

The Ericsson Bulletin

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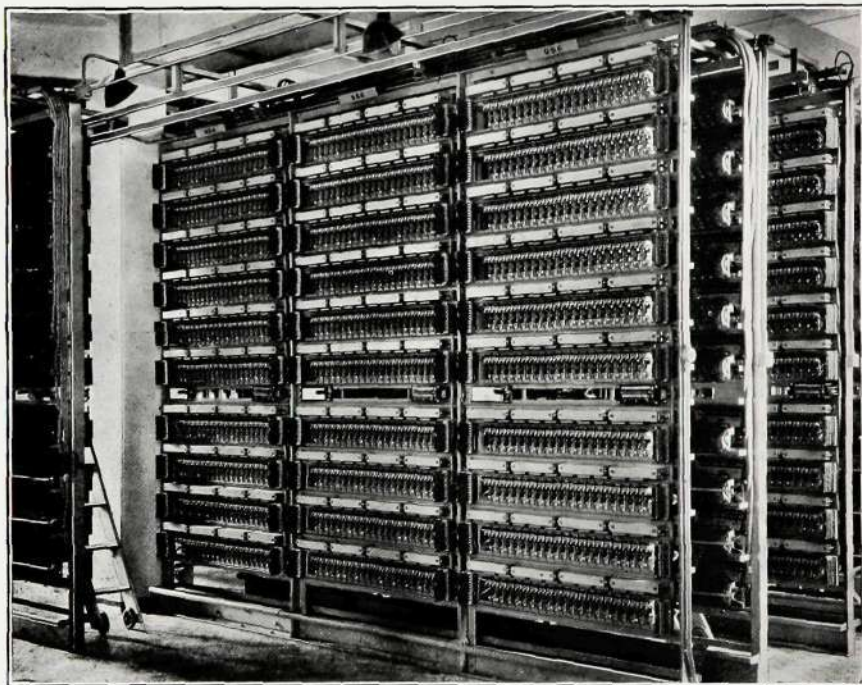
TELEPHONE WORKS,
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Head Office : 67/73, KINGSWAY, LONDON, W.C. 2

Liberty Automatic Telephone Exchange

London Director Area

 IN the first issue of the Ericsson Bulletin there appeared descriptions of automatic telephone equipments which were supplied at home and abroad. From the experience gained by these and many other exchanges, new types of racks and circuits have been evolved and designed in conjunction with the Post Office Engineers.



Liberty Exchange—Uniselectors

Liberty Exchange, in the London Director Area, (originally known as Merton Abbey), is one of the first to incorporate the new features. The exchange serves mainly, a residential area, and has an initial equipment for 3,880 working lines and ultimate capacity for 10,000 lines.

The automatic equipment is mounted on the new single-sided open-type racks as may be seen from the illustrations, and from the point of view of maintenance, accessibility and general appearance, these racks are a considerable improvement over the older type.

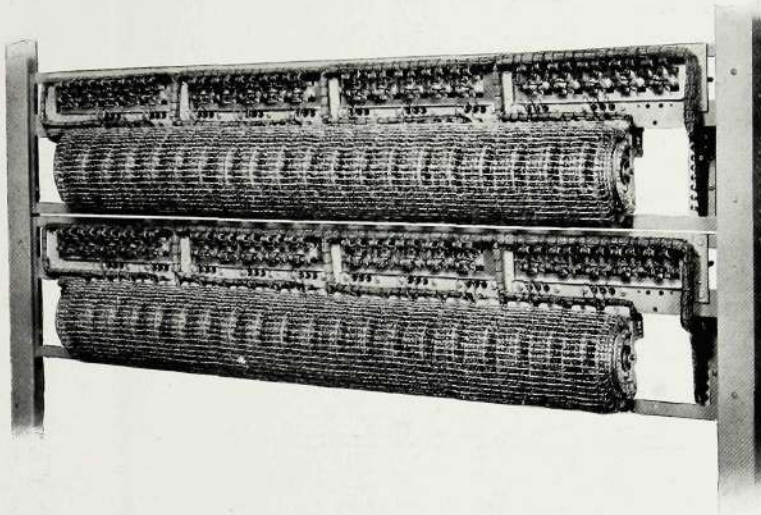
The uniselectors or rotary line switches are now mounted on separate racks from the final selectors, and the connections

between the two are made at the I.D.F. by means of jumpers. A view of the Un-selector Racks is shown, also an illustration of the wiring side of two unselector shelves, giving an idea of the neat wiring scheme to which the equipment lends itself.

The old method of associating a grading frame with each selector board is now replaced by centralized grading frames or units known as Trunk Distribution Frames. These frames are similar in appearance to the intermediate distribution type, and shelves or groups of shelves are cabled to one side of the frame where the outlets are commoned as required and then jumpered to the other side to pick up the trunks to the next rank of selectors.

It is therefore a very easy matter to re-arrange the gradings should this become necessary through altered traffic conditions.

In conformity with common practice, travelling ladders are provided on each side of the main and intermediate distribution frames, and a further development of this scheme is embodied at Liberty Exchange,



The Wiring Side of Two Unisector Shelves

where they are also provided on the apparatus side of each suite of automatic racks. A new feature of these ladders is an efficient brake, which by means of a strong spring is forced against the top running rail and automatically locks. Release can only be effected by the operation of a lever on the side of the ladder, thus eliminating the possibility of accidents due to the ladder moving when in use.

The lighting arrangements have been carried out on up-to-date lines, and by means of lamps, with parabolic reflectors, fitted on the apparatus side of alternate racks a flood lighting effect is given. The usual type of hanging lamps are fitted on the wiring side of the racks. For close inspection and adjustment special 50-volt lamps are used, battery being picked up

from jacks mounted on the sides of the racks.

The exchange equipment is situated on three floors. On the ground floor are located the Main Distribution Frame, Power Equipment and Test Desk, together with the Unisector, Code and 'A' Digit Selector and Director Racks. The Intermediate Distribution Frame, Numerical Selector, Final Selector and various miscellaneous racks are situated on the first floor. The Batteries are also accommodated, but partitioned off, on this floor. The second floor is reserved entirely for the manual equipment.

The main and intermediate frames are situated on different floors and a large cross section of cable is run between these frames. An idea of this cable can be seen from the illustration which also shews the

general method of cabling adopted by the Ericsson Company.

This exchange is one of the first to embody two new systems of junction working recently adopted by the Post Office. One of these, the "Straight-Forward" Junction System, necessitates keysender 'B' operators. The distant 'A' operator chooses her own junction and is connected automatically to a keysender 'B' operator. The 'A' operator asks for the number required; this the 'B' operator sets up on the digit keys fitted on the section, thereby completing her association with the call. The supervision of the call and the clearing down is solely under the control of the originating 'A' operator.

Where a number of keysender 'B' positions are provided, arrangements are

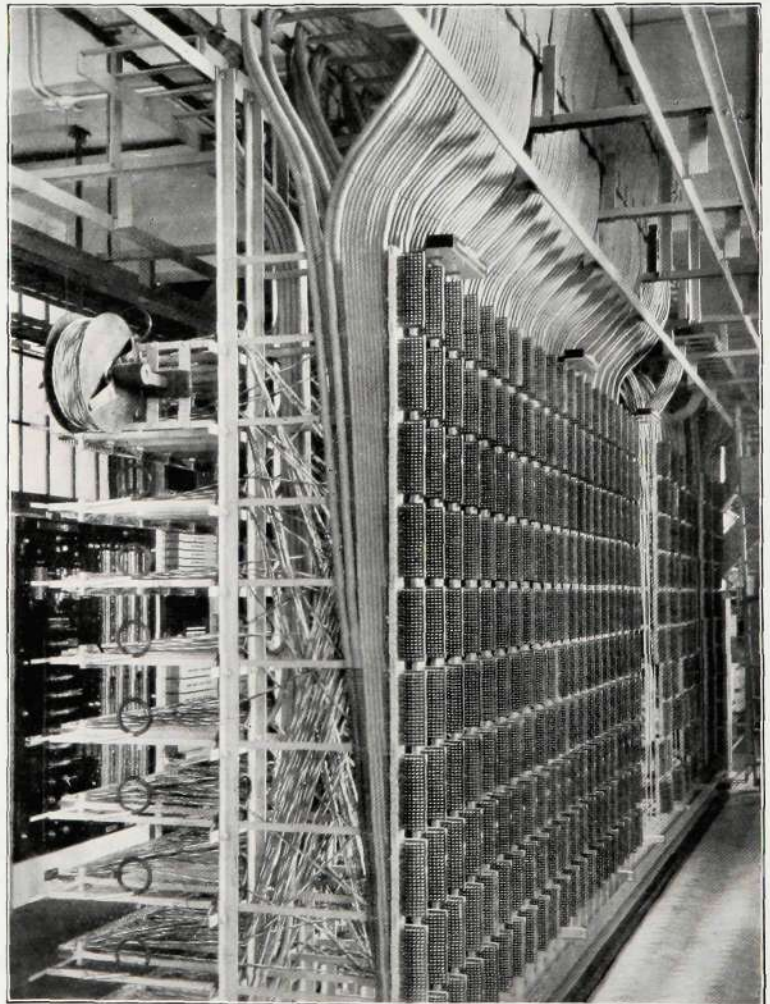
made to distribute the calls evenly over the staffed positions.

The other junction system, known as the "Voice Frequency" System, dispenses with the keysender 'B' operators, and provision is made on the 'A' boards at other exchanges for sending the digits. Instead of using dial impulses, certain alternating current frequencies within the voice range are transmitted to represent various digits, these are received by the voice frequency equipment at Liberty, and converted to the appropriate impulses which are then sent out by the sender to operate the local switches.

