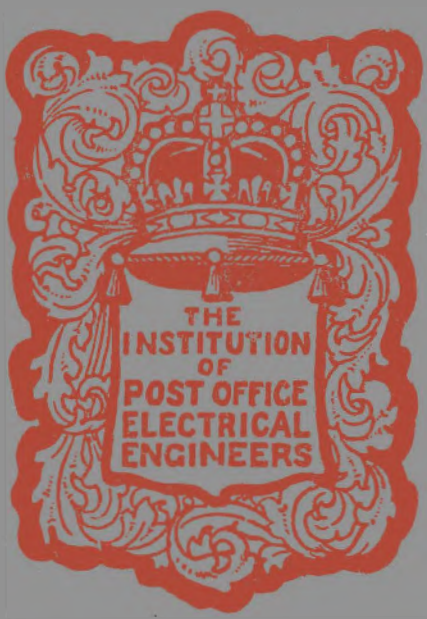
THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



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PORT OF LONDON AUTHORITY: PRIVATE AUTOMATIC BRANCH EXCHANGES.

By ALEC. B. EASON, M.A., A.M.I.C.E.

SECTION A.

THIS article gives a short description of the Port of London Authority's automatic telephone system throughout the various Docks and Offices. The automatic and manual equipment was manufactured to Post Office Specification upon plans and data furnished by Mr. G. F. Preston, C.B.E., M.I.E.E., and installed in 1925 by Messrs. Siemens Bros., Ltd., Woolwich. The following schedule gives briefly an outline of the general scheme:—

Name of P.L.A. Office or Dock.	Equipment for extensions Init.	Ult.	Manual positions provided initially.	Extensions dial out to public exchange.	Inc. calls received *via*
Head Office	200	400	8	Royal	Royal
Tilbury	60	100	1	Tilbury	Tilbury
London & Katherine's	70	120	Nil	Royal	Royal
India and Millwall ...	130	200	Nil	East	,,
Victoria and Albert...	160	250	Nil	Albert Dock	,,
Surrey Commercial ...	120	200	Nil	Hop	,,
Gravesend	Manual P.B.X. with a dial for dialling into the P.L.A. system.				

A detailed description is given of some of the special circuits used in the exchanges, but no attempt is made to describe the ordinary preselector and selector circuits which are of the standard Siemens No. 16 type as used for Swansea, Sheffield, Edinburgh, etc.

The allocation of lines and junctions between the various exchanges is shown in Fig. 1. The figures quoted against exchange lines and junction lines are only approximate; the precise number of channels to and from the public exchanges and

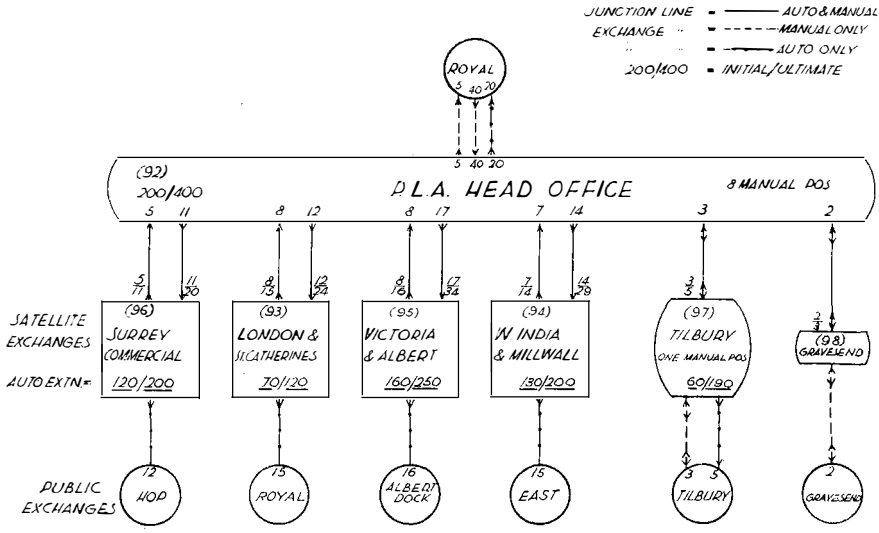

FIG. 1.—P.L.A. EXCHANGES AND TIE LINES.

between the P.A.B.X.'s will depend upon the requirements at a particular date. The figures given, however, show the general relationship between the various lines and extensions.

The multi-office numbering scheme differs from that used for public exchanges, in that only three figures need to be dialled for local calls, whereas five figures are required for inter-exchange calls. This scheme saves the provision of certain plant, and can be adopted because the persons using the telephone are all officials in the one organisation.

