The Ericsson Bulletin

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Telephones : Beeston 54225 (3 *Lines*)

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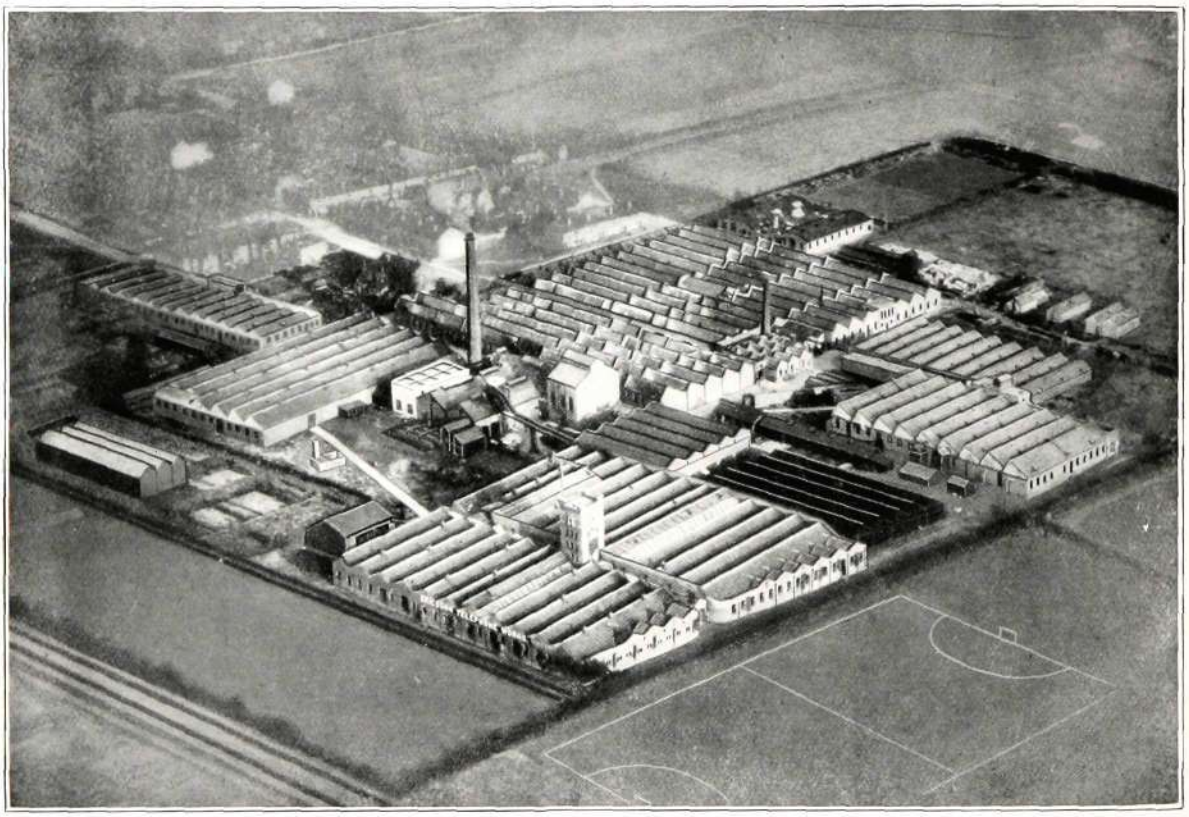


Aerial View of the Works, Beeston, Nottingham

Jubilee Year

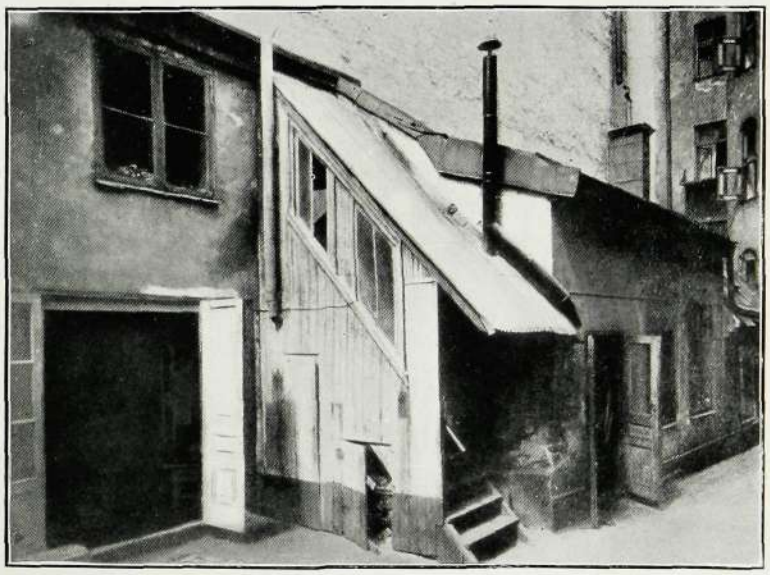
THEIR Majesties' Jubilee encourages one to indulge in reminiscence—that is the only excuse we offer for what follows and in this spirit we would like to tell something of our history and of the circumstances which have led us to our present position, after a journey lasting 55 years to the present time.

We do not propose to trace the story of the telephone from the days of Graham Bell, the "father of the telephone." This has been told so often that the facts are familiar to all. Soon after Bell demonstrated his sample instruments to the British public in 1878, several small companies were formed in this country to exploit the telephone but no serious or adequate steps were taken to provide a public service until the National Telephone Company was formed. That Company steadily built up a system throughout the country which, in 1912, was transferred to the State for a sum of twelve million pounds.

Like so many other large industrial concerns, the Ericsson Company's beginning was very small and passed unnoticed in a busy world. Its subsequent expansion has been rapid and extends to the five continents.

Lars Magnus Ericsson was born at a small village in central Sweden on the 5th May, 1846. His parents were in very humble circumstances and his path was not smoothed by the death of his father which forced him to seek work at the early age of twelve. Fortunately he was a lad of great originality of thought and strength of character and what he lacked in the good things of this world he sought to acquire by diligent work and spare-time study. At the age of twenty he decided to try his fortune in Stockholm, where he secured work with a firm of instrument makers. Six years' close study, allied to his natural ability, secured for him a government scholarship and enabled him to acquire wider experience and training. At 30 he laid the foundation of the present world-wide Ericsson organisation. Somehow or other, he secured a capital of £55 (the present capital of the Ericsson group of companies totals millions of pounds).

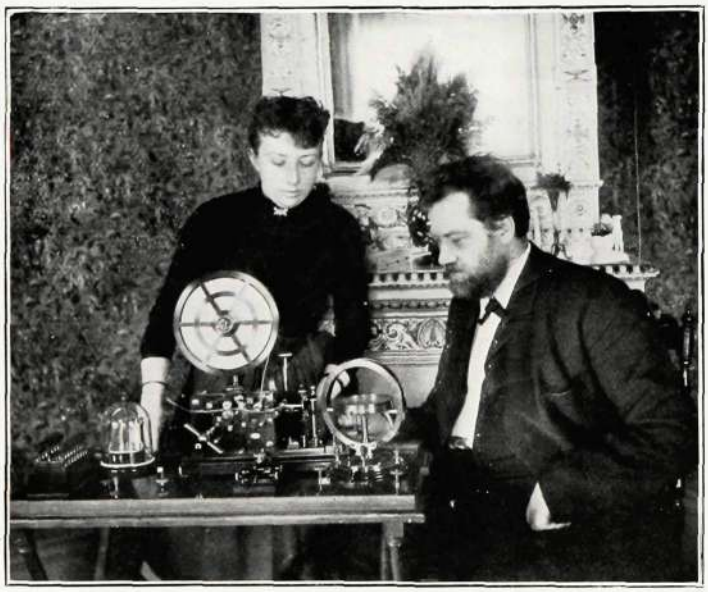
Ericsson's foresight, or genius, led him the following year into the field which was then being opened by the invention of the telephone in America. At first he conducted his work in the kitchen of his small house, but after a few months the demand for his handiwork encouraged him to pro-



L. M. Ericsson's Original Workshop in Stockholm (1876)

cure additional accommodation which he secured in a courtyard near the cattle market in Stockholm. Throughout their long lives together his wife's advice and help were a tower of strength to Ericsson and in those early days, when his time was fully occupied making telephones, his wife would wind the coils on her sewing machine and in between this and her housework she also found time to keep the account books.

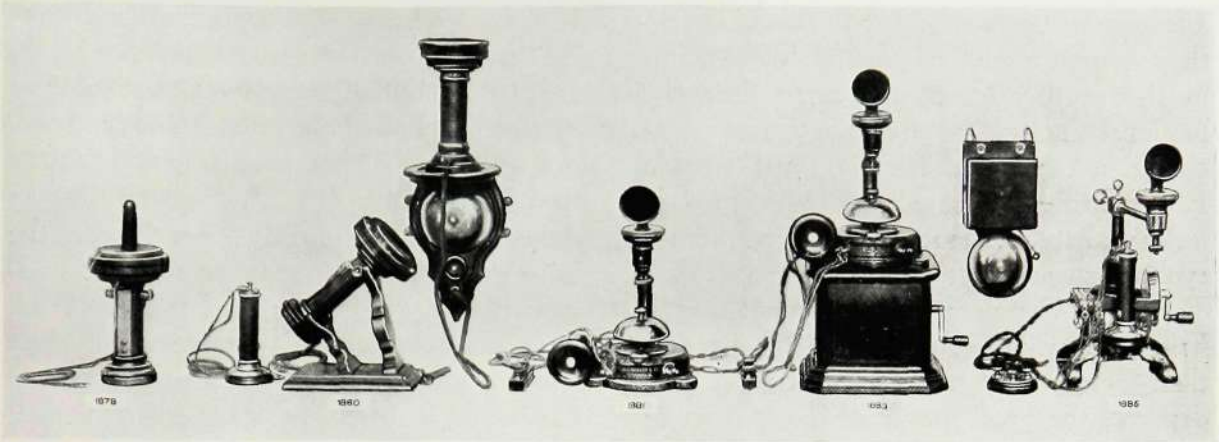
In 1879 Ericsson again had to seek larger quarters and from this time it can be said his enterprise emerged from the handicraft to the industrial stage. Hitherto, in addition to experimental work with telephone instruments, he had also been making telegraph receivers, fire alarm equipment and measuring instruments. With the commencement of the Stockholm telephone net-work in 1880, Ericsson concentrated more upon the telephone. He designed one which experts of that time declared superior to the American ones and the telephone material used in Sweden became exclusively of Ericsson manufacture. It is appropriate to comment here upon the fact that the modern trend of telephone instrument design has been to revert to the hand-microphone, the original manufacturer being Lars Magnus Ericsson more than fifty years ago.