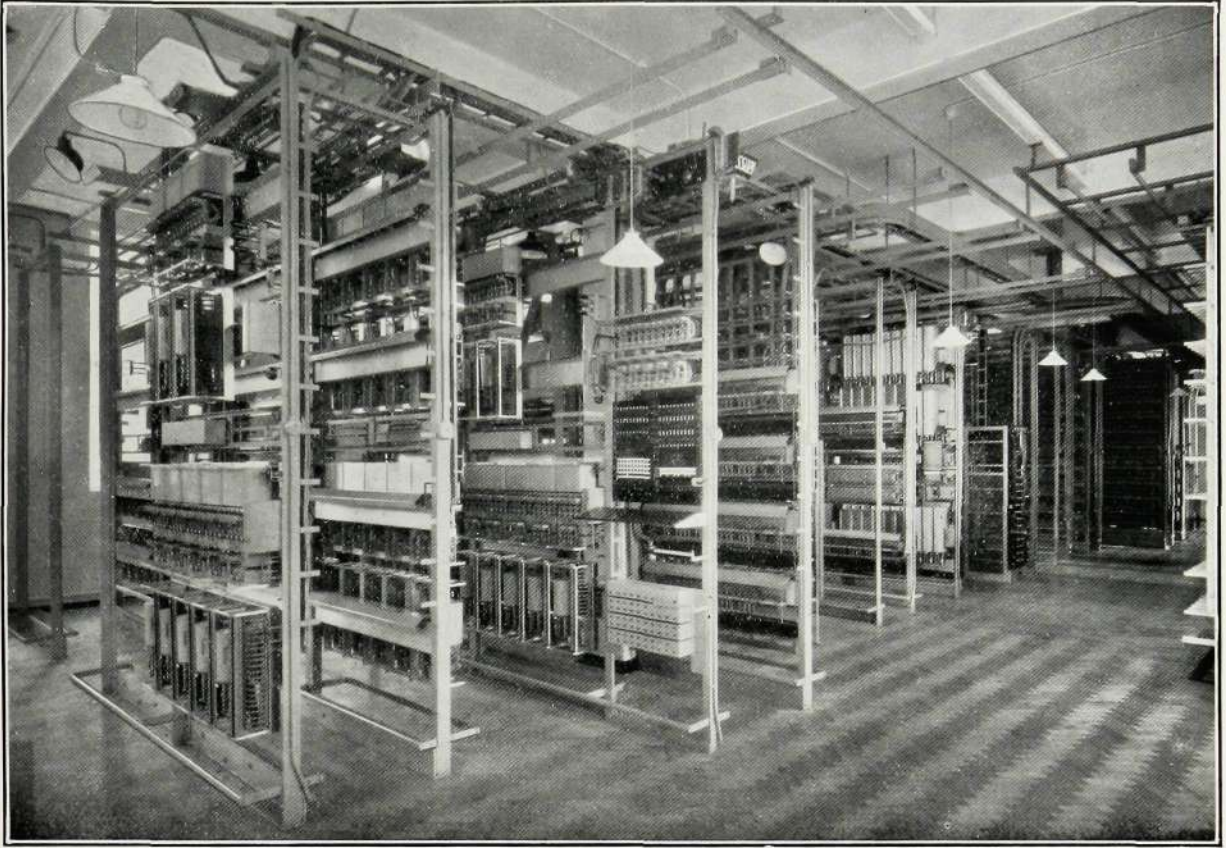
For calls to exchanges situated outside the unit fee area, excess fee metering facilities are provided. The metering pulse is controlled by the director, the first translation digit 1, 2 or 3 sent out, determines whether the metering shall be single double or triple. The 1st code selector is stepped up in accordance with the first translation digit and, by means of suitable contacts, prepares the circuit for the appropriate metering. The switch then releases and is ready for the remaining digits sent out by the director to route the call to the exchange required. On the called subscriber lifting his receiver, one, two or three meter pulses, as previously determined, are sent out by a special machine via the 1st code selector which is

connected indirectly to the calling subscriber's meter, the meter thereby being stepped 1, 2 or 3 times.

Another new feature adopted in this exchange is the Chargeable Time Indicator Equipment. This apparatus, consisting of relays and a line switch per cord circuit, is controlled by the toll operator who, by throwing a key, brings the equipment into use. At the completion of a call she restores the key and the duration of the call



Liberty Exchange—I.D.F. Multiple Side



Liberty Exchange—Directors and General View of the Equipment

in minutes is then displayed by a strip of lamps on the front of the switchboard.

The manual switchboard associated with the automatic equipment is divided into two suites "A" and "B." The "A" suite deals with Assistance and Enquiry Calls, and consists of 10 two-panel sections, 3 of which are used for toll working. Visual engaged lamps are associated with the multiple serving junctions to other exchanges as well as those to local selectors.

The toll multiple, only fitted on the toll positions, has a new feature known as the Group Engaged Tone. The outgoing jacks are arranged in groups and when all lines in a group are engaged, a distinctive tone will be heard by the operator on testing the first jack in the group so that she will therefore, pass to, and test the next group.

The "B" suite consists of one keysending position, and as cords and plugs are unnecessary a low type of section, about 4 feet high and having a sloping keyboard, is supplied.

The power equipment is on the normal basis of duplicate motor generators and batteries. The motor generators for charging purposes develop 450 amperes at 57 volts and have a voltage regulation of 50 to 67 volts.

Duplicate ringing machines are provided, one arranged to work from the local supply and the other from the exchange battery.

In conclusion it may be of interest to mention that Liberty Automatic Exchange was successfully put into service on September 14th, 1932.

Police Telephones and Signals

A New System

RAPID and reliable means of communication are just as essential for the efficient functioning of a police force as they are for the operations of an army in the field.

Police forces to-day are becoming more and more alive to this truth, and where not oppressed by false doctrines of economy they are making bold efforts to adapt to their requirements all the means of communication which present day science has made available.

The post, the telegraph, and the public telephone systems of the country, as well as wireless telegraphy and telephony both stationary and mobile, are all means of communication which police generally employ, and most forces have also pressed into their service the modern fast motor vehicle for communication purposes as well as the rapid transport of personnel.

Here and there in the past an enterprising police authority has provided throughout its area a system of private telephones for police use, but no close study of

the particular problems of police communication appears to have been undertaken until after the Great War, when an investigation was begun which has resulted in the carefully planned system now manufactured and marketed by Ericsson Telephones Ltd.

This new system was first demonstrated to police authorities in 1930, when an early model equipment was set up at police headquarters in the City of Glasgow, and was there inspected by the Chief Constables and senior police officials of Scotland.



Inauguration of the Ericsson Police System at Renfrew in 1931

(1) J. Robertson, Esq., Chief Constable of Renfrewshire and Aulsebrook; (2) W. Fairweather, Esq., D.L., Vice-Constable, Renfrewshire C.C.; (3) Councillor W. G. O. Lindsay, J.P., Renfrewshire C.C.; (4) G. Gray, Esq., Deputy Chief Constable of Renfrewshire; (5) Brigadier-General R. M. Dudgeon, D.S.O., M.C., H.M. Inspector of Constabulary for Scotland.

The first authority to realise that in this new system lay the solution of local police communication problems was the Renfrewshire Constabulary, and orders were speedily placed for two complete installations for the towns of Renfrew and Johnstone.

The Chief Constable of Renfrewshire, Mr. John Robertson, had long been a keen advocate of the more ample use of the telephone for police purposes, and had been striving to find reliable means for making the police telephone network available also to the public, to the end that the police might the more efficiently fulfil their role of public servants as well as guardians of the peace. To him great credit is due as the pioneer user of this new system, and the experience gained in the operation of these two initial installations should prove of great benefit to his area as well as to the police forces of the country at large.

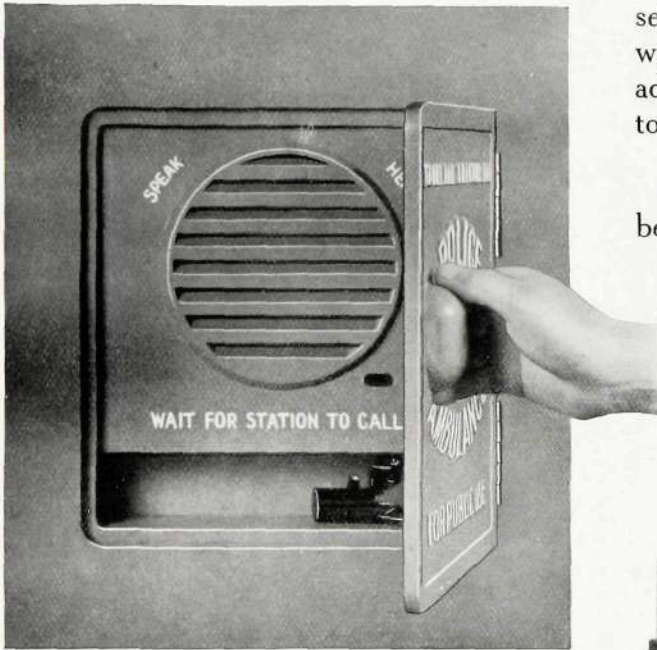
Following upon the enterprise of the Renfrewshire authority many other forces became interested in the facilities afforded by the system, and the General Post Office decided to adopt it as their standard system for police purposes. At the beginning of 1932, the City of Edinburgh Authorities

signed the first contract for the provision of the system by the Post Office. This contract covers the whole of the police divisions of the City.



Officer using the Police Micro-telephone

General interest then led to an invitation to the Post Office to arrange an address on the subject to the Annual Conference of the Chief Constables' Association, and a most interesting and instructive paper was read before that body at the Guildhall, London, on 17th June, 1932, by Mr. L. Simon, Director of Telegraphs and Telephones, G.P.O.



Kiosk Unit—View of the Public Side

The system is fundamentally of the common battery type, and it embodies a party-line feature which considerably economizes in line plant requirements. Another feature, which is of much value in keeping down the line fault duration figure, is a system of continuous electrical line test, whereby any class of line fault is indicated at the police station immediately upon its occurrence.