SECTION B.—TRAFFIC AND NUMBERING SCHEME.

The traffic to be dealt with falls under the following categories:

Outward calls, an extension calling the following:—

Type.	*Direction.*	*Type.*	*Level used.*
Local,	to an extension on same Exchange.	Auto	2, 3 or 4
Inter-Ex.,	to an extension on a Satellite.	ditto	92 to 97
,,	to an extension at Gravesend.	Auto-manual	98
Public,	to a member of the public, *via* a local or junction call.	ditto	0
,,	to a member of the public, *via* Trunk or Toll exchange.	ditto	91
Local,	to the P.L.A. manual board for an enquiry.	ditto	91

Incoming calls.

Incoming from the public; any type, trunk or local, etc.	to an extension at the Head Office or Tilbury.	Manual	The P. L. A. operator plugs into the extension line multiple on the Manual positions.
Ditto.	to an extension at a Satellite.	Manual-auto	The P. L. A. operator plugs into o/g junc. and dials the No. required.

The difference in procedure between day and night calls is described in Section C.

A typical numbering scheme, to give the above mentioned facilities is given below. This refers to Surrey Commercial Docks; at other exchanges the numbering is similar.

Level.	*Purpose.*
1	Spare: N.U. tone.
200—299	Extensions: Surrey Commercial: local calls.
300—399	,, ,, ,, ,,
4	Spare: N.U. tone.
5	,, ,, ,,
6	,, ,, ,,
7	,, ,, ,,
8	,, at Surrey Commercial. (At Tilbury, 8 calls Tilbury Manual board).
91	P.L.A. Manual board at Head Office.
92200—92599	Extensions at Head Office.
93200—93319	,, ,, London and St. Katherine's Docks.
94200—94399	,, ,, India and Millwall Docks.
95200—95449	,, ,, Victoria and Albert Docks.
96200—96399	,, ,, Surrey Commercial (when called from other exchanges).
97200—97299	,, ,, Tilbury Docks.
98	Gravesend manual P.B.X.
99	Spare: N.U. tone.
90	,, ,, ,,
0	Public Exchange.

If the caller wants some information, or some enquiry is to be made, the procedure at first is the same as for trunks; "91" is dialled and the PLA operator will give the required information.

The PLA operator can complete local calls to the extensions, if the caller finds it difficult to get the extension required; the caller dials 91 and asks the PLA operator to dial the number and complete the call for him; or the call can be completed later when the wanted extension becomes free. In the case of Head Office extensions the operator can repeatedly test the multiple jack, until she finds it free and can then plug in and call the line which has been busy, and then recall the extension which originated the call.

Incoming Calls from the Public System circulate either from Royal Exchange to the PLA Head Office or from Tilbury Exchange to the PLA, Tilbury Docks. At the Head Office manual board, the local extensions are multipled and if the call is for a Head Office extension the operator plugs in direct, no automatic plant being used for the call. For calls to the satellites the operator plugs into a disengaged line in the outgoing junction multiple of the inter-office junctions which radiate from the Head Office to the various docks. These junctions also come from the levels of the 2nd selectors and terminate upon 3rd selectors at the satellite exchanges.

The method of busying junctions so that a 2nd selector will not pick up a junction which an operator is using, and so that the operator will find the engaged test upon the outgoing junction multiple jack, if an automatic call is in progress is explained in Section E, dealing with a *bothway* junction. In that case there are four channels which have access to the one line, viz., auto extensions at either end, and operators at either end; anyone of these which takes possession of the line must busy it to the other three.

We shall discuss the handling of calls in more detail.

Local Calls circulate *via* 1st and 2nd preselectors to 1st selectors and then *via* final selectors to the required extension.

If the call is to a *satellite*, it reaches a 2nd selector at the Head Office, when 9 is dialled, and reaches a 3rd selector in the exchange required *via* a two-wire junction, or *via* a direct three-wire trunk in the case of calls to the Head Office when the 2nd digit is dialled: the remaining three digits of the extension wanted are then dialled and pick up a final selector and the required extension.

Calls to Gravesend are completed manually after the P.B.X. operator at Gravesend has been reached by dialling 98; the manual board taking the place of 3rd selectors at the other docks.

Local and Fee Junction Calls to the public can be made by dialling "0"; junctions from this level go direct to the relative public exchange and the public exchange operator makes the connection and meters the call, as in the case of an ordinary subscriber.