Ericsson assisted by his Wife experimenting at home

The National Telephone Company readily appreciated the sterling merits of the telephone equipment made by Ericsson and a steady flow of orders resulted. Compared with present day standards these were infinitesimal, nevertheless they were of great importance to Ericsson in those days. Mr. Dane Sinclair, who was at that time Engineer-in-Chief of the National Telephone Company and subsequently Chairman of British Insulated & Helsby Cables Ltd., visited Ericsson in order to examine the possibilities of securing a greater output of these coveted telephones and promised an order for 300 instruments if special efforts were made regarding delivery. An order of this magnitude had never before been dreamed of by Ericsson and it may be supposed that it caused him much thought and head-scratching. By utilising all his resources he was able to offer 10 per week; this however, didn't suit Mr. Sinclair, who wanted no less than 50 per week. The result was a further extension of premises and plant. Events have shown that this order undoubtedly helped materially in the building up of the Ericsson concern, and since then millions of Ericsson telephones have been installed in all corners of the world.

Ericsson insisted upon a very high standard of workmanship from his employees.



A Few of Ericsson's Original Telephones

He personally inspected every piece of apparatus before it left the premises and woe betide the man who put an inferior piece of work before him. It has been said that this would cause him to fly into a temper, with the possibility of the offending article being thrown at the head of the defaulter. This may be an exaggeration, but the exacting demands made upon the employees laid the foundations of Ericsson's business upon a solid basis, which succeeding generations of Ericsson men constantly endeavour to uphold. It is no platitude to say that the name Ericsson conveys to the telephone world a guarantee for an article reflecting both care and skill in its production.

By 1889 the Stockholm telephone factory had achieved an output of 20,000 telephone instruments and the total number of employees had increased to 96, including Ericsson himself.

In the early nineties, Ericsson directed his attention to the export markets and branches were opened in countries near to Sweden and later-on a chain of factories was built covering nearly every country in the old world.

In 1903, after 30 years' incessant and fruitful labour, Ericsson withdrew from the leadership of the great organisation he had founded and retired to an estate in the country, where during the next 23 years he was afforded the great pleasure and privilege of seeing the extraordinary expansion of the Ericsson organisation. This remarkable and lovable man died in 1926, in his eightieth year, and by a strange coincidence at the time the Company was celebrating the half-century of its existence.

This brings us more particularly to the British section of the Ericsson organisation. A sales office had been opened in London in 1898 but in the early days of the present century it became evident that manufacture would have to be undertaken in Great Britain in order to satisfy the reasonable national desire for production at home. Messrs. Ericsson therefore decided to erect

A Modern Ericsson Telephone

a factory in London and with this intention they bought a plot of land at Tottenham, in the north. About the same time the National Telephone Company had purchased a factory at Beeston, just outside Nottingham—incidentally it was in this factory that the famous Beeston Humber cycles were originally made. The National Telephone Company made a proposition to Ericssons' which caused them to abandon their factory project. This change of plan deprived the good people of Tottenham of what has proved to be a very successful venture giving steady employment to thousands of people; nevertheless, they had good reason to be grateful to Ericssons' in other respects. The parcel of land was of considerable size, and a lot of timber was required to fence it—this timber became the main source of fuel supply to the district; no sooner was it erected than it disappeared and it became a race as to whether the erectors could put up as quickly as the Tottenhamites could pull down. We believe it was in this way that the name Tottenham Hotspurs originated!

At the suggestion of the National Telephone Company a new Company was incorporated in 1903 under the name The British L.M. Ericsson Manufacturing Co. Ltd. The Capital of this Company was equally subscribed by the National Telephone Company and by Ericssons. The Beeston telephone works, employing at that time 130 people and covering one acre, were transferred to this Company. (Going back a little, it is interesting to recall that the first telephone exchange in Nottingham was opened in 1881 with two subscribers—it is safe to assume that "wrong number" or "number engaged" were phrases not then known in the district.)

Extensions to the Beeston works have subsequently been made at very frequent and regular intervals so that to-day about 15 acres are built upon and a further 8 acres are available for expansion. As extensions are at the moment being erected, it looks as though the remaining unoccupied land will not be more than the Company will require in the future.

As we have already mentioned, the business of the National Telephone Company was acquired by the State in 1912. This necessitated the repayment of their share holding in the British Ericsson Company, consequently the share capital of the Company was reconstructed. The capital was increased from £100,000 to £200,000 by a public issue of shares.

The business continued to expand considerably and a Debenture issue of £100,000 was made a little later, while in 1926 it was again found necessary to increase the share capital, this time from £200,000 to £500,000 at which figure it still stands. At the same time permission was obtained to change the Company's name to Ericsson Telephones Ltd.

When Shakespeare made one of his characters in Macbeth say "if you can look into the seeds of time and say which grain will grow and which will not, speak then to me," he was voicing a wish that frequently occurs to each of us, but he knew, as we know, that the gratification of this desire would remove the zest from life. The journey is invariably more thrilling than the arrival. Ericsson did not realise that the seed he was planting in that back kitchen was destined to become an organisation giving employment to upwards of 12,000 people and even now the high water mark is yet to be reached. Saturation point in the demand for telephones is a long way off—in all countries of the world a considerably greater telephone density is urgently demanded and nowhere more than in the enterprising countries of the British Empire owning allegiance to Their Majesties King George and Queen Mary.

Central Automatic Telephone Exchange, London

AS the name implies, "Central" exchange is situated in the very heart of the city. Together with City exchange it is housed in the Faraday Building South, which is an imposing structure between Queen Victoria and Knightrider Streets.

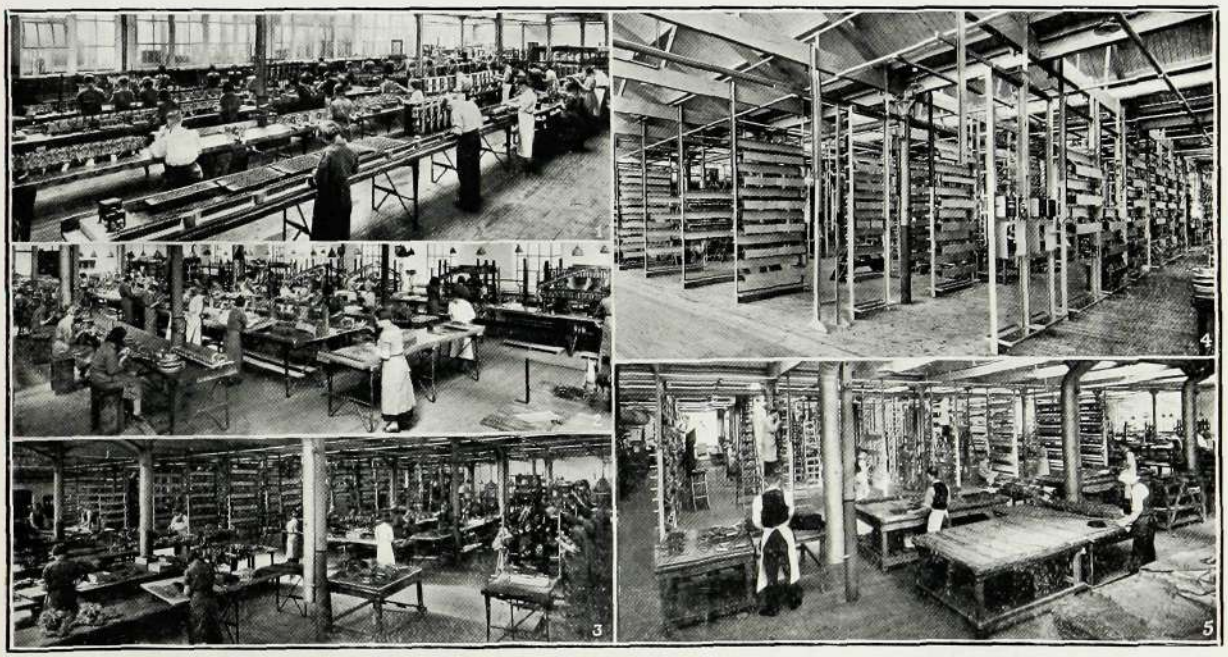
The exchange serves the Fleet Street newspaper and printing offices, Temple, Smithfield Market and other important areas, and undoubtedly it is one of the busiest in Great Britain.

With initial equipment for 9,200 multiple numbers, Central is only 800 short of its 10,000 line capacity.

The exchange apparatus (part of which is common to both the Central and City exchanges, as will be explained later) is distributed over four floors.