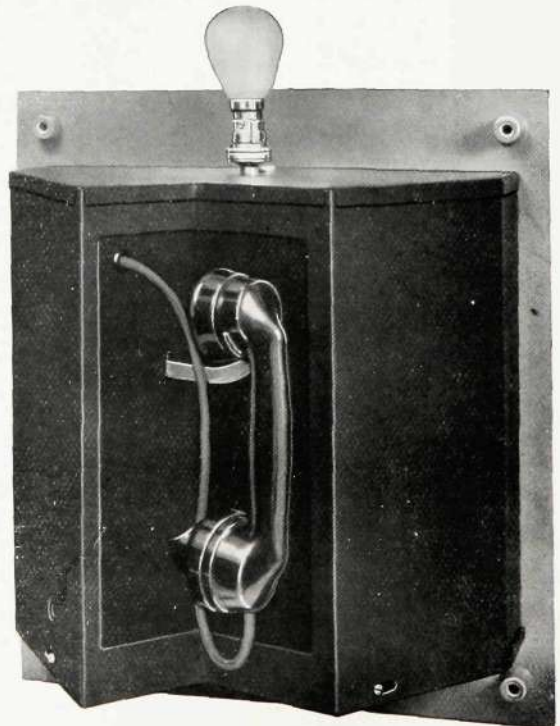
With a view to minimizing the duration of apparatus faults, the whole of the equipment associated with the police lines is

constructed in units which can be jacked-in and out without the need for undoing terminals or unsoldering connections.

Spare units are held in reserve at the police station, and can be used for speedy replacement when a fault develops in any equipment unit.

Signalling on the party-line is fully selective to three stations, and where outward calling facilities are not required, additional stations can also be connected to the same line.

For the street points an equipment can be provided either of the pillar type or for mounting in the wall of a police kiosk, and the signal call lamps may be mounted upon wall brackets, suspended from over-street wires, or fixed upon the tops of the street pillars.



Kiosk Unit—View of the Police Side

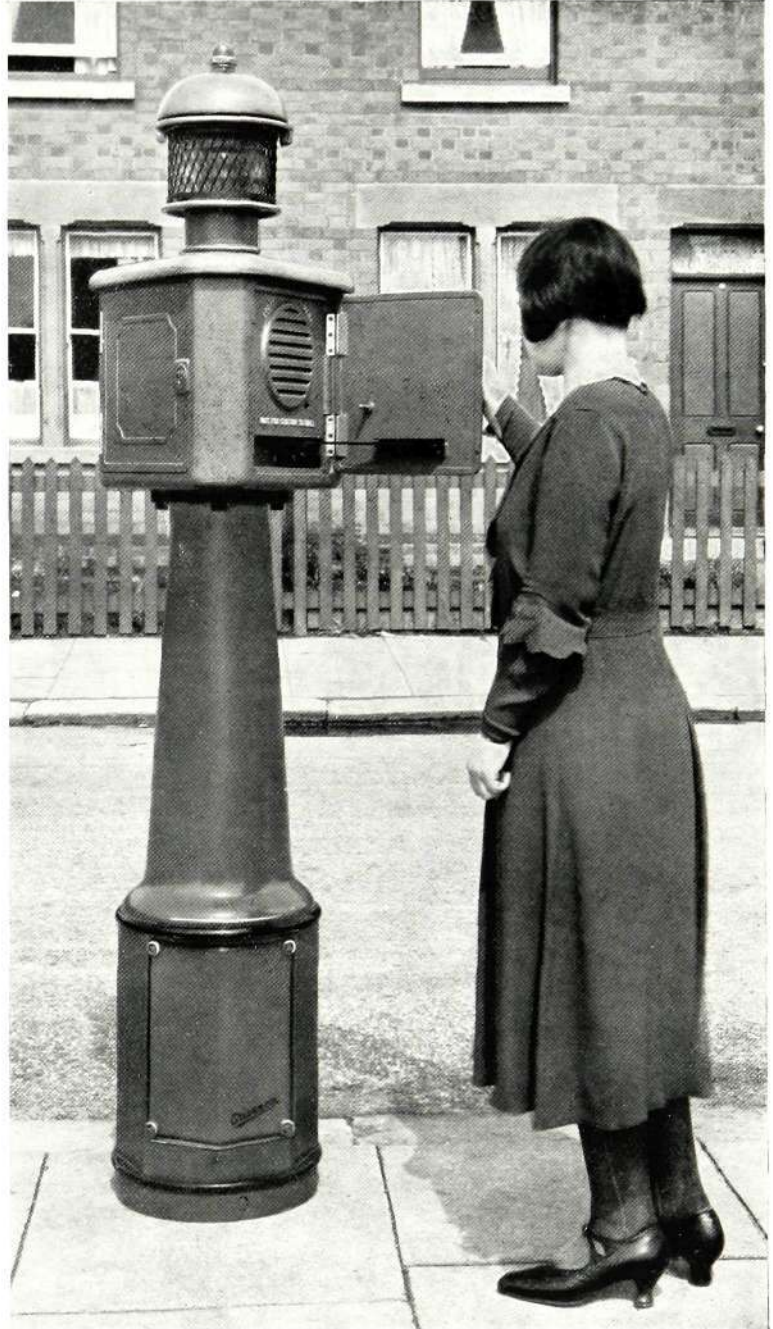
At the street points dual telephonic facilities are provided, namely, (a) by normal microtelephone available only to police or other authorised persons in possession of a key, and (b) by loud-speaking telephone available to the public at large upon simply holding open a door which is self-closing but non-locking.

The class of call originated at a street point is automatically signalled to the answering operator at the police switch-board, a police call being indicated by a green light and a public call by a red light.

The loud-speaking telephone for public use is located behind a protective grille and requires no handling by the caller. It is only necessary to "pull and hold open the door," and thereafter to speak in a normal manner in the general direction of the grille. The answering voice of the police operator can be clearly heard, even in street traffic noises, as an amplifier at the police station is employed in the circuit.

In order to reduce the risk of false calls and skylarking, the action of opening the public door can be arranged to cause the associated signal lamp at the street point to light up as a steady signal throughout the period during

which the door is open. This arrangement is also useful for indicating to any police officer within vision that a member of the public is communicating with the police



Making a Call to the Police Station

station, and if the officer is not already more seriously engaged he would proceed to the street point in order to investigate the reason for the signal, or to render such assistance as may be desired.

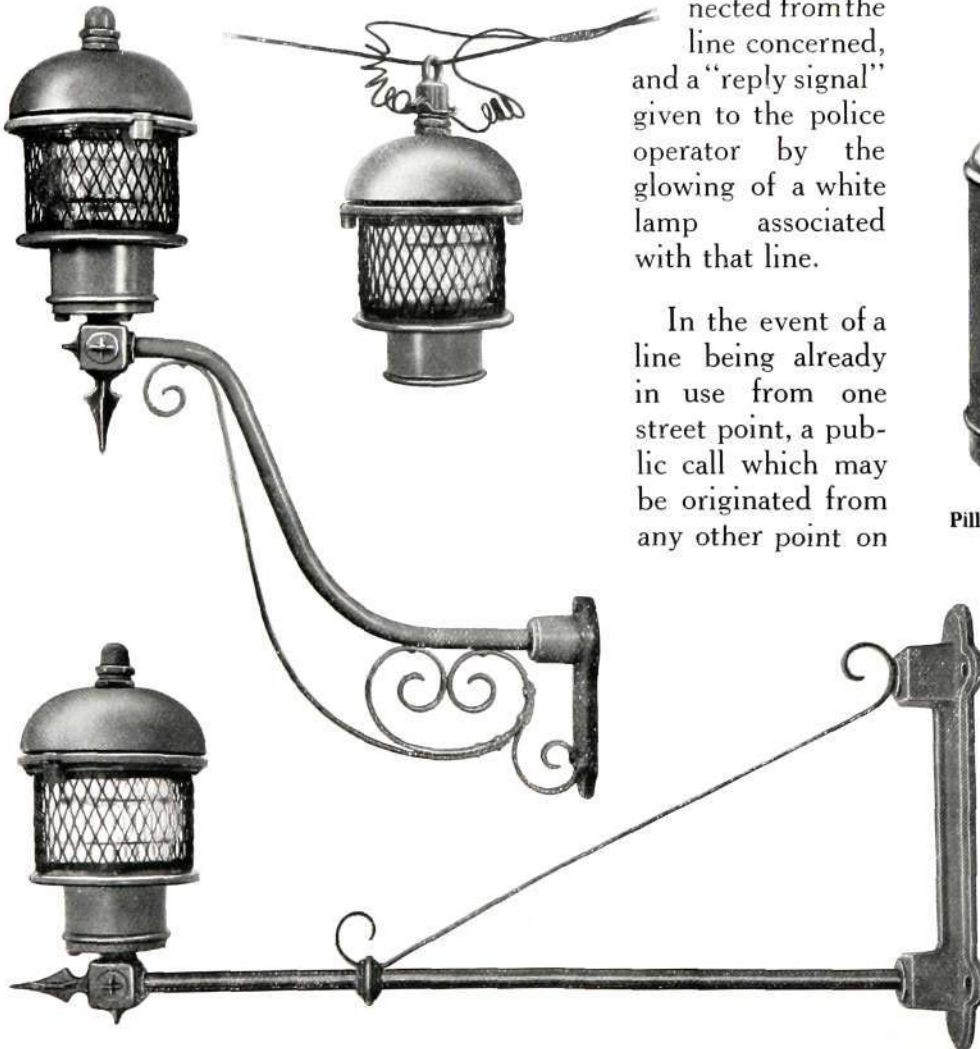
The same signal lamp is employed when the police operator rings out to call any nearby officer to speak on the telephone, but in this case the lamp operates as a flashing signal. The operation of calling out to street points is entirely controlled by the police operator. He can switch on the ringing condition to one street point, or to

any number of these simultaneously, and can likewise terminate the flashing of the signal call lamps at will. No re-setting of relays at the street points is involved. As soon as an outward call is answered at the street point, ringing is automatically disconnected from the line concerned, and a "reply signal" given to the police operator by the glowing of a white lamp associated with that line.

