods, wheels and axles, axleboxes and piston and crossheads.

The photographs in the bench panels are interior and exterior views of various sections of the works.

SECTION 11.FIRST FLOOR
BAY C.**EARLY EGYPTIAN, BRITISH AND AMERICAN
LOCOMOTIVES.**

Some of the early types of locomotives of the Egyptian State Railways are displayed in these panels, in the form of line drawings. In the side panels examples of early British and American designs are shown.

GEORGE AND ROBERT STEPHENSON.

These illuminated panels display photographs and drawings of some of the locomotives built by these famous early locomotive engineers, including the "Locomotion" which opened in 1825, the first public steam railway in the world.

DRAWING OF CIRCULAR RAILWAY.

This drawing by Thomas Rowlandson (1756—1827) depicts a circular railway laid down by Richard Trevithick in 1809, in a field adjoining the New Road at a spot now forming the southern half of Euston Square, London.

The engine was named "Catch me who can". It had a vertical cylinder 14 1/2" diameter by 4'-0" stroke. The working pressure was 100 lb. per sq. inch, the engine weighed 10 tons, and travelled at 15—20 miles per hour. The public were permitted to try the then new mode of travel on payment.

FOREIGN ROLLING STOCK.

This panel displays a selection of photographs of modern locomotives, included among which may be seen the following types. High pressure compound steam, pulverised and oil fuel fired, compressed air, and other designs. The photographs represent the latest practice of locomotive engineers in various countries.

TRAVELLING ON THE LIVERPOOL AND MANCHESTER RAILWAY — 1833.

This original coloured print depicts two typical trains on the Liverpool and Manchester Railway about 1833. The upper picture shows a train of the first class with mail coach and a landau with its passengers mounted on a truck.

The lower picture is a train of the second class with its passengers in open coaches.

LIGHT RAILWAYS.

This is a series of photographs of rolling stock and works of the Delta Light Railways, Fayoum Light Railways and the Chemin de Fer de la Bas-Egypte. A map shows the Egyptian State Railways system and these Light Railways.

SECTION 11.

FIRST FLOOR
BAY D.

SECTION 11.

FIRST FLOOR
BAY D.
(END WALL).
PRESENTED BY
R.E. TREVITHICK.
ESQ., 1932

SECTION 11.

FIRST FLOOR
BAY E.

SECTION 11.

FIRST FLOOR
BAY E.
(END WALL).

SECTION 11.

FIRST FLOOR
BAY F.

SECTION 11.

FIRST FLOOR
BAY F.
(END WALL).

**GOODS TRAINS ON THE LIVERPOOL AND
MANCHESTER RAILWAY — 1833.**

This original coloured print depicts two typical goods trains on the Liverpool and Manchester Railway about 1833. The upper picture shows a train drawn by the locomotive "Liverpool", the open trucks are loaded with miscellaneous goods.

In the lower picture a cattle train is shown, being hauled by the locomotive "Fury". Sheep were carried in two deck wagons; pigs were carried in open wagons in which there seems to have been difficulty in restraining them, as they were accompanied by their drovers.

SECTION 11.

FIRST FLOOR
BAY G.

LOCOMOTIVE PARTS.

This series of drawings shows various locomotive components.

SECTION 11.

FIRST FLOOR
BAY H.

MACHINE TOOLS.

Drawings of typical machine tools and accessories employed in the production of locomotives and railway rolling stock are displayed on this panel.

SECTION 11.

FIRST FLOOR
BAY J.

CARRIAGES AND WAGONS.

This panel displays photographs and drawings of old Egyptian State Railways Carriage and Wagon Stock, and copies of the specification and drawings of Joseph Wright's railway and other carriages for which he was granted patent rights in 1844.

SECTION 11.

FIRST FLOOR
BAY J.

STATE CARRIAGE.

This coloured drawing shows the State Carriage for H.H. The Viceroy of Egypt, constructed by J. Wright and Sons, Saltley Works, Birmingham, in 1858.

The colours shown on the drawing are identical with those employed on the actual carriage.

SECTION 11.

FIRST FLOOR
BAY K.

**THE FIRST AND LATEST LOCOMOTIVES OF THE
EGYPTIAN STATE RAILWAYS.**

Mounted on this panel are sectional elevation drawings of the first and latest type of Egyptian State Railways locomotives. The side panels show details of the Locomotive Stock in the Years 1894 and 1906 respectively.