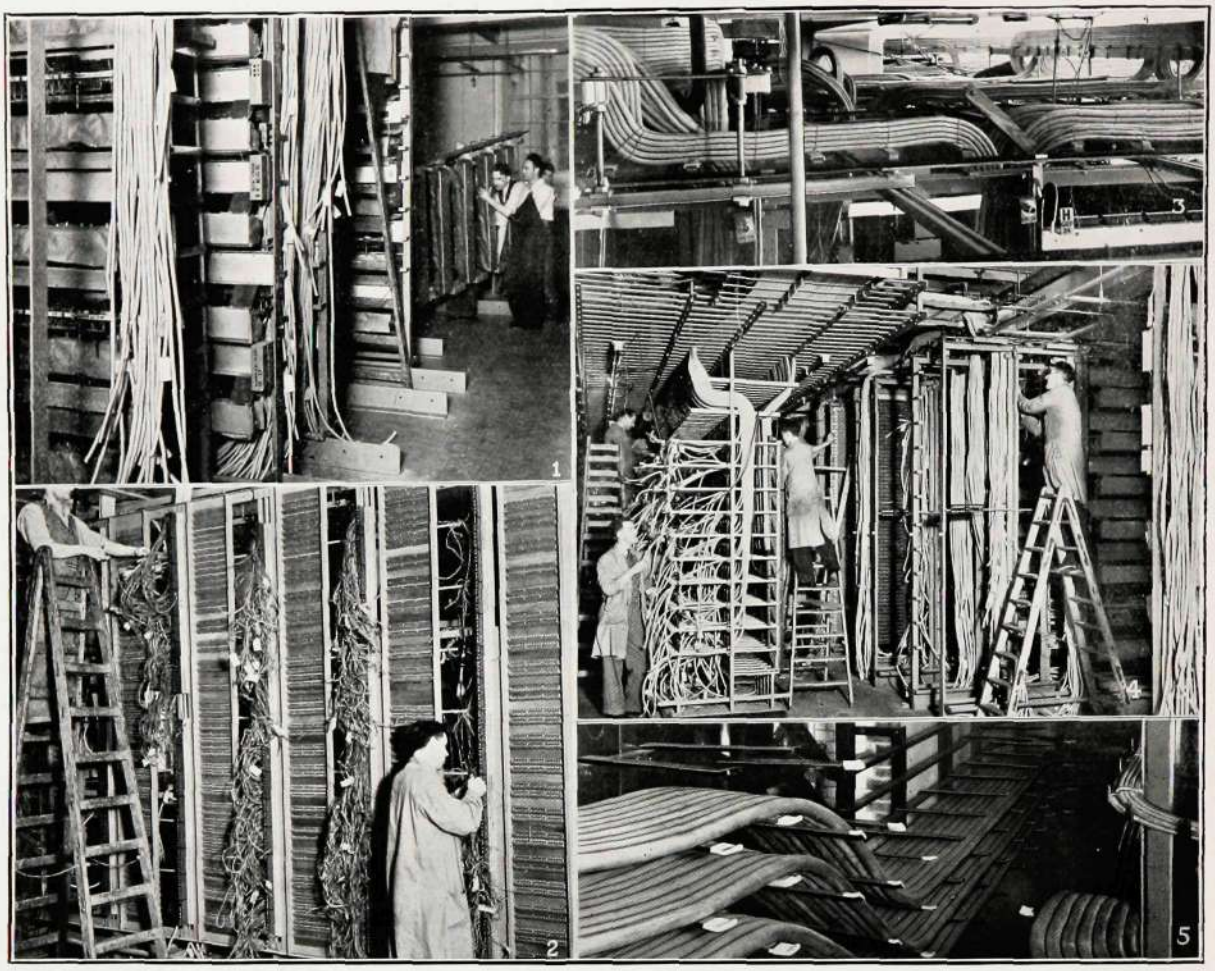
When Central was cut-over, at 1.30 p.m. on March the 9th of this year, it signified the London *debut* of the new 200-outlet line finder scheme, with partial secondary working, recently adopted by the Post Office; but as a description of the line finder is included elsewhere in this issue, it needs little mention here.

As an indication, however, of the amount of traffic at Central, it may be stated that the number of primary and auxiliary finders



Central Exchange — During Manufacture at the Works

(1) *Wiring-up line relays and jacked-in apparatus.* (2) *Wiring-up banks* (3) *Local cable making.*
(4) *Equipping and wiring frames.* (5) *Forming local cables and testing completed frames*



Central Exchange — During Construction on Site

(1) *Erecting racks and running cables.* (2) *Wiring a Trunk Distributing Frame.* (3) *Cabling over racks.*
(4) *Cabling I.D.F. and line relay racks.* (5) *External cables entering the building*

per ordinary group of 200 subscribers, is much higher than the average, being as much as 16 primary and 18 auxiliary finders per group.

A point of interest in connection with the Central line finders, is that they utilize the new standard " 3,000 " type post office relays throughout.

The following quantities relating to the equipment and wiring of some of the main items of the apparatus, will give an idea of the size of the exchange :—

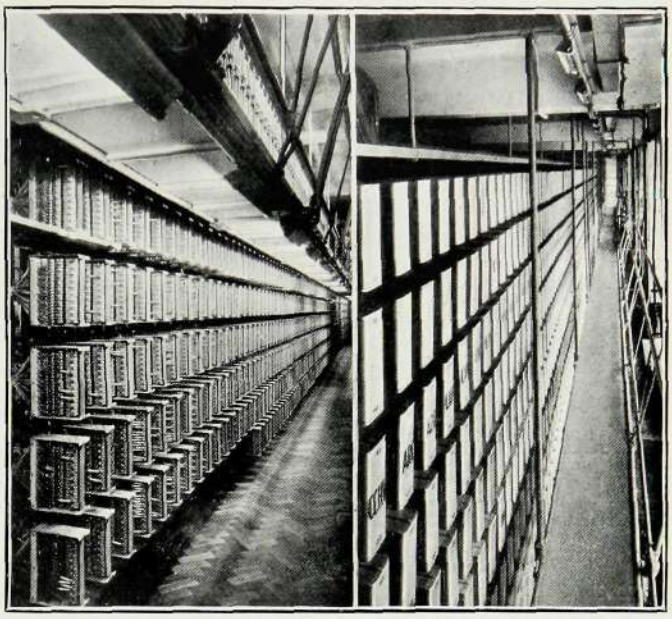
Description	Switches	Wiring	Racks
Primary Finders	1324	1560	33
1st Code Selectors	965	1100	37
2nd ,, ,,	1448	1690	29
3rd ,, ,,	347	440	9
1st Numerical ,,	1654	1920	32
2nd ,, ,,	1440	1680	28
Final Selectors (Ordinary)	160	300	40
Do. (PBX. 2/10)	1182	2070	
Do. (PBX. 11/20)	337	410	27
Do. (PBX. Over 20)	434	540	
"A" Digit Selectors	257	300	5
Directors	286	340	34

The " A " digit selectors, directors, and most of the 2nd and 3rd code selectors are common to both Central and City exchanges, but were, of course, installed as part of Central, the cut-over date for which was prior to that for City.

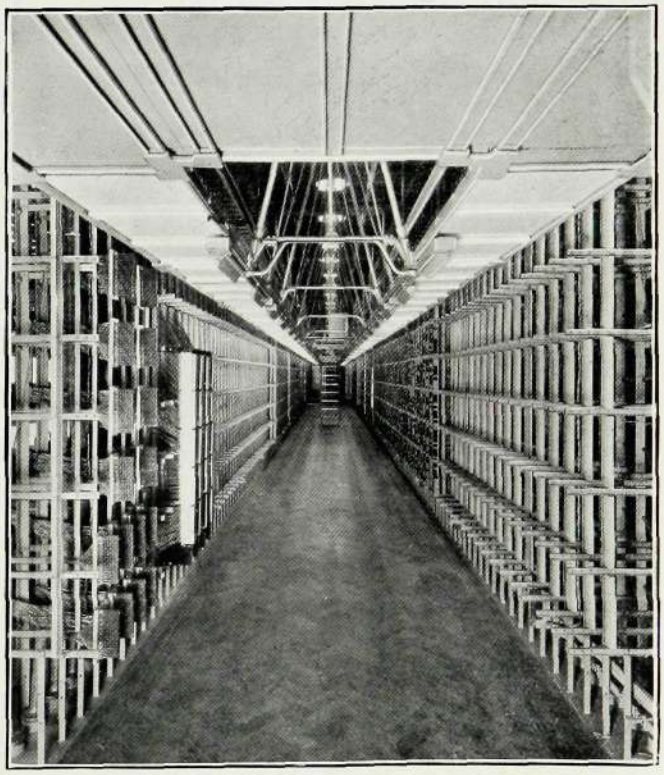
A joint cable-chamber serves the two exchanges and is one of the largest in the country, being 122 feet long and 15 feet wide. It is fitted with two sets of cable racks, one set below the subscribers' main frame and the other below the junction main frame.

The main distribution frames, on the ground floor, carry the usual protective equipment for the two exchanges. Each frame comprises 152 verticals, one being allocated to subscribers' circuits and the other to junction circuits, of which no less than 8,600 are "through" junctions not associated with either the Central or City exchange.