In the event of a line being already in use from one street point, a public call which may be originated from any other point on



Pillar without Signal Lamp



Various Types and Methods of Mounting Signal Lamps

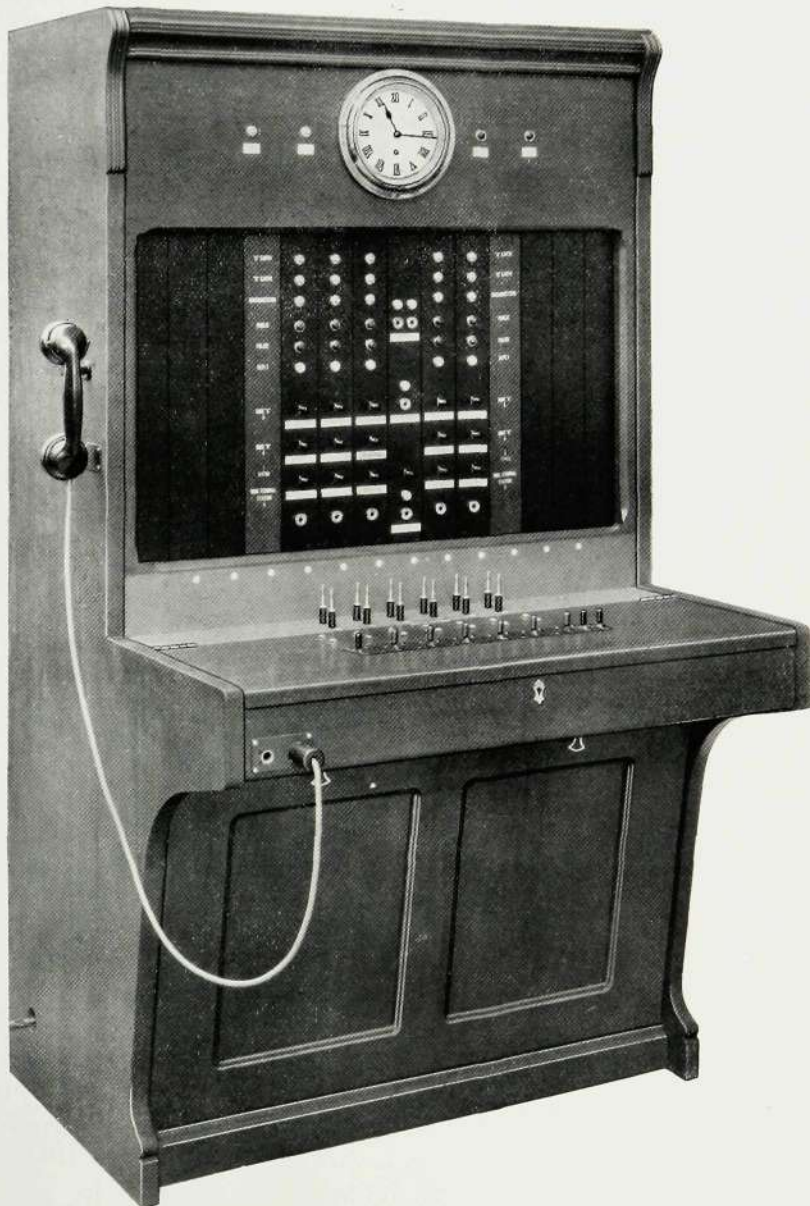
that line will still set up the "public call" signal at the police station, so that priority is always assured to calls from the public, on the assumption that such

calls will generally be brought about by some emergency calling for immediate attention.

Public exchange facilities for the purposes of the police, are provided by the General Post Office in connection with this system, but connection of public callers beyond the police system proper is barred.

The provision of exchange facilities is of great value to the police, particularly in view of the greatly increasing mobility of the criminal.

The extent and requirements of different police areas varies within wide limits and to meet this several sizes of switchboards have been developed.



A Police Switchboard for small Areas

A New Impulse Ratio Tester

(Patent No. 366711)

VARIOUS methods of measuring the impulse ratio generated by an automatic telephone dial have been devised, but they are usually not designed to give a steady reading, or if so, accuracy is obtained only if the dial speed be kept constant.

The Ericsson patented impulse ratio tester however, gives a direct indication of the impulse ratio of dials, even if the dials tested have different or unknown impulsing speeds. The pattern illustrated is suitable for testing the standard British Post Office type dial.



Ratio Tester in use

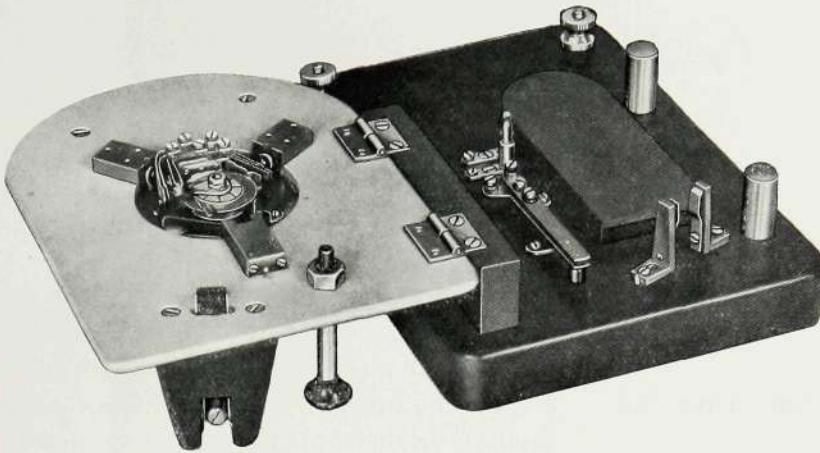
In order to make a test, the dial is placed in a dial-holder on the face of the instrument, and an electromagnetic clutch attachment is clipped to the label-holder of the dial. The clutch attachment has an arm that is pressed between spring clips fixed to the base in order to prevent the

attachment from rotating as a whole when the finger-plate is operated. The spring clips also engage contacts to which the clutch magnet winding is connected, and contact springs behind the dial-holder engage the impulse spring terminals of the dial. The instrument is wired so that the clutch magnet is in series with the dial impulsing springs, the circuit being normally opened at the contacts of a key.

The dial and clutch having been fixed in position, the finger is placed in the "O" finger-hole and brought round to the dial finger-stop, a pointer on the clutch moving round with the finger-plate until it also encounters a stop. The key is then operated and the finger-plate released.

The clutch magnet energizes in a circuit completed by the key and attracts an iron disc to which the pointer is attached, thus preventing it from rotating with the finger-plate. During each break period of the impulses however, the circuit is broken by the dial impulsing springs so that the clutch magnet de-energizes and allows the pointer to move with the finger-plate. The pointer thus moves in a series of jerks and its final position indicates the ratio measurement.

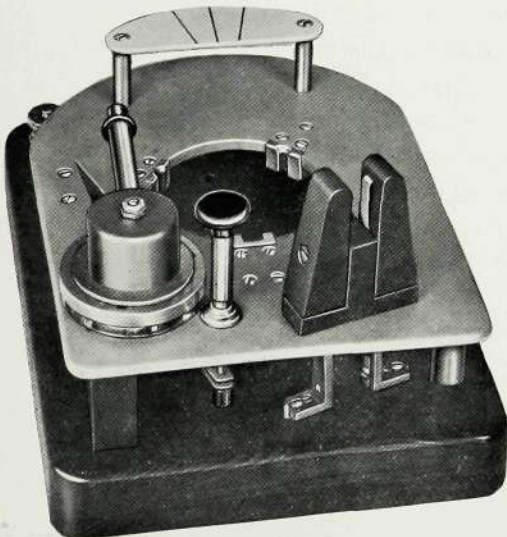
For workshop use, the ratio scale has three marks representing the normal ratio and the upper and lower limits allowable; these correspond to impulse breaks of $66\frac{2}{3}\%$, 70% and 63% respectively of a complete impulse. If desired, the scale may be divided in any other suitable manner and marked with ratio values.



Ratio Tester open for adjusting Dial

In order to allow adjustments to be made to the dial without having to remove it from the ratio tester, the face-plate is hinged and has a large hole through which the back of the dial is accessible. If therefore, a dial under test is found to fall outside the allowable limits, the face-plate is merely turned about its hinges and the dial adjusted to alter the impulse ratio; the result of the adjustment is then checked by making another test.

A condenser and resistance are provided which serve as a spark quench, thus preventing damage to the dial impulsing contacts.



Ratio Tester when not in use

When not in use, the clutch is attached to a holder provided for this purpose on the face-plate.

The instrument can be designed to work on a specified d.c. voltage such as that of a telephone exchange battery, or of a battery having, say, four dry cells.

The fact that no correction has to be made to allow for varying impulsing speeds can be demonstrated in a very striking manner by making repeated tests upon the same dial, during which, the finger-plate is either deliberately speeded up, slowed down, or even momentarily stopped. Even under these conditions the final position of the pointer after each test varies inappreciably, thus providing convincing evidence of the reliability of the ratio tester to cope with all variations in impulsing speed likely to be met with in practice.

The ability to indicate impulse ratios correctly at varying speeds is due to the fact that the final angular displacement of the pointer is equal to the sum of all the angular displacements of the dial finger-plate during the break periods of each impulse. The angular displacement per complete impulse (comprising a make period and a break period) of the dials standardized by the Post Office Engineers has been fixed at $\frac{180}{7}$ degrees, and this obviously is not changed by altering the dialling speed.