Trunk and Toll Calls to or from any extension must be dealt

with by the PLA operator so that the payment may be controlled, and the call when it matures may be circulated to the calling extension. As all inward traffic comes into the Head Office, except in the case of Tilbury, naturally outward trunk traffic must take the same route. The caller dials 91 and gets the attention of the PLA operator.

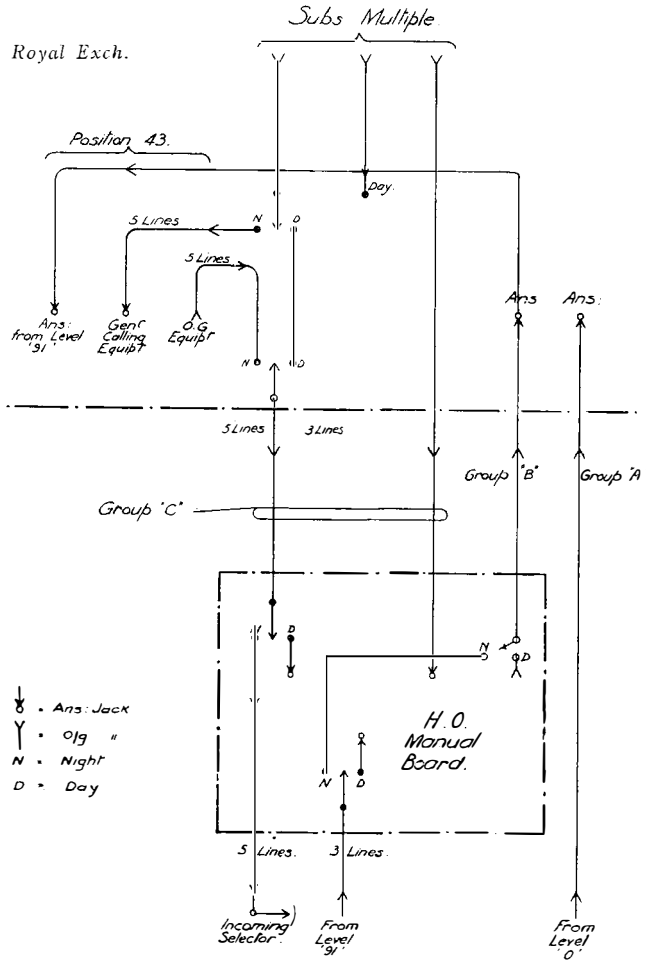

FIG. 2.—P.L.A. HEAD OFFICE LINES TO ROYAL EXCHANGE.

SECTION C.—NIGHT SERVICE ARRANGEMENTS. (FIG. 2).

The night arrangements at the Head Office and at Tilbury are similar and only those at the Head Office will be described. The main feature is that the P.O. operator at Royal will dial PLA extensions when the subscriber's PABX operators are not on duty.

The lines from the PLA to Royal Exchange consist of three groups, A, B and C.

Group A consists of lines carrying outward local and junction traffic from the Head Office extensions to Royal Exchange, obtained by dialling "o."

Group B consists of lines worked manually from the Head Office to Royal.

Group C consists of lines from Royal to the Head Office, several of which are switched to apparatus at night to carry night traffic.

An extension wanting a trunk call at night dials 91, as is done during the day, but the call arrives at a special position at Royal, having been transmitted over one of Group B lines to answering equipment on a special position at Royal. The Royal operator completes the Trunk call in the ordinary manner.

Calls being made to the PLA at night are put through on the subscribers' multiple as during the day, but as the lines are now intercepted the call is received on answering equipment at the special position in the same exchange, where the Department's operator can complete them by dialling into the PLA system. She plugs into special outgoing jacks at Royal which are connected to the lines of group C, arriving at PLA Head Office on incoming selectors: she then dials the five digits of the required extension number whether it be at the Head Office or at one of the Docks. The caller must be in a position to ask for the particular dock and particular extension number required.

Section D.—Plant and Traffic Routes at Tilbury Docks.

This exchange has one manual board and 60 extensions. The local calls are dealt with as in other exchanges.

The junction traffic is dealt with *via* three routes:—

1. *Via* "o" level circuits *to* the Tilbury Public Exchange.
2. *Via* manaul bothway junctions to and from Tilbury Public Exchange.
3. *Via* manual and auto junction lines to the Head Office for traffic in the PLA system.

There are three "o" level lines, which are not allowed trunk facilities. If an extension wants a trunk call, 8 will be dialled and the call will arrive at the PLA manual board. The operator will book and pass the call to the Tilbury Public Exchange over a bothway manual exchange line.