The views of the main frames shown, afford some idea of the work entailed in manufacturing, installing and wiring these structures. It will be seen that mezzanine platforms are provided to facilitate access to the upper portions of the frames, they being more suitable than the usual travelling ladders in view of the large area to be covered. The platforms, which extend round both sides of each frame, are of the new standard type, and are suspended iron structures, rubber-covered on the upper surface and white painted underneath, with strip lights along the bottom edge to illuminate the lower portion of the M.D.F. Iron ladders, which are part of the general construction, lead from



Central Exchange — Main Distributing Frames
(Left) Subscribers Line Side, lower tier; (Right) Junction Line Side, top tier



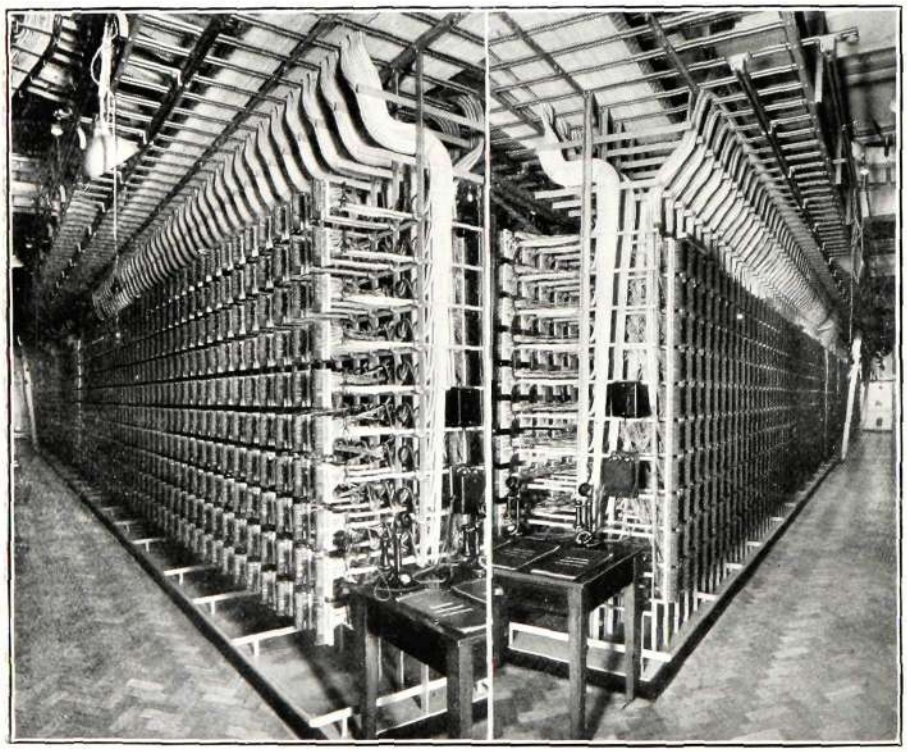
Central Exchange — Main Distributing Frames
Lower Tiers, Subscribers Lines on the right, and Junctions on the left

the floor to small bridges joining the two platforms at intervals along their length. It may here be mentioned that the total weight of ironwork alone, in the main frames and platforms, amounts to approximately 16 tons. This does not, however, include the jumpering field ironwork.

The power plant, which is also situated on the ground floor and serves both exchanges, comprises the normal duplicate motor-generator sets, each having an output of 2,000 amperes at 57 volts; two supply-driven and two battery-driven ringing machines, each with a 4 ampere output at 75 volts; a power board of the usual type; and a generator choke coil. The latter is for use when a generator is required to be connected in parallel with one of the exchange batteries, and is of the totally enclosed, oil immersed type. It may be seen in the right-hand corner of the power board equipment illustration. Attention is drawn also to the main bus bars which are of copper, with a cross-sectional area of 6 square inches to ensure that the voltage drop is confined within the limits specified, throughout the two exchanges.

The two exchange batteries, each of 25 fully plated cells, with a capacity of 12,900 ampere-hours, have a maximum discharge current of 1,930 amperes and a charging rate of 1,800 to 2,000 amperes. They are protected by 2,000-ampere circuit breakers, and are located in the basement together with a 7-cell counter-E.M.F. battery capable of carrying a current of 350 amperes continuously.

A large test desk occupies part of the ground floor and comprises 15 testing and 11 miscellaneous sections at present. Nine of the testing sections are allocated to subscribers' circuits and 2 to junctions with 2 fault control and 2 advice-note positions.

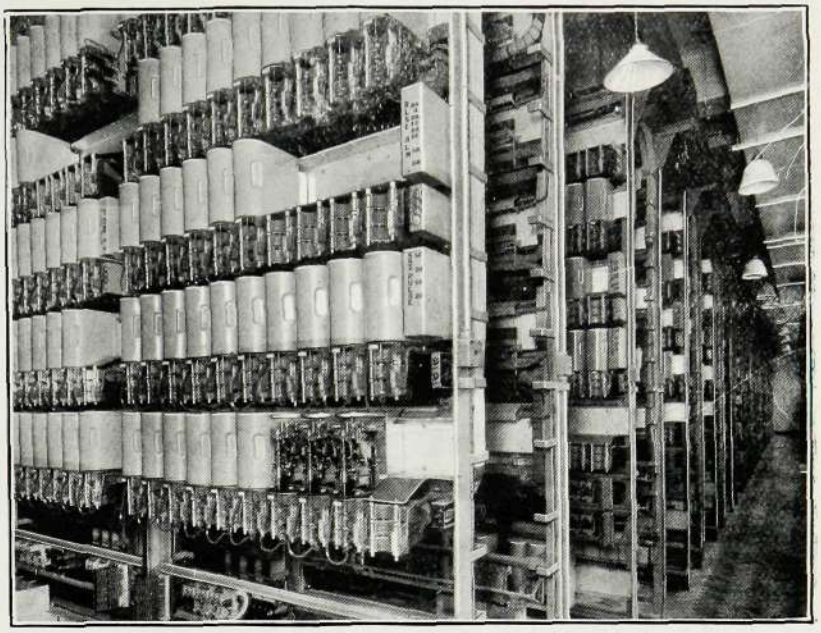


Local Side *Multiple Side*

Central Exchange — Intermediate Distributing Frame

An unusual feature of the exchange is the abnormal number of P.B.X. lines, necessitating a large board to accommodate the 30-volt and 50-volt P.B.X. fuses and resistance lamps for feeding out battery and earth to the P.B.X's. This is

shown to advantage beside the test desks and is made up of 3 "Sindanyo" panels with a total capacity for 3,300 fuses. Part of the panel on the extreme right is allocated to test desk, S.A.R. and miscellaneous fuses. In this connection it may be mentioned that the Post Office Engineers have now authorised the equipment of individual fuse panels on the special apparatus racks for future exchanges, which means that the manual board and desks are now the only items of exchange equipment which are not served by local fuses, with the exception of a few odd racks requiring 50 volts for battery jacks, and as the manual board for Central Exchange is remote from Faraday Building, being situated at Wood Street, there was no necessity to provide switchboard fuses at Central.



Central Exchange — Primary Finder Racks

It will readily be appreciated that in an exchange of the size of Central there is of necessity an enormous amount of overhead cable and cable-racking, and nowhere is this so much in evidence as above the intermediate distributing frame. This frame has 114 verticals, equipped with nearly 2,000 connection strips, on which are terminated all circuits which require jumpering facilities, and when it is realised that, at a conservative estimate, something like 200,000 wires have to be soldered to these connection strip tags, the magnitude of the installation staff's task can be imagined.

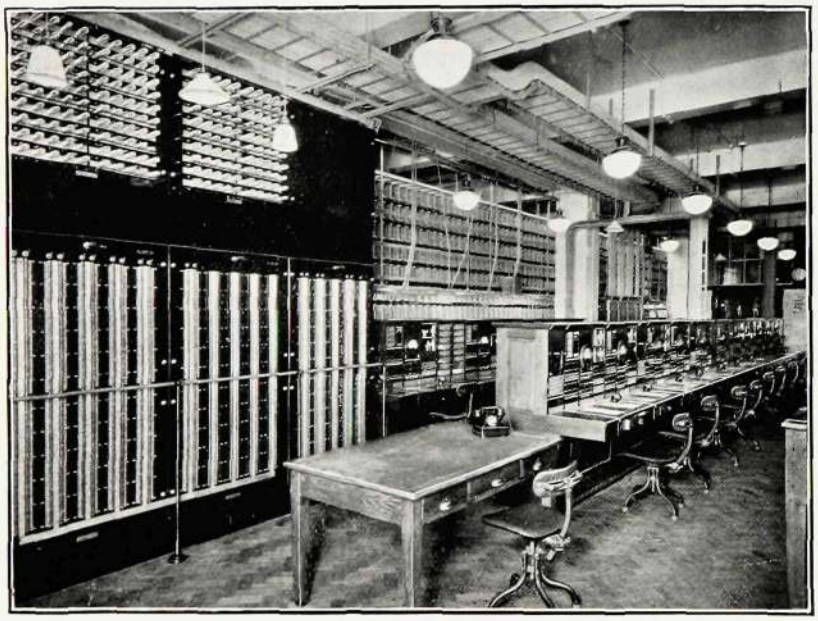
It is therefore to the credit of all concerned that the exchange was completed three weeks prior to the originally agreed date, at the special request of the Post Office.

The various apparatus racks are of the single-sided type, 10′ 6″ high, with pressed steel channel shelves. These racks are supported on continuous footings, which ensure an even distribution of weight, and are held rigid by means of overhead interconnecting ironwork. Each large suite of racks is served by the latest type of travelling ladder which can be raised from the floor and hooked on to the rack guard rails when not in use.

Owing to the large number of circuits to be tested and the consequent introduction of the time factor, a departure from the usual practice was made with respect to certain of the automatic routiners, two being provided for each of the following :— Directors, final selectors, 1st code selectors, and group and 2nd code selectors.

In the case of the director routiners, each of which was arranged to serve approximately half of the ultimate number of circuits, facilities were given for testing the whole group of directors from either routiner, by the operation of an extension key.

One of the two group selector routiners was allocated to 1st and 2nd numerical selectors and the other to 2nd and 3rd code selectors, there being no arrangement for extending tests in this instance.