Greyhound Racecourse Totalisators



WHEN the Betting Act became law in 1928 the first Ericsson Totalisator was developed to cover the requirements of the Racecourse Betting Control Board (R.B.C.B.) of Great Britain. Subsequent experience on equipment manufactured, installed and maintained for the R.B.C.B., and the introduction of fully mechanized machines on Greyhound Racing Tracks, led to the development of the Ericsson C60 Totalisator. The system has been improved and simplified, while retaining the essential features and safeguards required by the R.B.C.B., and is

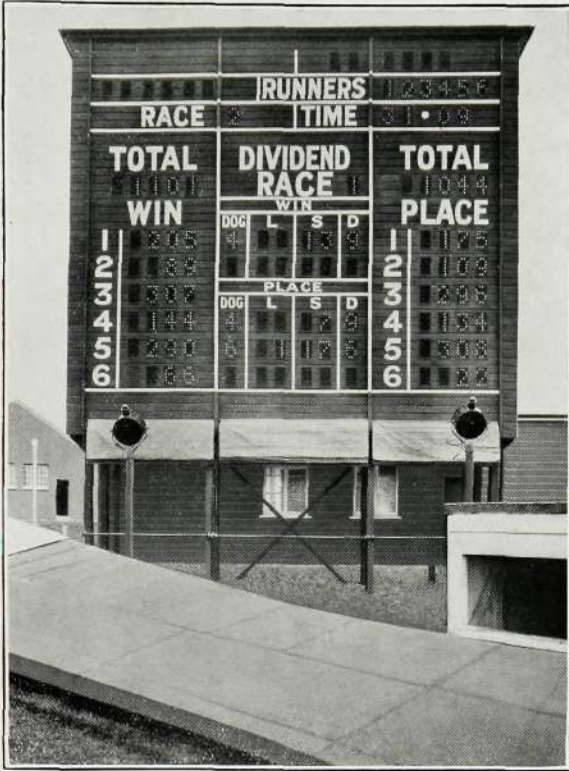
now sufficiently flexible to cover the requirements of the smallest of Greyhound or the largest of Horse Racecourses.

The cardinal features of the Ericsson Totalisator are :—

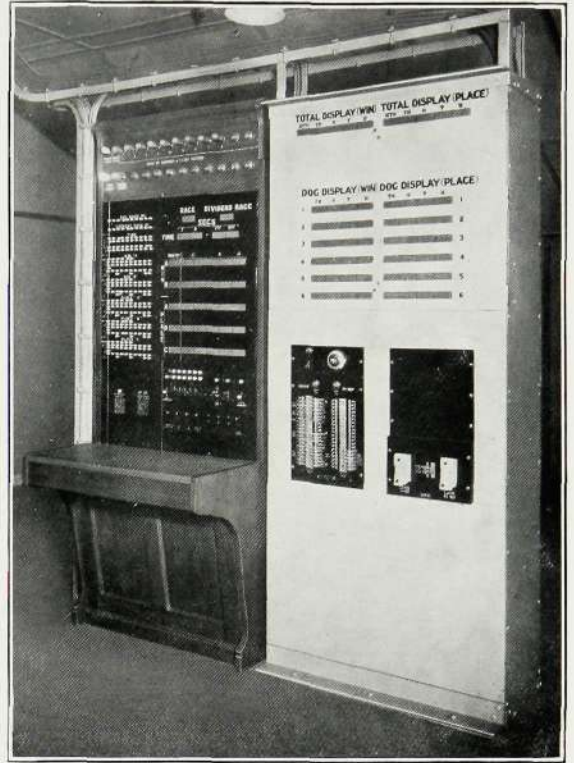
- (1) It automatically displays to the public the exact accumulating amounts invested on each runner for win, place and totals.
- (2) It is fraud and fool-proof, unfailingly accurate, and more rapid in operation than any other totalisator.



Wimbledon Greyhound Racecourse—General View



**Plymouth Greyhound Racecourse—
The Indicator**



**Glasgow (White City) Greyhound Racecourse—
Control Switchboard and Miniature Indicator**

The functions of a totalisator are to issue a ticket; upon which, details are printed to identify the runner, the stake value and whether win or place, the race and the race meeting; and to register the stake upon some recording device in strict accordance with the particulars printed upon the ticket. Preferably, the recording device should automatically display or control displays to the public, to show the accumulating totals invested on each runner for each class of stake.

The totalisator must command the confidence of the public by its unflinching accuracy in recording and totalling the amounts wagered, in its freedom from breakdowns, and in the speed with which stakes are registered and queues at selling windows kept down.

In the Ericsson system the equipment is built up of items of apparatus, the soundness of design of which has been proved by years of public service in automatic telephone exchanges throughout the world. It comprises, in the main, two standard components, the relay and the rotary line switch, built up into circuits which are designed to allow a liberal factor of safety for all operations. Every operation during the actual recording of the stake is checked, and an alarm is given should any portion of the equipment fail to function correctly and within a predetermined time. If for any reason the stake cannot be recorded the relative ticket *is not issued*, and the alarm conditions automatically set up indicate the trouble.

For every ticket issued, from any part of the track, an impulse is given to



Wimbledon Greyhound Racecourse—Clubroom Selling Windows and Miniature Indicator

a rotary line switch in an adding machine appropriate to the runner and the class of stake selected. The adding machines are located at a central point, namely, the control room, and rotary line switches forming the adding machines are provided for each denomination served by the ticket machines and for each digit displayed on the indicator; each adding machine serves one runner for one class of stake, i.e. for win or for place. The runner and class of stake are selected on the ticket machine when the demand is made, and the stake impulse is thus routed to the appropriate adding machine.

Each ticket machine issues tickets of one value only, being permanently wired to a particular denominational common according to the requirements of the track. A machine issuing 2/- tickets can therefore impulse 2/- switches only; the appropriate switch in the adding machine is thus selected automatically.

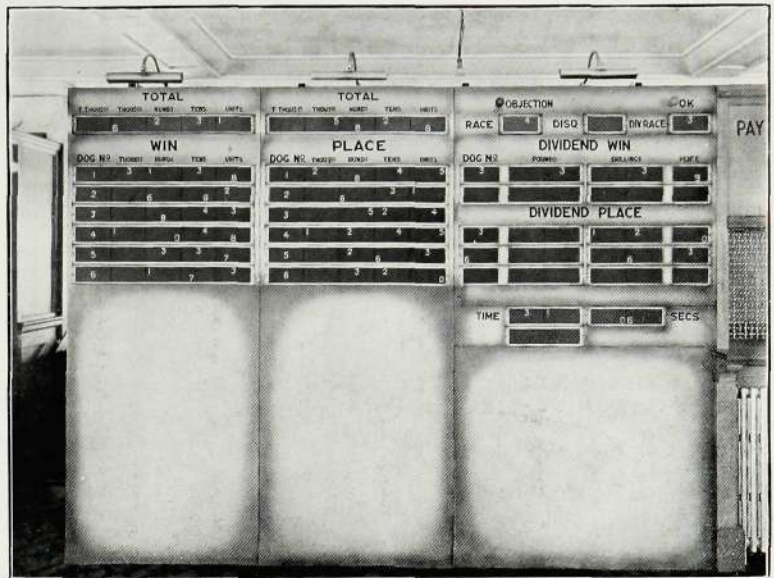
Electrical linking arrangements are provided between the different denominational switches in any one adding machine, so that when a switch of lower denomination has been stepped ten steps by the issue of ten tickets of that value, the switch of next higher denomination is stepped one step by an impulse received from the switch of lower denomination in passing from its ninth to its tenth position. The whole arrangement provides an electrical counter, similar in effect to a standard "veeder" counter, except that it is not confined to unit impulses; the tens, hundreds, &c., sections of the counter being capable of individually responding to impulses from appropriate ticket machines.

It will thus be seen that the position of the denominational switches of any one adding machine represents a measure of the number of tickets issued for the runner concerned. The switches do, in fact, register the number of unit stakes invested in the particular

runner, and where the unit stake is 2/-, as is usually the case, a direct reading is provided in pounds and tenths of a pound.

All indicators are controlled directly from the switches in the adding machines, being connected in parallel thereto and providing a visual indication in figures of the position of the adding machine switches. The figures on the public indicators are built up by illuminated lamps which change their formation with the varying positions of the switches, which in turn vary with the issue of tickets from the ticket machines. In addition to the public indicators, large and small miniature indicators are provided to display results in the club and in the control room respectively, the reading on each being shown by means of individual lamps lighting up figures.

Provision is made on the indicators for the display of winners, the dividend to be paid per unit stake on winning tickets, and miscellaneous signals with regard to racing results. The setting up of winners is directly under the control of some official of the racecourse, usually the judge, and suitable controlling equipment is provided for this purpose near the winning post. As soon as the winners have been declared, the control room staff work out the dividends and set them up provisionally on the miniature indicator in the control room. When these have been checked by the totalisator manager or other responsible official, they are then displayed on the public indicators.



Wimbledon Greyhound Racecourse—The Clubroom Indicator

Safeguards are provided to ensure that tickets cannot be obtained from a ticket issuing machine for a race which has been run and thus upon a known winner. As soon as the race starts, all ticket machines are locked to prevent the further issue of tickets. In order to bring the machine into use again for the next race, each ticket seller has to operate a lever on the side of the machine, which automatically changes the race number printing drum, inside the machine, to the following race number. All tickets subsequently issued will bear this new number. The mechanical linking arrangement between the race number change and the electrical circuit of the machine ensures a really satisfactory control of ticket selling. The interior of a machine cannot be interfered with in any way by a ticket seller.