THE ROYAL TRAIN.

On occasions when H.M. King Fouad I, travels by rail the Royal Train, the rolling stock, of which is represented by photographs in these illuminated panels, is used.

The vehicles include H.M.'s. Personal Saloon, Royal and Ministers Saloon, State Saloon, First Class Car, Rear and Leading Brake, Staff and Official Carriages, and the locomotive which is especially allocated for hauling this train.

The complete train as marshalled for service is shown in the centre of the panel, and interior views of the vehicles are mounted on the bench under the main panel.

LOCOMOTIVES — 1888 to 1932.

This series of photographs shows various types of locomotives dating from 1888 to the present day, which have been, or still are in service on the Egyptian State Railways system.

THE OVERLAND ROUTE. — EUROPE-INDIA.

One of the stages of the Overland Route to India, that through Egypt is represented in this illuminated diagram. The three routes used in this connection are clearly indicated by lighting which is operated by the relay switch mounted in front of the panel.

The illuminated photographs include typical scenes on the route, as well as one of Thomas Waghorn, the projector of this route, and H.H. Mohamed Aly Pasha, who at his own expense, in 1841, made the way between Suez and Cairo passable for carriage travelling.

AN IMPRESSION OF MEANS OF TRANSPORT.— 10,000 YEARS AGO TO DATE.

This series of illuminated scenes depicts the evolution of means of transport from pre-historic times down to the most modern methods of travelling.

AN IMPRESSION OF MEANS OF TRANSPORT.— 1700 YEARS AGO TO DATE.

The means of transport used in Roman times about 1,700 years ago is the first scene displayed in this illuminated panel, other pictures show transport developments during the centuries up to the present day.

SECTION 11.

FIRST FLOOR
BAY L

SECTION 11.

FIRST FLOOR
BAY M.

SECTION 11.

FIRST FLOOR
BAY N.

SECTION 11.

FIRST FLOOR
BAY N.
RIGHT SIDE.

NO. 11.

FIRST FLOOR
BAY N.
LEFT SIDE.

SECTION 11.

FIRST FLOOR
BAY P.
(END WALL).

ORIGIN OF RAILWAYS IN EGYPT.

This illuminated panel shows a series of early photographs and a map of the first section of railway in Egypt, together with a copy of the original contract made between representatives of H.H. Abbas Pasha I, and Robert Stephenson, M.P. and its Arabic translation. This section of the first railway in Egypt, was constructed by this celebrated engineer, between 1852-1856; he supplied the first locomotive and also built the original railway bridge over the Nile at Benha, this now serves as a road bridge.

The replica of the original contract to construct the line, was graciously presented to the Museum by H.M. King Fouad I.

SECTION 11.

BETWEEN
BAYS P AND Q.
(END WALL).

ILLUMINATED MAP OF EGYPTIAN STATE RAILWAYS.

This illuminated map shows the length, in kilometres, of track laid in 10 year periods, covering a period of 80 years commencing with the first section laid from Alexandria to Cairo. Eight switches mounted on the stand in front of the map operate coloured lights which clearly indicate the length of track laid in each period, the ninth switch operates the lighting indicating chief towns.

The rolling stock in service in 1932 was 606 locomotives, 1,437 carriages and 13,104 wagons.

SECTION 11.

FIRST FLOOR
BAY Q.
(END WALL).

EGYPTIAN STATE RAILWAYS, 1932.

A series of photographs depicting some of the rolling stock, permanent way, buildings and bridges of the Egyptian State Railway system are mounted in this illuminated panel. The rolling stock shown comprises Passenger and Mixed Traffic Locomotives, Articulated Steam Rail Car, Pullman Car, First Class Bogie All Steel Carriage and the Upper Egypt "train de luxe"

SECTION 11.

FIRST FLOOR
BAY Q.

H.H. KHEDIVE ISMAIL PASHA I.

During the reign of H.H. The Khedive Ismail Pasha I, (Father of H.M. King Fouad I) from 1863-1879, he initiated a vigorous programme of construction of branch lines, and extended the Main Line south to Minia.

This panel, which is illuminated includes a map shewing the railway track laid at the commencement of his reign, and another shews developments which took place during his period of power. Other photographs show rolling stock which entered the service, and works carried out during this period.

SUEZ CANAL.