Central Exchange — Test Desks and P.B.X. Fuseboards

The normal method of routine testing selectors, allows for each switch in a group to be seized in succession by the routiner until every selector in the group has been tested, when the routiner then moves on to the next group. At Central, however, it has been arranged to test all final selectors, except the P.B.X. over 20 type, in such a manner that, generally, switches in the same group are not busied by the routiner in succession. This is accomplished by a method termed "staggered access" wiring, recently standardised by the British Post Office, and although under this scheme it is often necessary to provide more access uniselectors in the initial stage than would have been equipped in the normal way, the additional advantage of being able to increase the final selector equipment without having to provide further access switches and wiring, amply justifies this expense.

The layout of Central exchange equipment, other than that already mentioned, is as follows :—

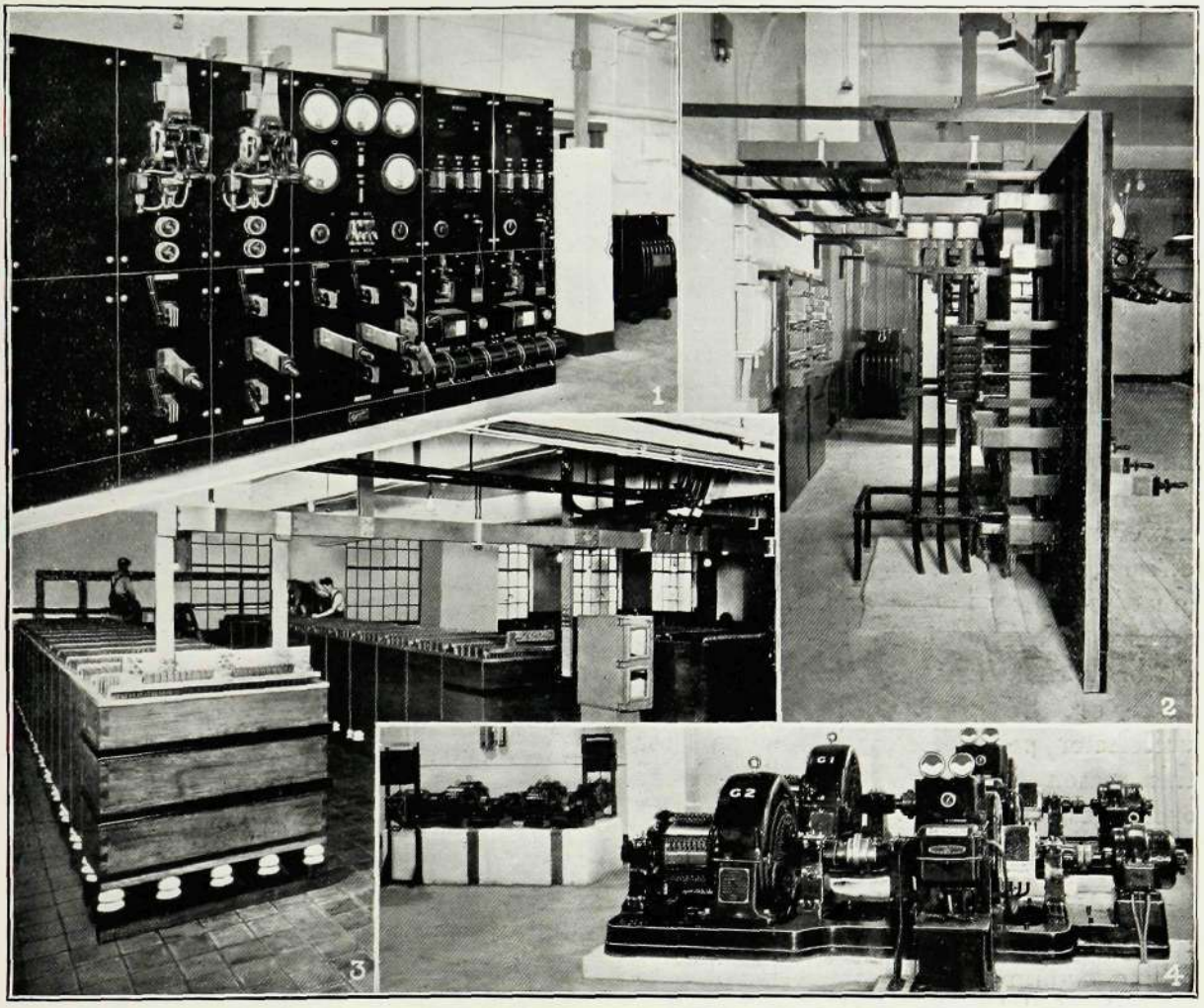
First Floor :—Line and cut-off relays ; line finders; 1st, 2nd and 3rd code selectors; 1st and 2nd numerical selectors ; final and "A" digit selectors ; C.C.I. repeaters; coders; I.D.F. and various T.D.F's.

Second Floor : Directors, subscribers' meters, and miscellaneous relay sets.

As, however, these racks are of the well-known Post Office standard type, their individual equipment needs no description.

The subscribers' meters are of the new type as described in the previous issue of the Bulletin which also dealt with the "3,000" type relay as used in the Central exchange line finder equipment.

It is specially interesting to note that



Central Exchange — Power Equipment

(1) *Front of Power Board.* (2) *Rear of Power Board.* (3) *Battery Room.* (4) *Generators and Ringing Machines*

Central automatic exchange introduces the line finder system into the London area, just as the original Central manual exchange was the first of the London C.B. exchanges.

A period of 33 years bridges the gap between these two installations and it is felt that if the new exchange fulfils expectations, there will be no cause to deplore the passing of its predecessor which furnished yet another instance of the efficiency of telephone exchange equipment.

An Outline of the British Post Office 200-Point Line Finder System with Partial Secondary Working

THE development of line finders has been in progress for many years and although it is perhaps not generally known, a number of patents were actually taken out for line finder systems before the beginning of the present century. In all the early schemes, however, each line finder was connected directly to a selector and this resulted in a great reduction in the availability of the selector and meant a considerable increase in the total switches, also there was little saving over the systems using an individual uniselector per subscriber's line and for this reason the provision of line finder exchanges was delayed.

It may be said therefore, that although line finders were an obvious solution to the reduction in the cost of the subscribers calling equipment, it was not possible to reap the full benefit of this step until a scheme was evolved which, in addition to reducing the calling equipment, kept the number of selectors equal to, or less than the number used on the uniselector scheme. The present 200-point line finder system with partial secondary working appears to be the first solution put forward which uses standard Strowger apparatus and at the same time achieves this object.

It should be noted that the term " selector " is intended to refer to 1st code selector, 1st group selector or discriminating selector repeater since the present line finder system is suitable for director, non-director and satellite exchanges.

Trunking Arrangements and Traffic Considerations.

The economy in selectors has been brought about by the trunking arrangements, while a saving in equipment has been effected by providing common relay equipments for the positioning of the line finders.

As is well known, the number of 1st selectors is at a minimum when full availability conditions exist, *i.e.*, when every subscriber in an exchange has direct access to every selector, but for practical reasons the capacity of the line finder banks is limited and consequently it is not possible to obtain this ideal condition. A near approach to full availability is possible if full secondary working is employed, *i.e.*, when the subscribers' lines are terminated on the banks of primary finders and each primary finder is terminated on secondary finder banks. Each secondary finder is connected to a selector and the subscribers can therefore gain access to all the selectors in the exchange. This arrangement was not entirely suitable for the 200-point line finder system because, although the number of selectors could be kept to a minimum, the provision of a secondary finder for each selector did not justify the reduction in selectors obtained. An examination of traffic data revealed that the trunking arrangements shewn in Fig. 1, with partial secondary working gave a greater overall saving than could be obtained with full secondary working.

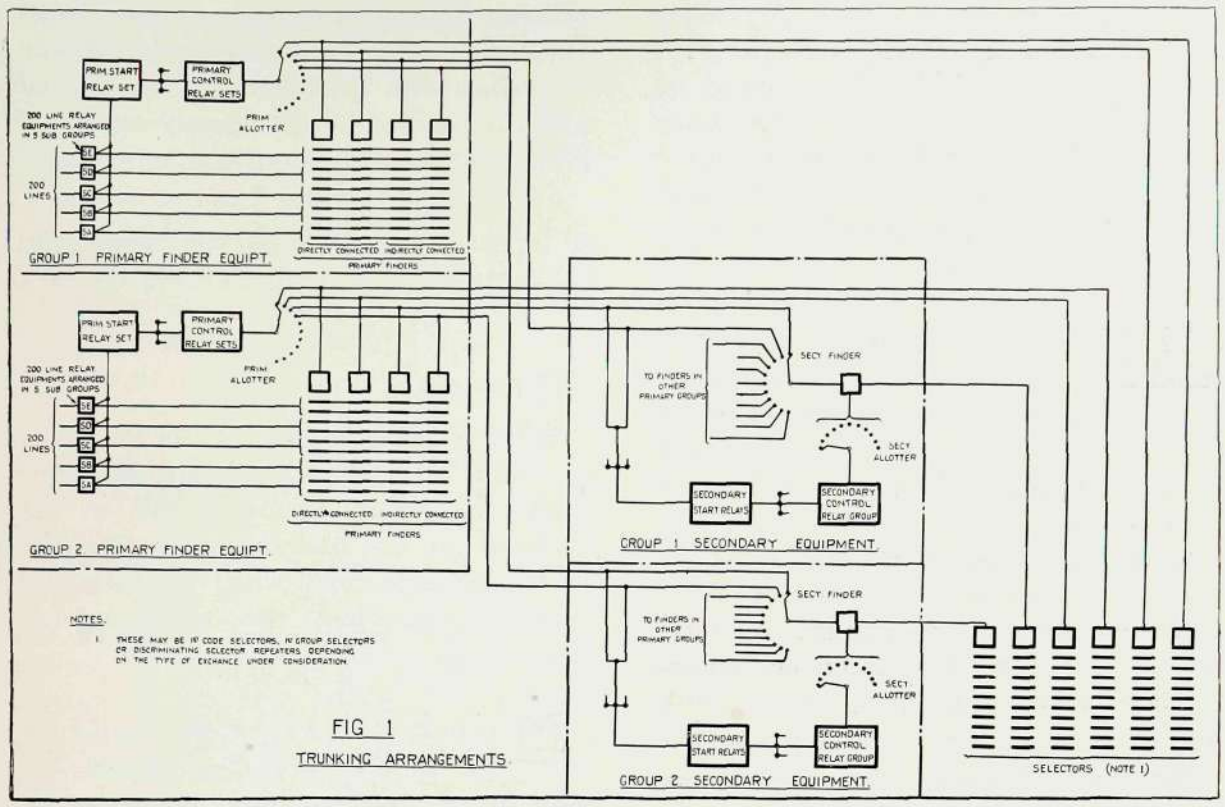


FIG 1
TRUNKING ARRANGEMENTS.