Ticket issuing machines are grouped in selling buildings situated in various enclosures round the track, and are looped together to one set of common conductors which are finally connected to the apparatus in the control room. The circuit arrange-



Wimbledon Greyhound Racecourse—Selling Booth (inside) and Ticket Issuing Machines

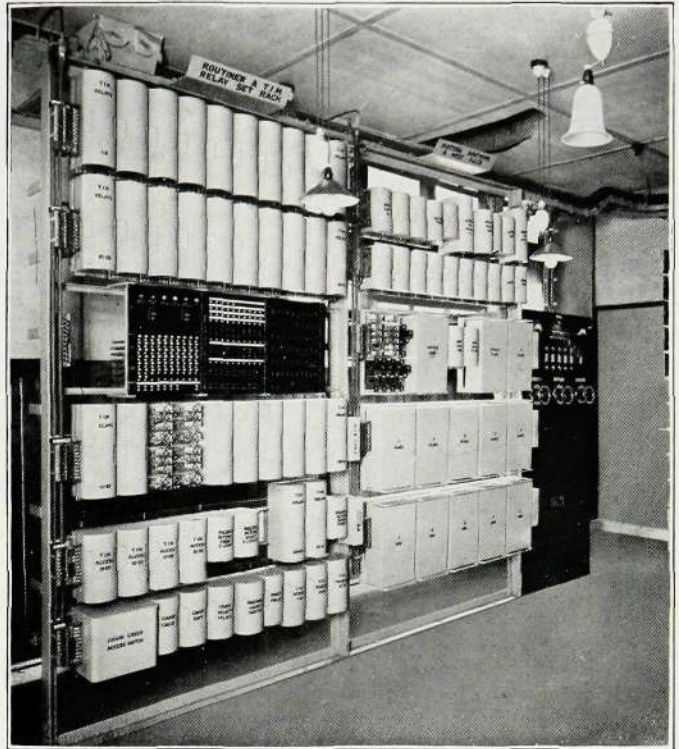
ments are such, that for each group of ticket machines and class of stake only *one machine at a time* can use the common conductors, and a feature of the system is the chain relay control which permits this to be done with great speed and without any deterioration of the general accuracy level of the rest of the equipment. A full-load ticket-issue speed of 60 to 75 tickets per minute can be obtained, even on heavily loaded groups; a particularly desirable feature when demands for multiple tickets are made and queues are forming at selling windows.

The chain relays are provided one per ticket machine, and form part of a relay set which is individual to a machine. If a group of machines are operated simultaneously, their relative chain relays set themselves in a queue and operate *one at a time*

to allow each ticket machine in turn, access to the common conductors over which the stakes are routed. A chain relay can operate only when its turn comes and when any relay previously operated has released. The chain relays of machines not initiating a stake operation at the moment, and of machines which have registered their stakes and are in the process of printing the relative tickets, form no part of the queue which is made up only of machines initiating bets at approximately the same time. Ticket machines are cleared out of the queue at the rate of over 30 per second, and this speed, together with the small number of machines initiating a stake operation at approximately the same time, makes the waiting time in the queue negligible, even for a large group of machines. With a group of 100 machines in one chain relay control, the ticket issue speed, with all machines serving the public

in the last five minutes preceding the start of each race, varies between 60 and 75 tickets per minute per machine, as previously stated. Of course, this does not mean that 6,000 to 7,500 tickets are being issued to the public in any one minute; the lag of the backers forming queues at selling windows, the making of the demand for a particular runner, and the handling of cash, all slow down the actual issue of tickets to the public. The issue speed quoted above is the average speed at which any ticket is ejected from the machine.

It is desirable that the whole totalisator should be under full control throughout all stages, and the Ericsson Totalisator being all electric is particularly suitable from this point of view. The ticket machines are under constant control, the totalisator is started and stopped by electrical contacts operated by a "Yale" lock, and all instructions to selling buildings are given by means of coloured lamps and hooters. Only the authorized person, equipped with the starting key, can operate the controls, all of which are conveniently grouped on the control switchboard. The possibility of accidental or malicious misoperation is thus reduced to one person who is under the direct supervision of the Totalisator Manager.



**Glasgow (White City) Greyhound Racecourse
Controlroom Apparatus**

The following greyhound tracks have already been equipped with Ericsson Totalisators, each of which fully justifies the claims made for this equipment :

- Dunmore Park, Belfast
- Perry Barr, Birmingham
- The Stadium, Sheffield
- Darnall, Sheffield
- Wimbledon Stadium, London
- White City, Glasgow
- Penny Cross, Stadium, Plymouth
- Boundary Park, Norwich.

Other totalisators for track use are in course of construction.

Battery-Call Railway Telephones

BATTERY-CALL Telephones find special application on Railway Systems. The natural development of the telephone network linking the various sections of the traffic-handling departments has followed these lines, because they best provide the particular class of service demanded with flexibility and economy. Thus special types have been developed to meet the requirements of various classes of circuits, operating conditions, etc., and these become known as Railway Telephones on account of their prime application.

Battery-Call Railway Telephones are made in various types ; with bell, or for use with external bell ; with single ringing key, or with two keys serving code and selective ringing ; with relays of various resistances for use on long distance and heavy omnibus circuits ; or designed for use in exposed positions and by inexperienced operators. These telephones are exceptionally robust and capable of long service even in unfavourable situations ; they incorporate those points of refinement and attention to detail resulting from close collaboration with the engineers of the Railway Companies coupled with Ericsson's unrivalled experience in this field. The instruments are designed to facilitate periodical maintenance inspection, and the moving parts are so arranged as to permit cleaning and adjustment should this be necessary.

For local working a typical instrument has a solid-back transmitter, "Bell" receiver, 100-ohm trembler bell and a ringing button which is fitted on the front of the case. The lightning arresters are fitted with Ericsson patent anti-dust and insulation

step carbons. In general appearance this instrument is very similar to that shown in fig. 5, except that the transmitter is fixed direct to the front of the case as in fig. 4, and the position of the ringing button is as stated.

For economy of battery and the maintenance of good speech on long or heavily loaded omnibus lines it is necessary to use sensitive and comparatively high resistance relays for calling. Engineers usually find it convenient to adopt two standard resistances for use on their long circuits, chosen according to the type of circuit, etc. Some companies have adopted 1,000 Ω and 5,000 Ω , others 3,000 Ω and 10,000 Ω as being the most suitable. Although higher resistance relays can be supplied for special conditions, in general it is not economical to exceed 10,000 Ω . As an indication of the relative impedance figures the following typical values, obtained at 800 \sim with 1.5V. impressed, are given.

1,000 Ω Relay	Z = 20,000 Ω
3,000 Ω „	Z = 65,000 Ω
5,000 Ω „	Z = 100,000 Ω
10,000 Ω „	Z = 125,000 Ω

For traffic control there are two general types of circuits, namely, main control trunks, and local control.

Control trunks connect the various District Control Offices to the Divisional Control Office, and the efficiency must be kept as high as possible because the number of stations in bridge probably average six, with lines up to say, 150 miles in length, and also on account of the composition of the circuit which varies with circumstances.

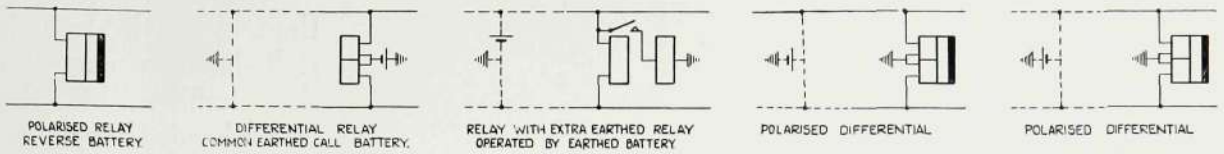


Fig. 1.—Various Methods of Selective Calling

The composition of three typical circuits employing instruments with 5,000^Ω relays is tabulated below.

The varying conditions peculiar to railway routes, such as, tunnels, viaducts, congested industrial areas, etc., necessitate the introduction, at intervals, of cable sections into the aerial line.

	Circuit 1	Circuit 2	Circuit 3
	Miles	Miles	Miles
Total length ..	177	141	65
Length, 200 lb. aerial	162	139	52½
Length, 40 lb. MTLC cable ..	15	2	12½
Number of Cable Sections ..	30	17	28
Number of stations ..	8	10	5

Owing to heavy reflection losses, due to the numerous cable sections being irregularly inter-spaced and varying from 100 yards to a mile or more in length, high efficiency telephone instruments are essential.

Ringling is by loop battery with code calls for the ordinary control offices and reverse battery selective call for the main office.

Local control circuits connect the signal boxes, depots, etc., to the District Control Office. The circuits are much shorter, but are generally very heavily loaded, the average number of instruments being between 15 and 20, although as many as 35 stations have been connected in some cases,

so that an instrument with a high resistance relay is required. Ringing is again by code call with loop battery. Where more than one selective call is required, as with two District Control Offices or an Exchange, any of the arrangements shown in Fig. 1 may be used. These are self-explanatory.

In some cases the traffic is so great that it is not possible to allow intercommunication between the sub-stations, and the circuit therefore is made "control only" by using polarised relays at the sub-stations and an ordinary relay at the control office as shown in fig. 2; or as in fig. 3, using a differential relay and earthed battery at the main station, the former being operated by earthing both lines with the call key at the sub-station. The sub-station instruments are code called from the main by loop battery to ordinary relays in the usual manner.

Instruments with relays are of various types to meet service requirements, but certain features are common to all types. Relays are usually placed on the inside of the hinged cover for accessibility, and are provided with dust covers.

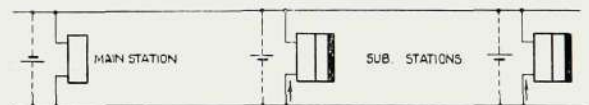


Fig. 2.—One Method for "Control Only" Circuits

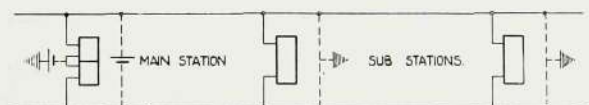


Fig. 3.—Alternative for "Control Only" Circuits

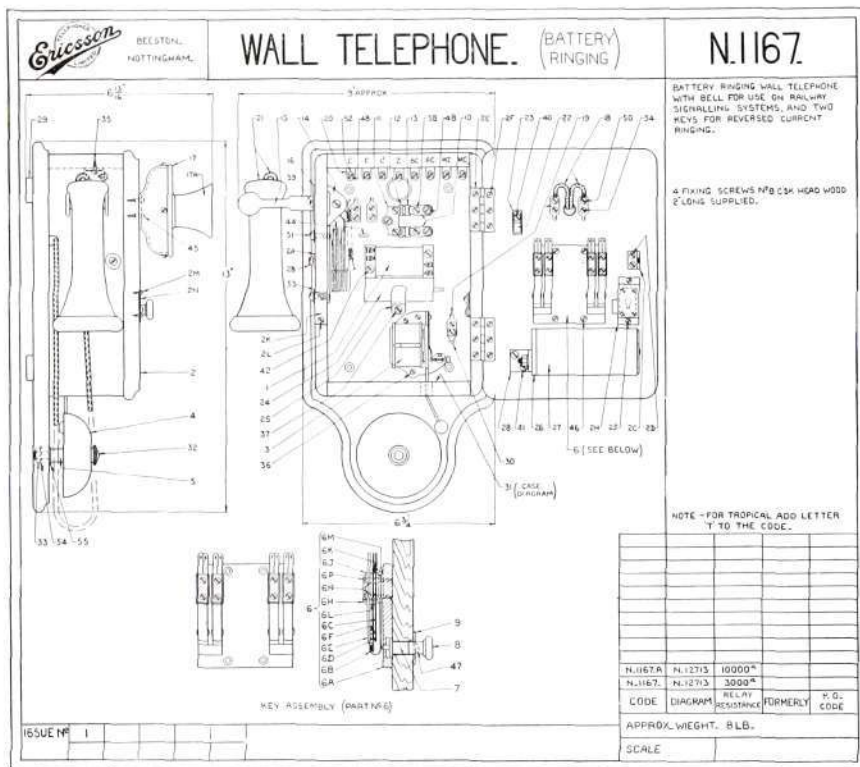


Fig. 4.—Assembly Drawing of a Railway Telephone

One type is shown in fig. 4 in the form of a drawing and is very similar to the local working instrument previously described, but a relay and two calling buttons are fitted. This style of assembly drawing, size 8" x 10", is supplied to customers so that they can readily refer to or order any of the component parts, by stating the code number of the particular instrument in use (given in