The construction and operation of the Suez Canal, the gateway to the East, from the first stroke of the pickaxe in 1859 down to the present day, is represented by this series of illuminated photographs. These include scenes during the making of this world famous waterway.

Shipping of all descriptions has passed through the canal since its opening, and photographs of some of the vessels are shown in the panel, together with dredgers which are constantly at work in order to keep the channel clear. Floating docks built for service in various parts of the world have been towed through the canal at various times, and some of these are represented in the panel.

WATER AND AIR TRANSPORT.

In this panel are displayed photographs of typical Nile river craft, and aircraft representative of the types used in the Royal Air Force, and by Imperial Airways and the Almaza Aero-drome.

LIFE SIZE OIL PAINTINGS.

These paintings include likenesses of H.M. King Fouad I and some of the former Khedives and Viceroys of Egypt. They are disposed, three on the walls of the ground floor, and three on the walls of the first floor, thus.

H.M. King Fouad I	... ..
H.H. Ismail Pasha...	... ..	Reigned 1830—1895.
H.H. Mohamed Ali Pasha	... ..	„ 1769—1849.
H.H. Ibrahim Pasha	... ..	„ 1789—1848.
H.H. Abbas Pasha I	... ..	„ 1813—1854.
H.H. Said Pasha	... ..	„ 1822—1863.

GENERAL MANAGERS OF THE EGYPTIAN STATE RAILWAYS — 1852—1932.

These are photographs of past General Managers of the Egyptian State Railways, the first of whom was Abdalla El-Inglesi Pasha, who was nominated as Mamour in 1852 on the completion of the first section of the railway. In 1853 he was promoted to be Manager of the system.

SECTION 11.

FIRST FLOOR
BAY R.

SECTION 11.

FIRST FLOOR
BAY S.

SECTION 11.

FIRST FLOOR
CENTRE BAY G.-H.
BAY H.
BAY G.

GROUND FLOOR
CENTRE BAY G.-H.
BAY O.
BAY P.

SECTION 11.

FIRST FLOOR
MOUNTED
ON WALLS.



U U U

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PRINTED IN EGYPT BY THE PRINTING OFFICE
OF THE EGYPTIAN STATE RAILWAYS, TELEGRAPHS AND TELEPHONES