Referring to Fig. 1 it will be seen that some of the primary finders are directly connected to selectors as in the early schemes while others are connected to selectors via secondary finders. The directly connected finders and selectors are arranged as first choices and in consequence their average occupancy is satisfactory without any increase in their availability being necessary. Taking an actual example we find that with a traffic of 5·4 T.U's offered to a group of 15 finders, the first 6 carry 4·2 T.U's., while the remaining 9 carry only 1·2 T.U's. The average traffic carried by the first 6 finders $= \frac{4 \cdot 2}{6} = \cdot 7$ T.U's which may be regarded as satisfactory, while the remaining 9 carry an average of only $\frac{1 \cdot 2}{9} = \cdot 13$ T.U's. In this particular instance it would be arranged that the first 6 choices in each 200-line group were connected direct to selectors, while the remaining 9 finders in each group would be connected to selectors via the banks of secondary finders ; the peak traffic from many primary finder groups is thus collected and handled by a group of selectors common to all subscribers.

Primary Finder Groups.

Each primary finder group consists of 200 lines terminated on the banks of a number of two-motion switches of the 200-outlet type. Provision is made for a maximum of 49 finders per group. Each group is provided with one primary start relay set and two or three primary control relay sets. When the number of primary finders per group does not exceed 20, two primary control relay sets are fitted, in all

other cases three are required. Associated with each primary control relay set is a 25-point allotter, which is arranged to preselect an idle primary finder. When more than 25 primary finders are fitted per group, two allotters are provided for each primary control relay set to accommodate the necessary outlets.

The 200 lines in each primary group are sub-divided into 5 sub-groups of 40 lines, each sub-group being connected to a separate start relay in the start relay set for reasons explained later. Fig. 1 shews the directly-connected finders connected to selectors while the indirectly-connected line finders are connected to the banks of secondary finders. For simplicity only two groups of primary and secondary equipments have been shown.

The indirectly-connected primary finders are connected to the secondary finder banks in a manner which ensures equal distribution of traffic to each secondary group. In the diagram, contacts of the secondary finder banks in group No. 1 are shewn connected to the 1st indirectly-connected primary finder in each primary group. The banks of secondary finders in other groups would be connected to indirectly-connected primary finders in other primary groups in a similar manner.

Secondary Finder Groups.

Each secondary group is provided with one set of start relays, two control relay groups and a number of secondary finders up to a maximum of 24 per group. A 25-point allotter is associated with each control relay group. The indirectly-connected primary finders and secondary equipment are brought into use only when all the directly-connected finders in one or more primary groups are engaged and consequently they are used only for the purpose of dealing with peak traffic. The normal traffic is handled by the directly-connected primary finders.

A Brief Description of the Switching Operations During the Setting Up of a Call.

Call Originated.

When a call is originated the line relay associated with the calling line operates, marks the calling line selectable in the banks of the line finders and operates the start relay associated with the particular sub-group in which the calling line is located.

Provision is made so that when calls are originated in different sub-groups at the same time, more than one control relay set is brought into use and consequently more than one line finder is caused to search for the calling line.

When three primary control sets are provided they are brought into use in the following manner :—

Call originated in sub-group 'SA' uses primary control relay set No. 1.

Call originated in sub-group 'SB' uses primary control relay set No. 1.

Call originated in sub-group 'SC' uses primary control relay set No. 2.

Call originated in sub-group 'SD' uses primary control relay set No. 3.

Call originated in sub-group 'SE' uses primary control relay set No. 3.

Calls originated in sub-groups SA and SB use primary control relay sets Nos. 1 and 2.

Calls originated in sub-groups SD and SE use primary control relay sets Nos. 2 and 3.

Calls in any three or more groups use primary control relay sets Nos. 1, 2 and 3.

Directly-Connected Primary Finder Available.

The start relay engages the primary control relay set which in turn steps the wipers of the preselected directly-connected primary finder vertically and horizontally to the calling line. When the calling line is found the caller is extended through to the selector and hears dial tone. The primary start and primary control relay sets are released and are available for use on other calls. The primary allotter preselects the next free directly-connected primary finder in the group in readiness for the next call.

All Directly-Connected Primary Finders Engaged.

If all directly-connected primary finders in one or more primary finder groups are engaged, the secondary allotters in all secondary groups are automatically brought into use and preselect free secondary finders. When a start relay operates, the primary control relay set steps the wipers of a preselected indirectly-connected primary finder vertically and horizontally to the called line, sends a start signal to the secondary finder start relays in the group with secondary finders having access to the primary finder in use, and marks the primary finder selectable in the banks of these secondary finders.

The secondary start relays engage both the secondary control relay groups in the group concerned and two secondary finders search for the primary finder marked by the primary control. The searching of the primary and secondary finders occurs simultaneously and when the primary finder has found the calling line, and a secondary finder finds the marked primary finder, the calling subscriber is extended through to the selector and receives dial tone.

The primary start and control relay sets and the secondary start and control relays are all released and made available for use on other calls. The primary and secondary allotters preselect free finders in readiness for the next call.

SUMMARY OF CHIEF FEATURES.

(1) Ensures that the average occupancy of all selectors is reasonably satisfactory.

(2) Routes normal traffic via directly-connected primary finders.

(3) Routes peak traffic via indirectly-connected primary finders and secondary finders.

(4) Provides common control for positioning of primary and secondary line finders.

(5) Suitable for use in director, non-director or satellite exchanges.

(6) Employs battery testing throughout.

(7) Provides for single or multi-metering on positive battery principles.

(8) Prevents testing relays from falsely switching to positive battery.

(9) Provides full preselection for allotters.

(10) Provides overflow metering to indicate if calls are originated while all primary finders are engaged.

(11) Gives a release alarm if a primary finder fails to release due to a mechanical defect.

(12) Gives an alarm if a call is not switched through to a selector within 6-12 seconds.

Arrangement of Equipment.

Single-sided type standard racks 8′ 6″ or 10′ 6″ high are used for accommodating the equipment. The relays are '3000' type except in the case of the L. & K. relays where the new '600' type relay is used.

L. & K. Relays.

These are strip mounted on vertical mounting plates each mounting plate accommodating 10 pairs of L. & K. relays. Capacity is provided for 700 pairs on 8′ 6″ racks and 900 pairs on 10′ 6″ racks.

The relays are fused from a small fuse panel on the rack in accordance with modern practice.

Primary Finder Racks.

Due to the employment of common control, the primary finders are simplified, and require only two relays per circuit. Capacity is available for accommodating a maximum of 50 finders on the 10′ 6″ racks, and from 15 to 49 finders per group are provided to suit the particular traffic requirements. In certain instances some finders of one group may be on one rack while others of the same group are on another rack. In this case the bank multiple and common leads associated with the same group are extended by means of tie cables. In addition to the primary finders, the primary start and control relay sets are also accommodated on the primary finder racks, all being of the jacked-in type. The primary start relay set consists of 9 relays while the

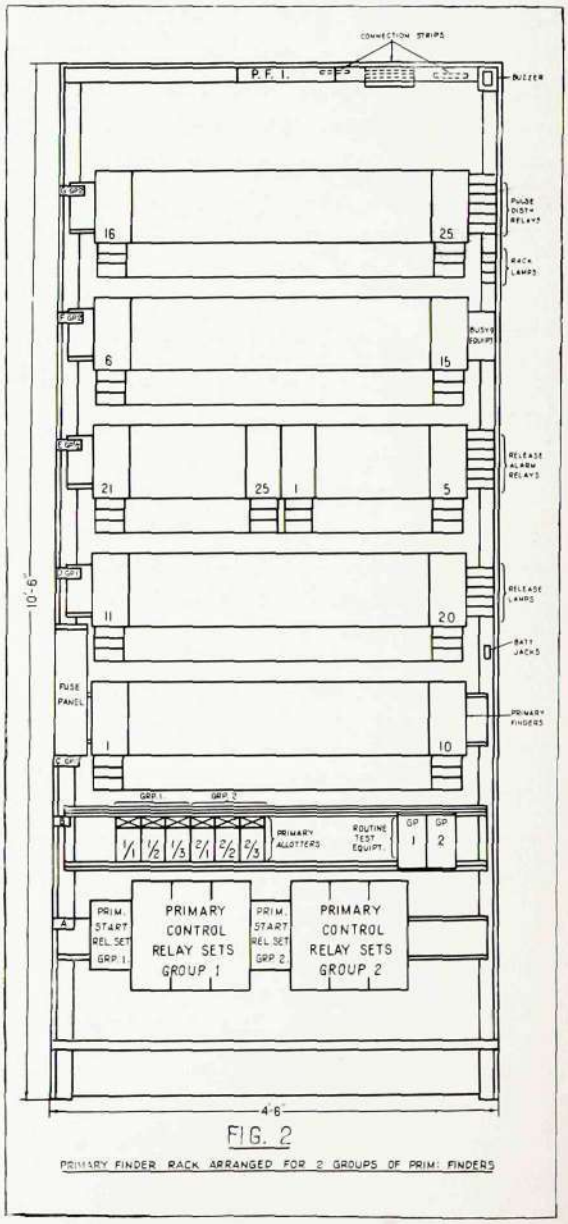


FIG. 2

PRIMARY FINDER RACK ARRANGED FOR 2 GROUPS OF PRIM: FINDERS

primary control relay sets each have 16 relays, or 17 relays when the number of primary finders per group exceeds 25.