the table at the bottom right-hand corner) and the number of the arrow-headed line pointing to the item required.

Another type for a similar service has a single three-position lever key which is used for calling instead of press-buttons; a watch pattern receiver and an underdome bell are fitted but lightning arresters are not normally provided.

Two instruments of note are shown in figs. 5 and 6. The former has a solid back

transmitter, "Bell" receiver, latest type induction coil combining maximum efficiency with economy of space, and an underdome bell. The relay is normally 5,000Ω and is adjusted for an operating current of 2mA. The single ringing button is conveniently mounted on the right hand side of the instrument.

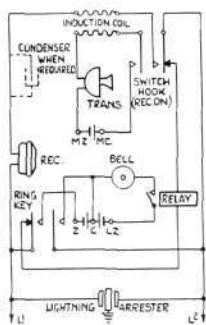


Fig. 5.—Single Button Telephone and Circuit

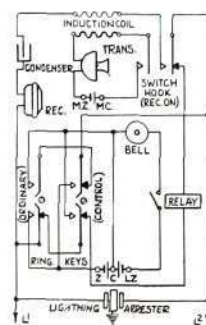


Fig. 6.—Double Button Telephone and Circuit

The latter has two coloured buttons on the front and the relay is either as just described for a code-called station or polarised for a selected station. The polarised relay carries twin dome contacts and is adjusted to operate on 2mA in the correct direction and not to operate with 15mA. in the reverse. Although the polarised and non-polarised relays do not mount on the same fixing centres, the mounted "relay and bracket" of either type is interchangeable.

For use with an external bell, a set very similar to Fig. 5 is available. It is fitted with a relay, also a single press key at the side but no bell. All these instruments have arresters with treated carbons.

The extension of automatic signalling has increased the demand for an extremely robust instrument for use by enginemen and others in normally unattended positions. Such a set must be consistently reliable, weatherproof, simple and immune from damage due to unskilled or rough handling.

In the instrument shown in fig. 7, the results of our long experience of heavy duty sets for use in mines and similar unfavourable situations have been embodied. A stout cast metal case houses the components, the connecting cable entering through a watertight gland to prevent ingress of moisture. The hermetically sealed replaceable capsule transmitter is mounted inside the front and protected by a grille. The receiver is also fixed inside the case and an extension flexible metal tube and earpiece are fitted externally. The flexible tube has a stout strain cable to prevent damage and a soft leather pad is fitted on the earpiece.

The ringing and speaking key is operated by a lever handle conveniently located on the right hand side of the case. The key with its cable arm is so arranged that it can be removed from its position and swung out for cleaning or adjusting the contacts without disconnecting the wiring from the key.

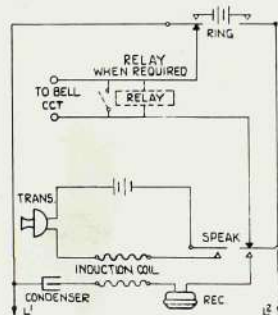


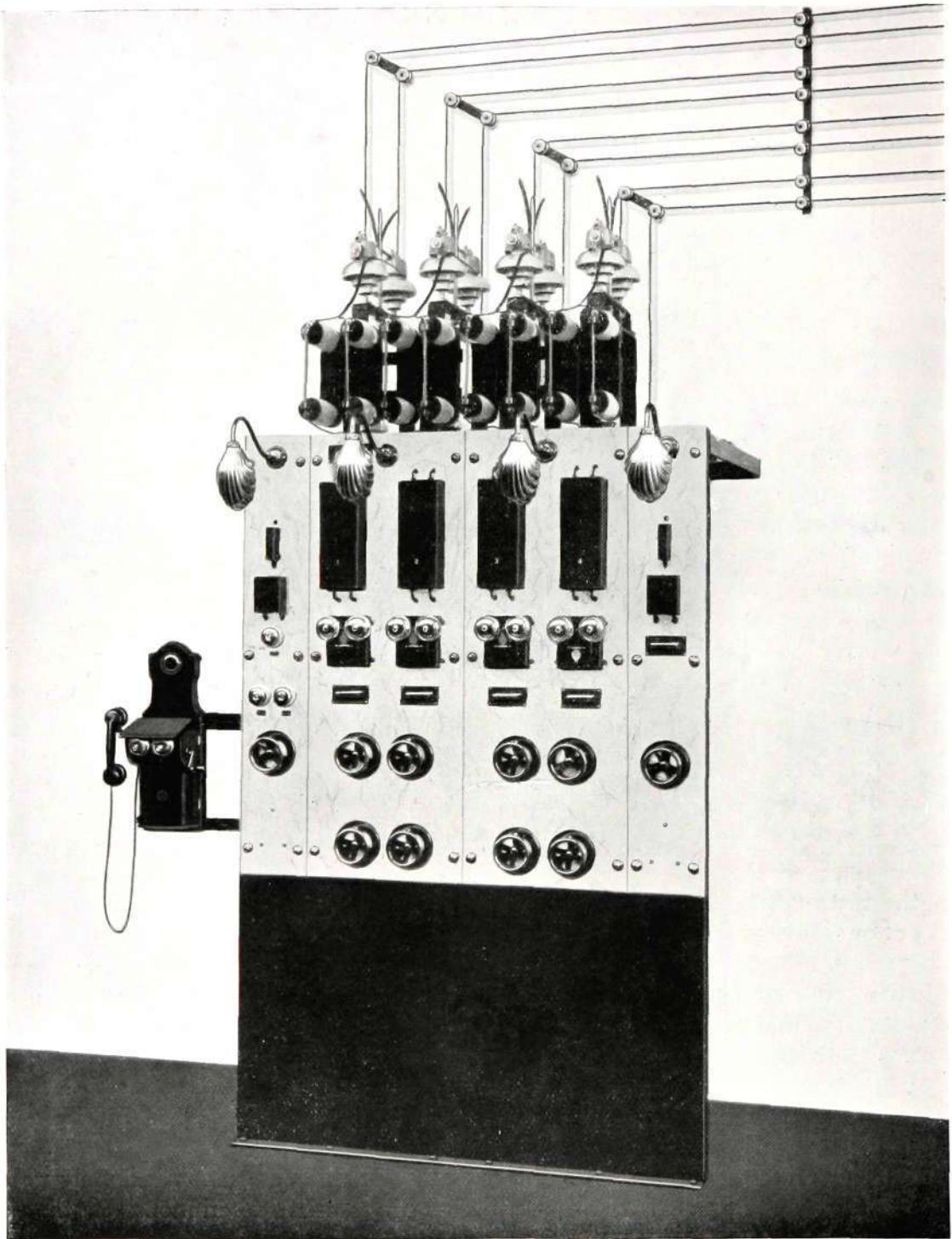
Fig. 7.—Metal Cased Telephone and Circuit

The induction coil and the receiver coils are impregnated to render them immune from the effects of moisture.

A relay can be fitted if required by removing the flat cover plate on the top and mounting the relay and a cover in its place. The wiring is so disposed as to render such a conversion a simple matter.

The case has two flat iron bars for mounting the instrument on a wall or on a wood frame. The front of the case is hinged on two rings and swings down when opened. The case is heavily enamelled black with the raised directions lettering picked out in white.

As in this publication it is only possible to give brief descriptions of the main types used in this important section of railway telephone communications, an outline has been given to indicate the general field of design.



Pykara Station, Madras Hydro-electric Development Co., India—
A Four-Line, High-Tension-Protected, Telephone Switchboard

A Protected Telephone System

for use along

High-Voltage Transmission Routes



ERICSSON Telephones Limited have supplied a large number of telephones and associated equipment for use on Power Systems in all parts of the world and have gained considerable experience in this class of telephone service.

Our well-known magneto telephone for use on high-voltage routes was introduced some years ago, and gives excellent results providing the telephone lines are of moderate length and good construction. It is absolutely safe to use, as complete protection is obtained by means of the long rubber tubes shown in the illustration. This design, however, with long rubber connections between the "dummy" handset and the actual transmitter and receiver fitted in the case of the instrument, is somewhat limited as regards range of operation, especially if the telephone lines are not of good construction.

Owing to considerable development during recent years of high-voltage overhead transmission, and of the much greater lengths of lines installed, a demand has arisen for a more efficient telephone system for the use of Power Companies.

The Ericsson Company has developed a comprehensive scheme for this purpose, and has recently supplied a large amount of high-voltage telephone equipment to the Madras Hydro - Electric Development Company for its overhead system in India. A brief description of this system may be of interest to engineers engaged in high-tension transmission.