مخططة متحف اسكك الحديدية

PLAN OF THE
RAILWAY MUSEUM



مخبر

ANNEX

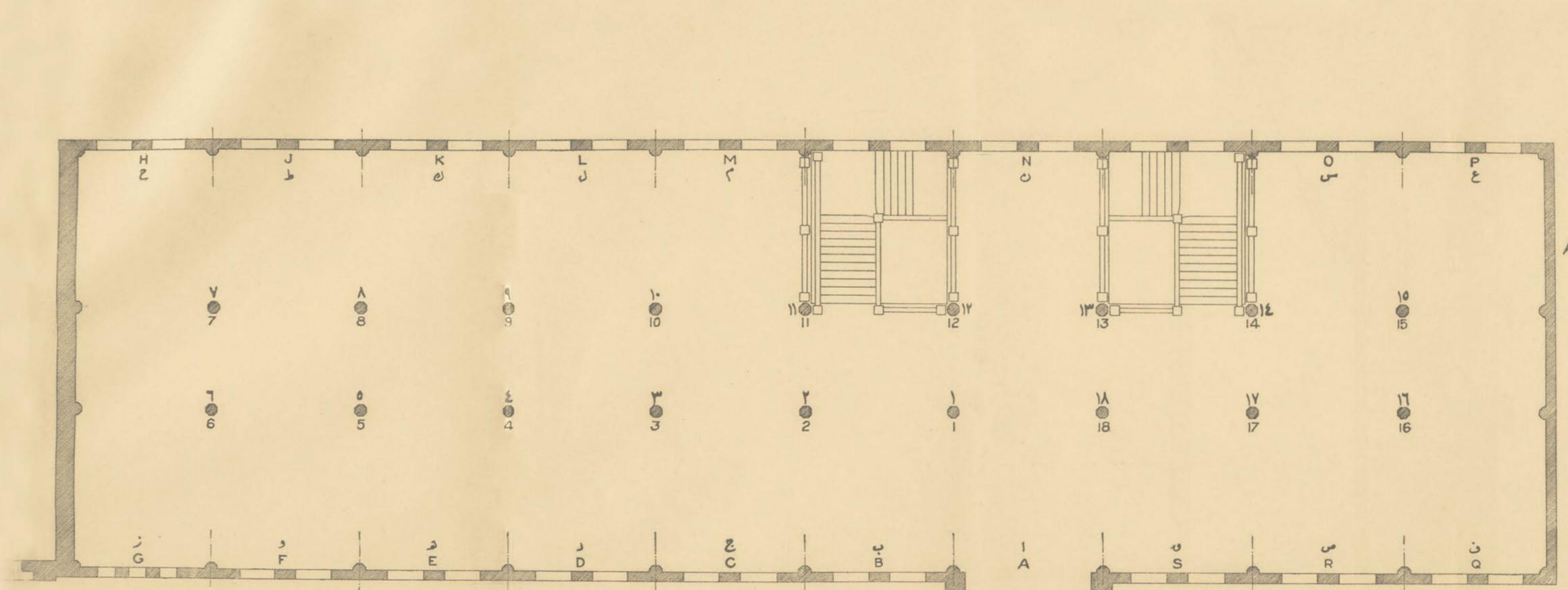
110

133

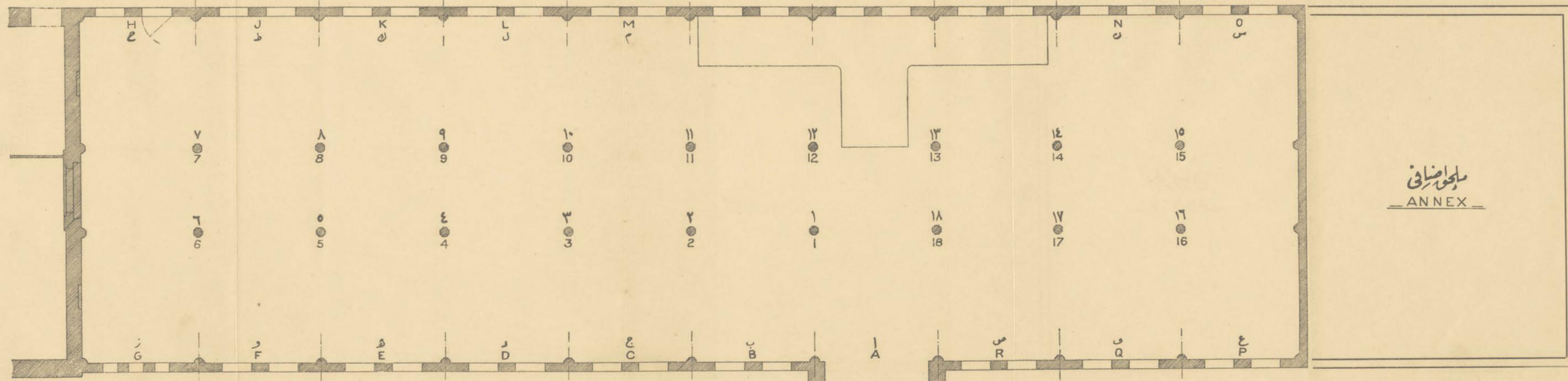
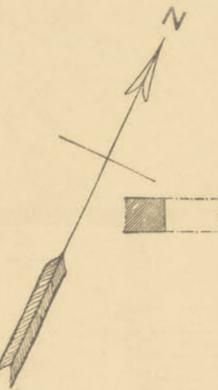
مخبر
FOUND F