Fig. 2 shews a rack equipped for two groups of 25 finders per group.

Secondary Finder Racks.

The 10′ 6″ racks accommodate a maximum of 120 secondary finders arranged in 10 shelves of 12 switches. The shelves are arranged as a complete unit and accommodate the secondary start and control relays. One relay is required per secondary finder, three per secondary start circuit and four on each of the control relay groups, all of which are strip mounted.

The secondary finder banks are multiplied in groups of 12, 17 or 24 as demanded by the traffic.

In small exchanges where few secondary finders are required arrangements are sometimes made to mount them on the primary finder racks or on any other rack which may have convenient spare space available.

Floor Space.

The economy in automatic apparatus brought about by the present line finder system results in a saving in floor space and to a certain extent enables the size of the exchange building to be reduced.

Comparison Between Uniselector Scheme and 200-Point Line Finder Scheme.

The following table gives a rough comparison of equipment for uniselector and line finder exchanges of various sizes :—

Traffic Units per Sub.	No. of Lines	Uniselector System		Line Finder System		
		Uni-Selectors	Selectors	2 Motion Line Finders	Uni-Selectors	Selectors
		A	B	C	D	E
·02	2000	2000	65	120	50	66
·06	2000	2000	191	240	87	161
·10	2000	2000	311	350	144	246
·02	4000	4000	125	240	92	124
·06	4000	4000	376	480	168	316
·10	4000	4000	623	700	286	490
·02	8000	8000	251	480	188	252
·06	8000	8000	747	960	336	632
·10	8000	8000	1241	1400	564	972

It will be noted that in all cases the number of selectors is approximately equal to or less than the number required in the uniselector scheme while substantial reductions have been made in the calling equipment, *i.e.*, comparing column " A " with columns " C " plus " D."

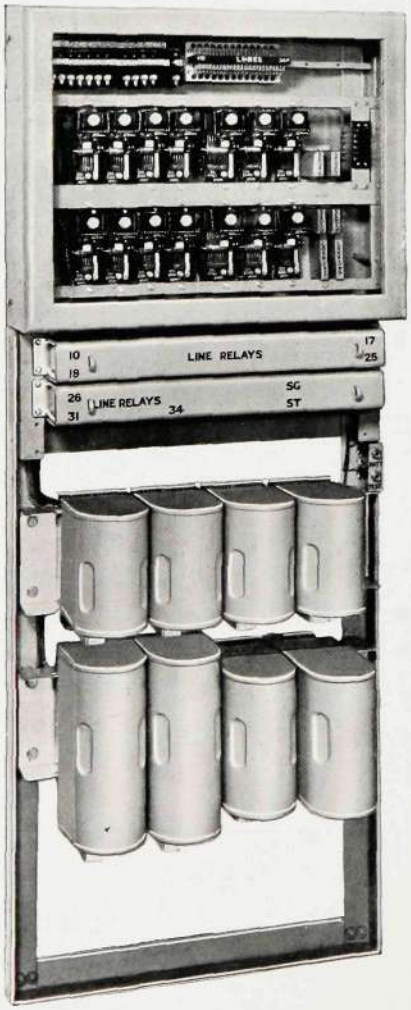
Register Controlled P.A.X's.

THE research, technical development and manufacturing experience gained in perfecting the equipment in use on the modern public telephone service is incorporated in the new Private Automatic Exchanges manufactured at our Beeston Works, and the facilities which are offered, or may be added on these boards, gives them the flexibility necessary for meeting the conditions likely to be put forward by varied business requirements.

Three types of switchboards are manufactured, covering a range of from 35 lines to 400 lines or more. The two smaller boards are non-extensible and have a capacity for 35 lines and 50 lines respectively, inclusive of all services. These exchanges operate from 24-volt batteries, or where A.C. mains are available from battery eliminators specially designed for this purpose. The largest switchboard is built up in 50 line units to any capacity from 50 to 400 lines for purely local traffic, but when required to work as a P.A.B.X. in conjunction with another exchange or other exchanges the ultimate capacity will be reduced by 50 lines for each 6 junctions or tie lines. This board operates from a 50-volt source.

The equipments for producing the various tones and the interrupted ringing are composed of standard relays for the most part, and a pole changer. They are mounted on jacked-in units of conventional form and incorporated in the general design of a switchboard.

The illustrations of the boards show the compactness and accessibility of the apparatus, the pleasing symmetry of the equipment and the robust construction.



PAX. 35 front view with covers on

The various pieces of apparatus are protected at the front and rear with dustproof covers. The non-extensible boards may be mounted close against a wall to save floor space.

The boards operate on the register control principle. The relays are of the P.O. 3,000 type, and the switches are of the Ericsson uniselector heavy duty types for 25 and 50 lines. The disposition and function of the various pieces of apparatus are described with reference to the views of the 35 line board.

In the top left hand corner is the fuse panel, to which the battery or eliminator leads are connected. The fuses are capable of division into two groups to allow smoothed current to be applied to the transmission circuits when a battery

eliminator is employed as the voltage source. To the right of this panel the connection block for the incoming subscribers lines is mounted. The external wiring from this block will consist of two wires for each instrument installed. Below this is mounted a gate on which all the uni-selectors are fitted. This gate is pivoted on the left, and fastened on the right by two thumb screws. At the back of this gate a a sheet of metal is fixed to the rear of the framework to prevent the ingress of dust. The gate can be swung outwards to expose the switch multiple wiring. A glass fronted cover latched over this gate permits observation of the switches and protects them from dust. The first four switches from the left on the top and bottom rows are the line finders and connectors respectively of the four links and the next three are the link finders and the tens and units switches of the two registers.

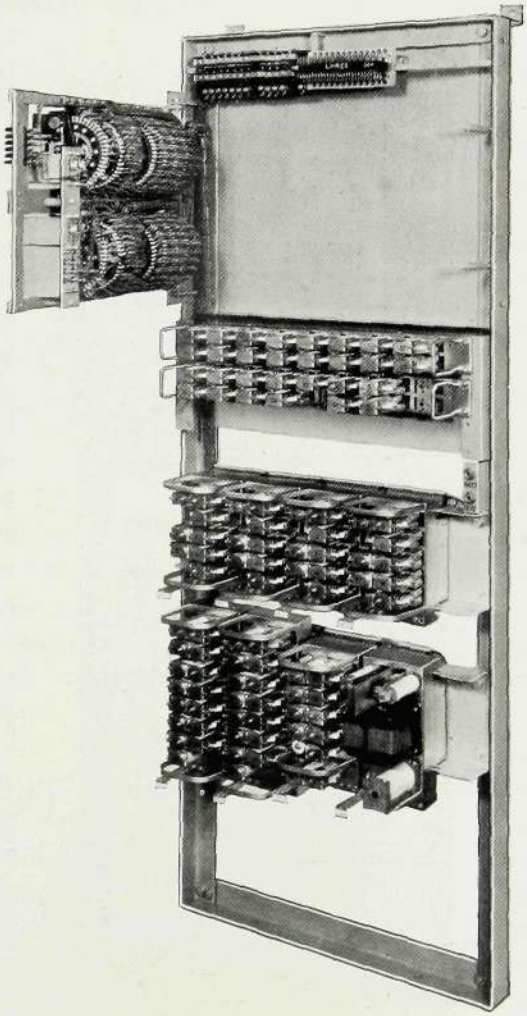
The mounting plates below these switches contain the line relays, extra relays for preference subscribers and 2 start relays.

The equipments for the four links are mounted on jack-in units on the next row and the two registers and the ringing and tones sets on jack-in units along the bottom row.

The units of the large switchboard are completely enclosed in steel cabinets with detachable doors both front and rear.

The dimensions of the switchboards are as follows :—

Type.	Height	Width	Depth
	ft. ins.	ft. ins.	ft. ins.
P.A.X. 35	5 6	2 1	10
P.A.X. 50	5 6	2 $6\frac{3}{4}$	10
P.A.X. 50/400 each section	5 9	2 $6\frac{3}{8}$	1 6



PAX. 35 with covers removed and switch gate open

The 35 line board has 2 registers and a maximum capacity for 4 links; the 50-line board, 2 registers and 6 links; and the 50/400 board 2 to 6 or more registers per board, 7 line finders and group selectors and 6 connectors per 50 line unit. In all cases the switchbanks with wiring are completed for these maximum figures but the switch mechanisms and link relays on the jack-in equipment may be supplied to traffic requirements.

A straightforward numbering scheme is adopted in each case; for the 35 line board it is 10 to 44, for the 50 line board 10 to 59 and for the 50/400 board 100 to 499.