Incoming trunk calls to Tilbury Docks will come over the trunk lines to Tilbury Public Exchange and be passed *via* the bothway exchange lines to the PLA board.

When extensions require information from their own operator, they will dial "8," and the call will arrive at the manual board.

Fig. **3** shows, schematically, the grouping of plant at Tilbury.

The 60 auto extensions come to break-jacks on the manual board and thence to 1st Preselectors. The banks of 1st Preselectors go to 1st Selectors. On level 2 are the final selectors for auto calls incoming to auto extensions. Manual calls are connected direct *via* the break-jack on the manual board.

On level " 0 " is the auxiliary equipment for calling the Tilbury Public Exchange.

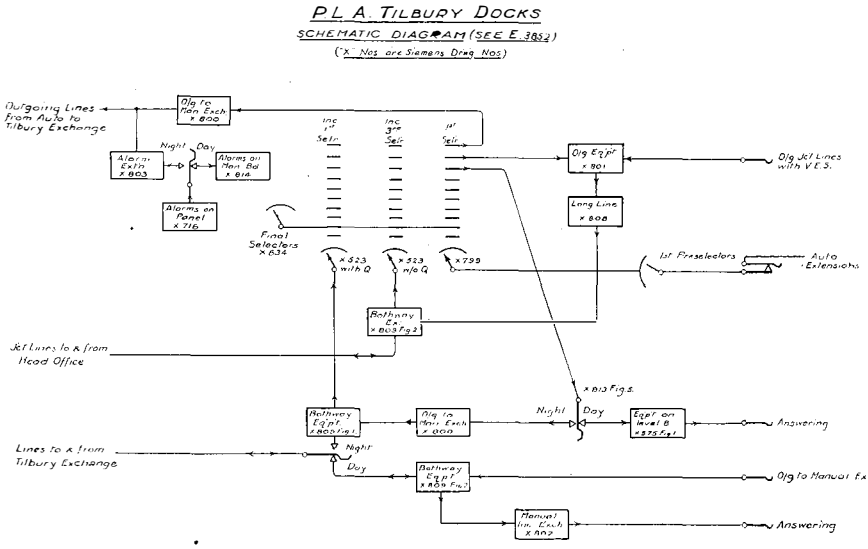

FIG. 3.—P.L.A. TILBURY DOCKS. SCHEMATIC DIAGRAM.

On level " 9 " is the equipment for calling the other PLA exchanges, *via* the tie lines: the manual board operator has access to these same tie lines *via* o/g jacks equipped with manual engaged signals. The bothway equipment busies the manual board jacks and relative bank when the tie line is being used for an incoming call.

On level " 8 " during the day, the call goes *via* auxiliary equipment to the answering jack on the manual board, and at night to the Public Exchange. (See below).

The exchange (manual) lines terminate on ordinary bothway equipment and answering jacks at the PLA manual board.

The traffic arrangements at night are as follows:—

The PLA operator before she leaves will throw night switching keys which

(1) Change over the manual exchange lines to (*a*) incoming 3rd selectors for incoming calls, and to (*b*) circuits from level 8 so that when extensions dial " 8 " for trunk

calls, the call will be received by a special operator in the public exchange who will control inward and outward calls for the PLA.

The routing is as follows: from level 8 *via* key to equipment for calling the public exchange, *via* bothway equipment to cut off the incoming selector *via* the other key to the public exchange.

Incoming calls come from Public Exchange *via* key and bothway equipment to an incoming selector.

The public exchange operator must dial the three figures of the extension number required.

(2) The night keys also throw over an alarm circuit so that faults occurring at night will give the alarm by lighting lamps at Tilbury Public Exchange instead of lighting lamps on PLA manual board.

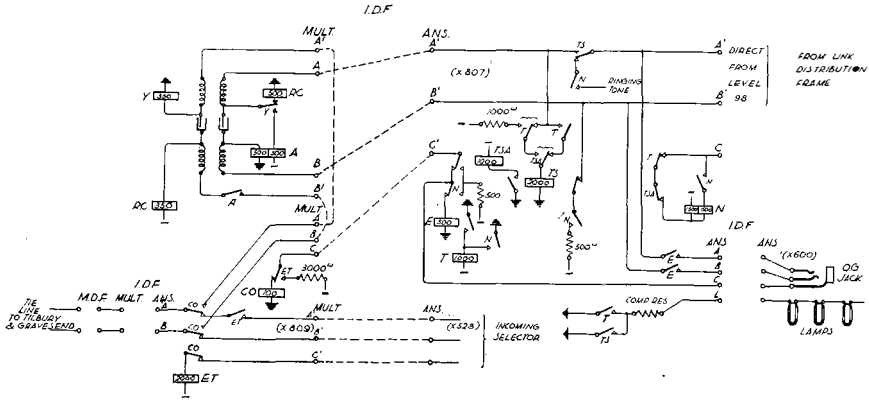

FIG. 4.—P.L.A. BOTHWAY EQUIPMENT ON TIE LINES. HEAD OFFICE.