خريطة متحف السكك الحديدية

PLAN OF THE RAILWAY MUSEUM



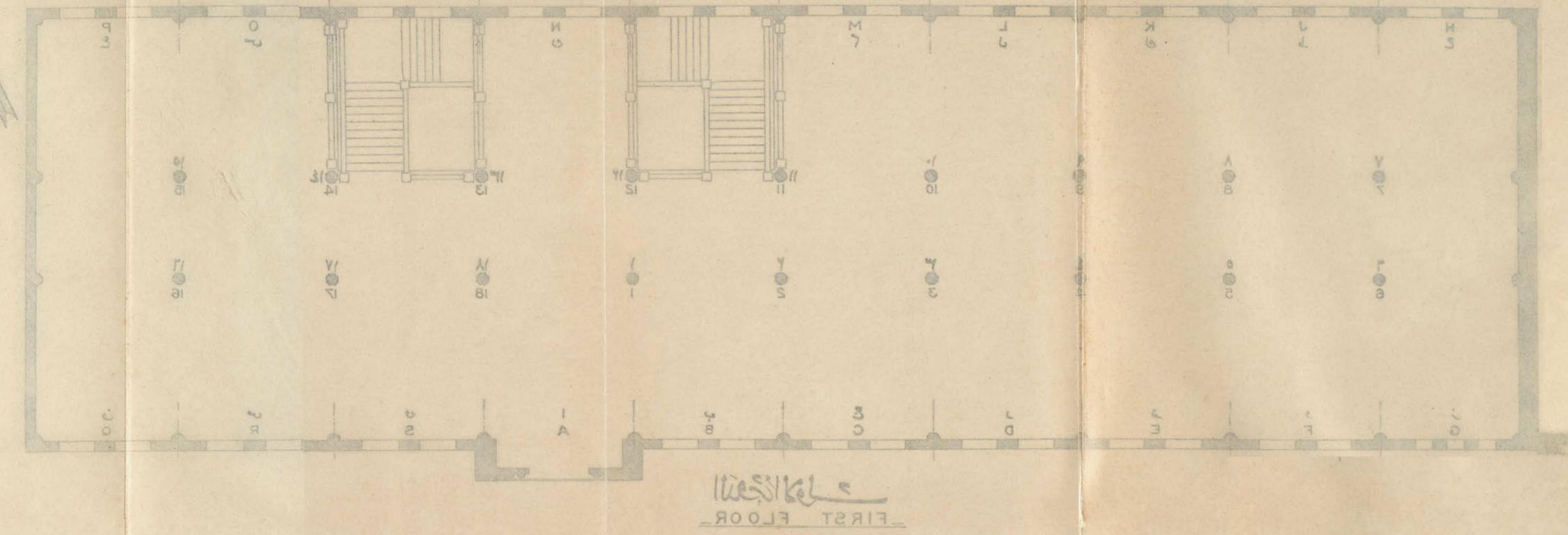
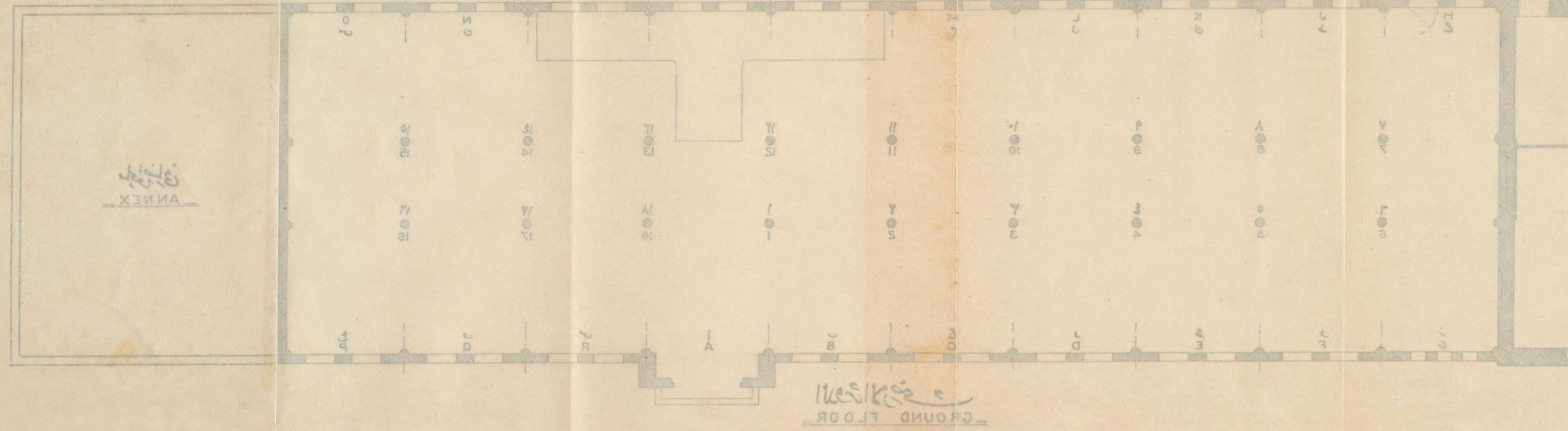
الدور الأول
FIRST FLOOR