As already explained,

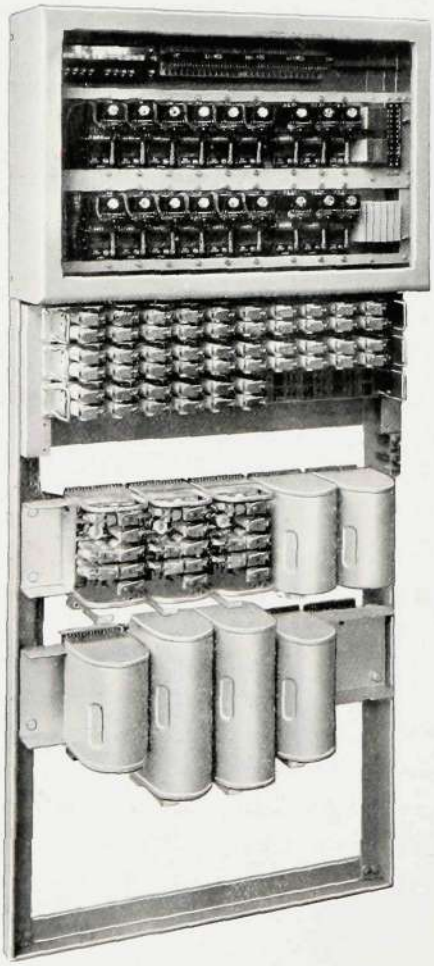
the relays are of the standard P.O. 3000 type. Among the many technical points of this relay the outstanding features which recommend it for service and maintenance are the twin contact springs and the method of applying tension to the individual springs against a buffer block to ensure correct individual contact pressures. In every case the relays on these switchboards operate to standard adjustment charts which preclude the use of ' two-step' relays.

The voltage variations from a battery eliminator on varying load are greatly in excess of those of a secondary battery and to cover these variations the 24 volts boards are designed to operate satisfactorily at a voltage varying between 20 and 30 volts and the larger boards between 40 and 60 volts.

The subscribers' instruments used in conjunction with these switchboards may be of the standard type fitted with the P.O. dial.

The process of a call on a 2-digit board is shortly as follows :—

When the calling subscriber lifts his hand-set, the loop through the telephone energises his line relay. The line relay actually disconnects itself from the line wires and holds up in series with a common starting relay.



PAX. 50 front view with some covers removed

This start relay causes the link finder switch of a free register to rotate and stop at a free line finder which has access to the calling line. The switch of this line finder will then rotate to find this calling line and when this is found the caller will be extended to the register, from which he will hear a dial tone of approximately 33 periods per second. When he then dials the wanted number, the impulses will be taken up by the tens and units switches of this register. The register will then endeavour to engage a common marking circuit and when this is obtained the connector associated with the engaged line finder will be set to the wanted number. The register will then be dissociated from this call and restored to normal in readiness for a further call and the caller will be deflected to the connector circuit. Should the wanted line test engaged, the caller will hear busy tone, consisting of a periodic note of high pitch but should the line be free periodic ringing will be sent to the wanted number and a periodic ringing tone will be sent back to the caller. When the call is answered, the ringing will cease and the two subscribers will be in speaking communication. This speaking circuit consists of an individual feeding relay for each subscriber interconnected by condensers. When either subscriber replaces the handset, his line is immediately released, the last subscriber retaining the link receiving busy tone.

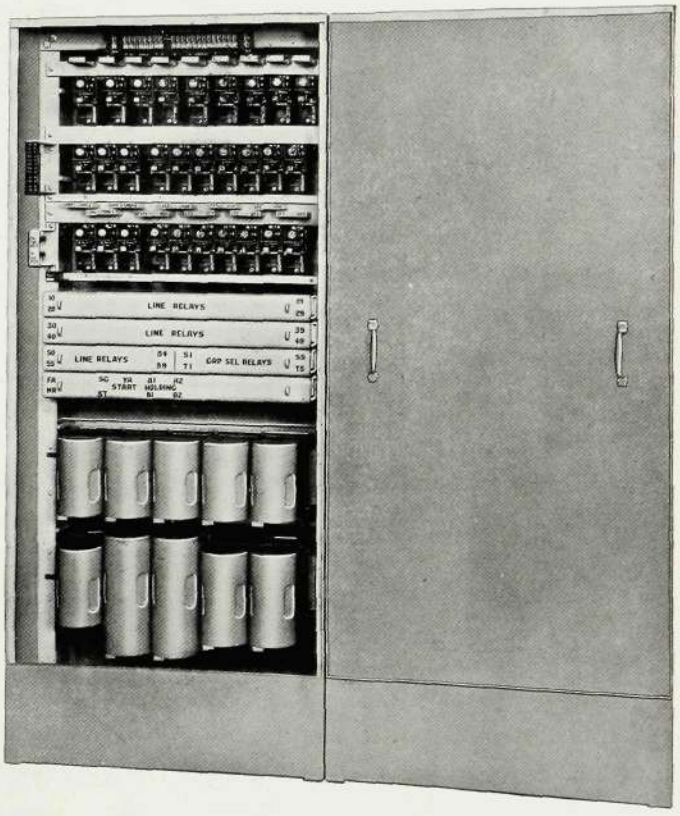
Preference Facility. When a preference subscriber makes a call to an engaged line, a warning tone is first sent to the subscribers in communication and then the preference caller is introduced into the conversation. Should the preference caller desire to withdraw and allow the original conversation to proceed, he may do so by replacing his handset, but if his call is private he asks the wanted number to hang up. This causes the line to be released from the previous call, after which the preference call will automatically ring the wanted line and be connected under normal conditions when the ring is answered.

Loud-speaker equipment may be introduced in place of any normal instrument without modification to the switchboards, the busy tone introduced on the line when the distant end clears obviating the risk of omitting to restore the amplifier key.

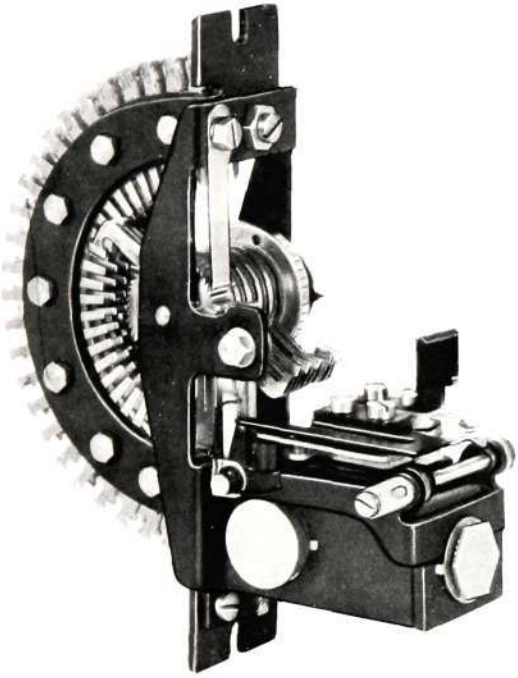
The circuit design of the connector permits dial impulses to be sent over the connector multiple to control the setting of switches. This feature allows facilities to be added which may be of primary importance to some administrations, such as Tie-Line, Round Call and Conference working. These types of calls are controlled by equipment units additional to the standard switchboards.

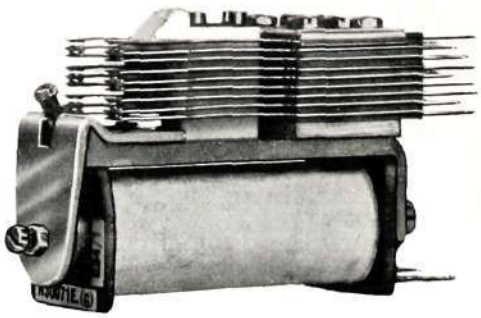
Tie-Line Working. A variety of tie-line circuits provide for automatic both-way working to other exchanges of various types. A tie-line relay set is designed to be connected to the multiple of a group selector stage on the larger exchanges and to the connector multiple on the small exchanges. If more than one tie-line is required, the call will automatically connect itself to the first free tie-line of a group. The registers are wired up to make these junctions available by dialling a single digit. It is thus possible to have full automatic intercommunication between two P.A.X.'s of the types described, and furthermore the standard circuit is designed to allow manual supervision for tie-line working with any type of manual board.

The Round Call or Person Finding facility supplies a means of rapid communication with a person who is within a building but not at his usual location. A number of persons holding important positions may be allocated round call numbers which will be dialled when they are unable to be found on their normal telephone numbers. Round



PAX. 50/400 showing two sections lined up making a 100-line equipment





Typical examples of the Two Main Pieces of Apparatus used, i.e.—The Switch and the Relay

call numbers are usually restricted to ten, but this figure may be exceeded when necessary.

The process of a round call is as follows : When a caller has been unsuccessful in finding the wanted round call subscriber at his normal telephone number he releases this connection and makes a new call by dialling the single digit allocated to the round call unit and then the round call number of the wanted line. This will immediately operate code calling equipments in various parts of the building. This code calling equipment may be of the type which sends out audible code signals or alternatively visible code signals with an audible tone to attract attention. The subscriber whose code is being transmitted is thus made aware that he is wanted and can quickly come into communication with the caller by dialling a specified digit from any convenient P.A.X. telephone in the vicinity.

Conference Calling is a means of collecting a number of subscribers on the same speaking connection for purposes of discussion or instruction. Two types of equipment are available for this purpose ; a manually operated and a dial operated system, the former being suitable for a P.A.X. with short lines and the latter for a P.A.X. having the subscribers spread over a larger area. Each subscriber given this facility has a special conference number in addition to the normal number and nine lines is a convenient maximum for this type of equipment.

Faulty Lines, etc. If a line is connected to a register for more than a predetermined time, a thermo-relay comes into operation and transfers this line from the register to a holding circuit, where it will be retained until the fault or loop is cleared. One of the normal numbers must be used for this holding circuit, this number being wired to a jack on the switchboard for use as a normal line when the maintenance engineer is in attendance.