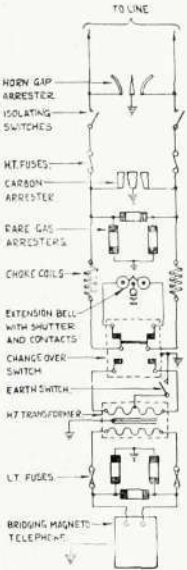


Magneto Telephone for use
on High-Voltage Routes

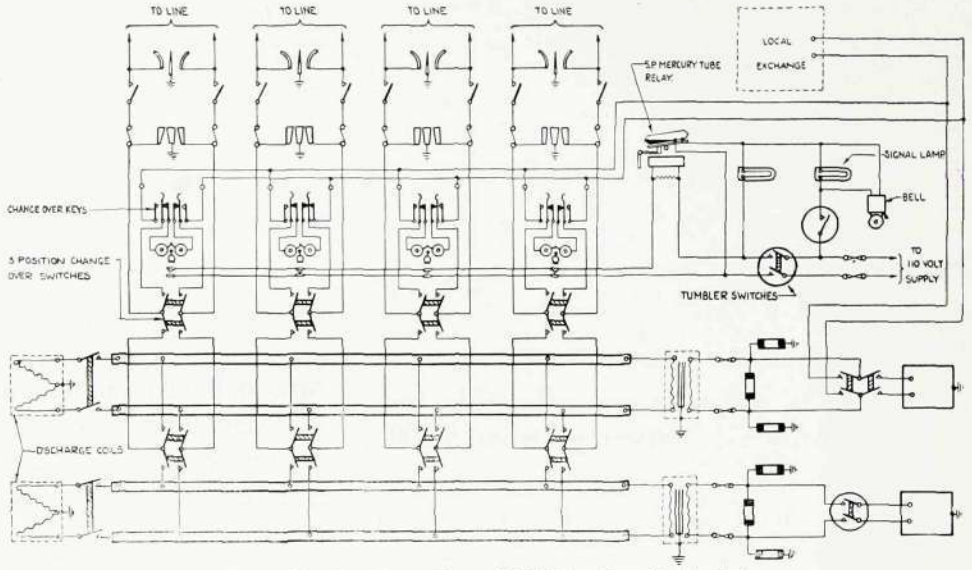
Standard Metal Cased Telephone Instruments are employed, with a very complete protective arrangement to ensure absolute safety to the persons operating the system.

In general, the arrangement consists of an equipment of fuses and arresters, together with special transformers which provide complete isolation for the actual telephone instruments during use. The switchboard is built up of white marble panels on which are mounted the various switches, fuses, etc.

The construction, it will be noted, is on the lines of a power control panel, and all connections controlled by the operator are made by means of robust quick-acting knife switches with bus-bar connecting circuits.



A Typical Protected Circuit



The Circuit of a Four-Line, High-Tension-Protected, Telephone Switchboard

Calls are received at the switchboard on magneto bells fitted with drop shutters to serve as indicators. The indicators are arranged to operate a call bell, and if desired, to light a pilot lamp.

Relays of the "mercury tube" type are provided to control the pilot lamps which are connected to the lighting supply.

Should atmospheric or other causes render the lines noisy during a conversation, "drainage" coils can be switched into circuit; these coils allow the lines to discharge to earth, but at the same time they are of such impedance that they do not impair the telephone transmission in any way.

Long-distance high-voltage transmission lines are at times subject to heavy potential surges, and where telephone lines run in close proximity, high voltages may be induced on the telephone system. This is one of the main causes of trouble on this class of telephone service. There is also the further risk that through gales or heavy snowstorms the overhead power conductors may come into contact with the telephone

wires. This is, no doubt, a rare occurrence, but it must be allowed for in a telephone system of this type if absolute safety is to be obtained.

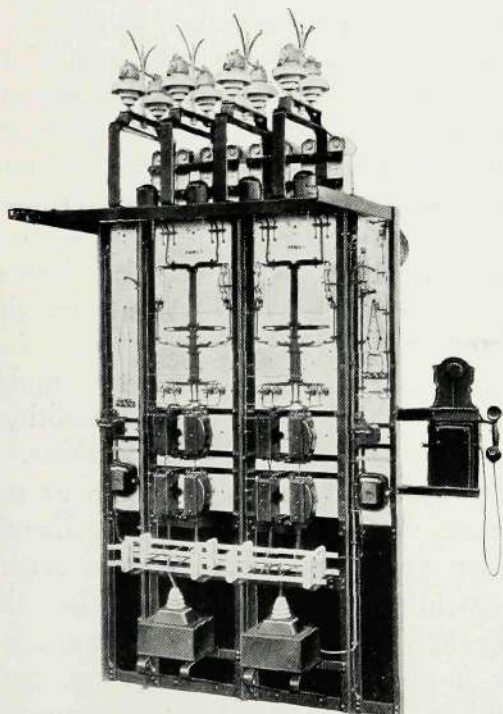
The method of protection in the Ericsson high-voltage telephone system is to isolate the telephone instruments by means of special transformers, and at the same time to arrange the circuits so that external connections are immediately broken should dangerous high voltages occur on the telephone lines; by this means the telephone instruments are protected from damage and any persons using them are rendered immune from danger.

The general arrangement of the various protective devices—fuses, arresters, isolating transformers, etc.—is clearly shown on the circuit diagrams, and the function of the apparatus will no doubt be readily followed; however, a brief description of the various items of equipment may be of interest.

The Horn-Type Arresters, the centre points of which are earthed, are directly connected to the external lines. A discharge to earth will occur should the voltage

of the telephone lines rise to about 3,000 volts or over, due, either to a "surge" or a direct contact with the power wires. In both cases the fuses on the telephone switchboard would blow and disconnect the apparatus from the external lines. Where a direct contact with high-tension wires occurs, the current through the horn-type arrester will probably rise to such a value that the telephone line will fuse and break connection with the high-tension system. The arresters are adjustable for any (approximate) voltage of from 3,000 volts upwards.

The *Isolating Switches* consist of copper links which can be withdrawn by means of a long insulated rod having a hook at the end. When the links are removed the switchboard is disconnected from the line, but the "horn" arresters, being "outside the links," are still in circuit as a safety gap to earth for the external telephone conductors.



Rear View of a Four-Line Switchboard

The *High-Tension Fuses* are specially designed for high voltage operation and will disrupt quickly. A discharge to earth through the carbon arresters will blow the fuses and disconnect the telephone from the high voltage.

Carbon Lightning Arresters consist of the usual arrangement of carbon blocks with a small air gap to earth. The design in this case, however, is somewhat special as the carbon blocks are so shaped and mounted that they tend to be self-cleaning as regards carbon dust. The arresters discharge to earth at about 1,000 volts.

The *Rare-Gas Arresters* are of similar design to the well-known "Vacuum" type, but are filled with rare-gas. Their inclusion in the circuit does not affect the transmission on the telephone lines,



Rare-Gas Arrester

but should the potential on the lines rise to over 250 volts, then a discharge to earth takes place in the usual way. In the Ericsson high-voltage telephone system they constitute an extra safety gap over the carbon lightning arresters.

Isolating Transformers. In order to ensure absolute immunity from personal injury through high voltage, the telephone instruments are so arranged that all external connections are made via the windings of special transformers. The insulation of the transformers is such that they will stand a coil-to-coil pressure up to 20,000 volts, and as the fuses and arresters ensure practically instantaneous disconnection of the external circuit, should high-voltage contacts or surges occur, it will

be appreciated that all risk of injury through shock is eliminated. The design of the transformers is such that the loss of efficiency in speech transmission is negligible.

Low-Tension Fuses are included on the "inside" connections of the transformers and, as in the case of the rare-gas arresters, they are an extra precaution to the high-tension fuses.

The Double-Pole Changeover Switches, which are of the quick make and break type, are for connecting the external lines to the various circuits; they are enclosed in metal cases which together with the operating handles are efficiently earthed.

The Telephone Instruments used in the main and sub-stations are the Ericsson all-metal magneto bridging type as shown at the left of the switchboard illustration. Bakelite moulded hand sets are provided and the cords are specially insulated to withstand damp and rough usage.



Portable Telephone for Tapping Points

Portable Telephones are provided for the use of linemen and patrolmen, and are of two types, namely:—

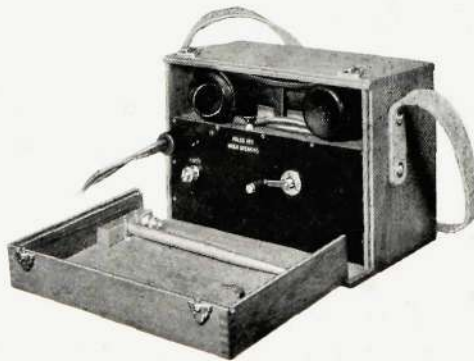
For use on telephone lines or tapping points where direct contact with high-voltage conductors is not possible, and a specially protected instrument, for use

on telephone lines running on the same poles as the power lines.

The former is contained in a leather case with carrying straps, and in order to make connection with the sockets fitted on certain poles, watertight plugs and heavily insulated cords are supplied. If desired, suitable instruments can be provided permanently fitted in weatherproof boxes for fixing to poles.

The latter instrument is specially designed to provide extra safety should the telephone conductors become raised to a high potential. To operate the instrument, connections are made to the telephone wires by means of long insulated rods built up from sections. The top section is fitted with hooks suitable for engaging the telephone wires and special high voltage low capacity fuses are also equipped in this section. The instrument is fitted with rare-gas arresters and a terminal is provided for earthing the case. Unless otherwise available, earth connection is made by

driving an earth rod into moist ground and connecting therefrom to the terminal on the set. This instrument is designed for safety under all conditions of working.



Protected Portable Telephone

Both types of portable telephones are provided with a moulded bakelite hand-set having a heavy rubber insulated cord.

In each Power Transmission Scheme the local conditions will naturally vary, and we shall at all times be pleased to prepare layouts and circuits to suit any requirements in this class of telephone engineering.