الدور الارضي
GROUND FLOOR

مبنى اضافي
ANNEX

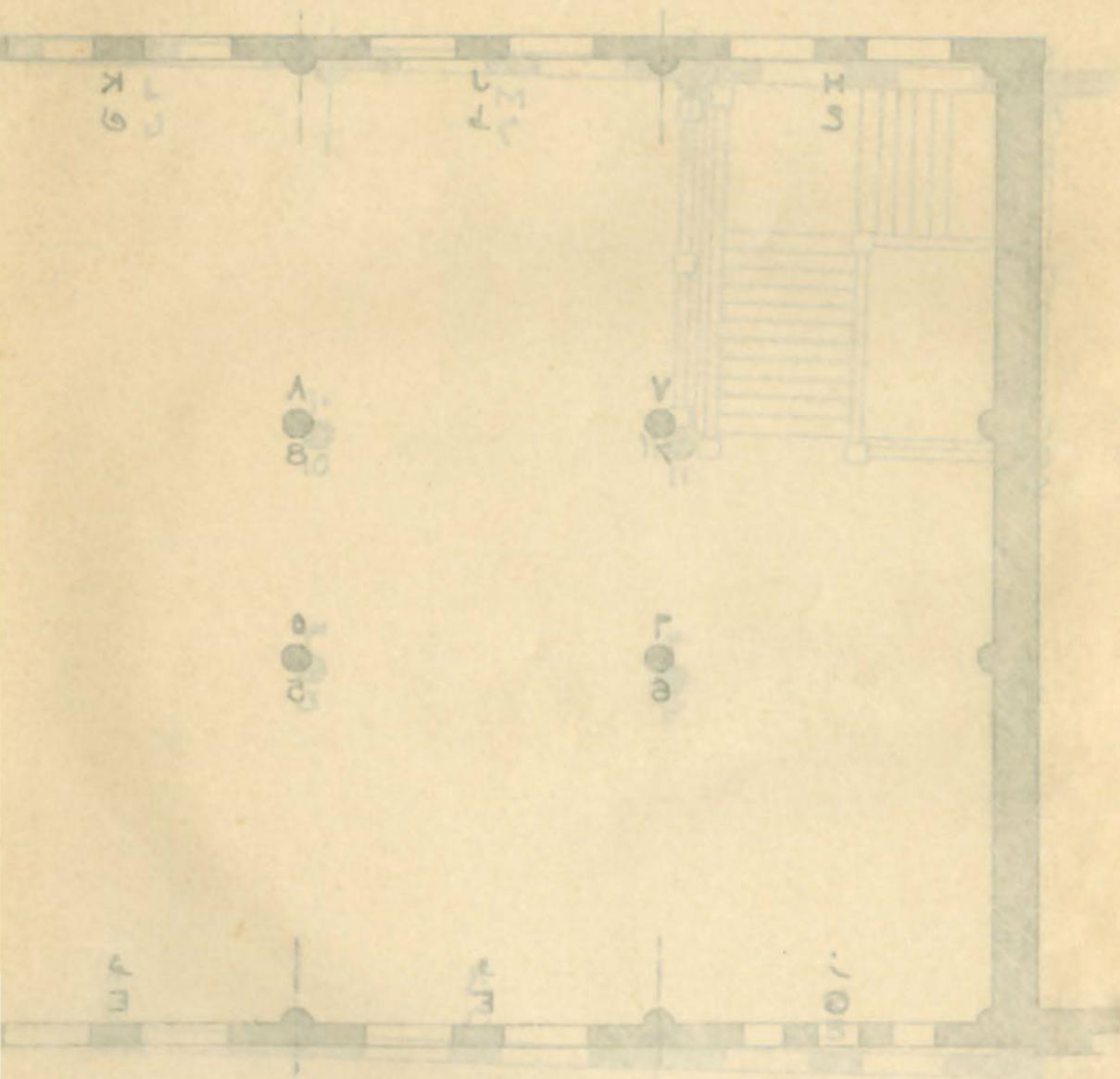
قيد كذا لاسا بفتحته قلبيخه
 PLAN OF THE
 RAILWAY MUSEUM



ANEX

قيد كذا لاسا بفتحته قلبيخه

قيد كذا لاسا بفتحته قلبيخه



الدائرة الاولى

FIRST FLOOR