SECTION E.—BOTHWAY JUNCTION LINE CIRCUIT.

The bothway junction line circuit between the Head Office and Tilbury or Gravesend is shown in Fig. 4. Its circuit operation is as follows:—

The Gravesend operator making a call takes possession of an incoming selector and dials the number required. The outgoing junction multiple and the banks of the 2nd selectors on level 98 are made busy so that the junction cannot be taken up simultaneously for calls from the Head Office to Gravesend.

The PLA operator making a call to Gravesend plugs in on the outgoing junction multiple, engages the banks on the level 98 and cuts off the incoming selector. Similarly, an automatic call to Gravesend will engage the outgoing junction multiple and cut off the incoming selector.

We shall first describe the operations for a *manual call* from the PLA operator to *Gravesend*.

(*e* = energised, *d* = de-energised, *h* = held, T′ = *via* a contact of T energised, ′T = *via* a contact of T unenergised or normal).

The operator plugs into the outgoing junction multiple

E *e* from the sleeve circuit.

CO *e* ,, ,, ,, ,,

T *e* *via* E and lights the visual engaged lamps and also cuts off battery from private of bank contact which is therefore busy.

The incoming selector is cut off at CO′.

A *e* in long distance equipment, by battery sent out on B line from cord circuit.

Battery is sent out on B line to Gravesend from the retard RC (350), *via* A′ and the Gravesend operator is called.

The Gravesend operator replies: and puts

Y *e* Battery on the A line and operates Y.

TS *e* Battery *via* A (500), Y′, repeater, A line, T′, ′TSA, TS (2000), earth.

TSA *e* *via* TS′.

TS joins the A line through to the cord circuit and extinguishes the supervisory lamp.

TS *h* Battery, 1000 ohm resistance, T′, TSA′, TS (2000), earth.

TSA keeps the battery from the private of the banks and keeps them engaged and TS keeps the visual engaged lamps alight.

The banks and outgoing junction multiple are thus kept engaged as long as either the Gravesend operator or the PLA operator has a plug in the line jacks.

Now consider the operations for an *automatic call to Gravesend* when the tie line is picked up automatically at the Head Office when someone has dialled 98.

The wipers of the 2nd selector wipe over the banks marked A′, B′, C′, and if the tie line be free, battery N (1500) operates the test relay.

N *e* the 2nd selector and relay N operates.

M *h* by earth on the private wire of 2nd selector.

T *e* *via* N′.

T lights the visual engaged lamps.

CO *e* Battery, 500 ohms, N′, ′TSA, ′ET, CO (100), earth.

CO cuts off the incoming selector.

N puts battery *via* 500 ohms on to B line and N puts ringing tone to the caller.

A *e* operates A.

A joins battery *via* RC (350) to the B line to Gravesend.

When Gravesend operator replies the actions of TS and TSA are as previously described.

The relays and retards energised during a conversation automatic call to Gravesend and supplied with battery from the Head Office are:—

Relay.	*Ohms.*	*Amperes.*
CO	500 + 350 ohms	0.0706
RC	350 + 23 + 800 line + 50 Gravesend	0.0490
A	500 + 23 + 500	0.0686
N	1500 + 1500	0.0200
T	1000	0.0600
TS	1000 + 2000	0.0200
TSA	1000	0.0600
Lamps,	150 (in circuit)	0.2500
	Say 0.60 Amp.	0.5982

Current will also be used in the 2nd Selector originating the call to Gravesend and Gravesend will supply battery *via* A wire to hold Y (350).

Now consider a call *from Gravesend.* When the Gravesend operator plugs in, battery on the B wire operates on a relay in the incoming selector: A relays pulls up V, which earths the C wire. This pulls up ET.

ET puts the A line through.

ET puts the engaged test on the *o/g* jack.

E *e* from ET and lights the visual engaged lamps.

T *e* from E, and engages the bank on level 98 by cutting off battery so that no auto call can be received.

Gravesend then dials in the ordinary way and the call will go through automatically to its destination.

During a call from Gravesend the current used is:—

Relay.	*Ohms.*	*Amperes.*
ET	2000	0.0300
E	3000 + 500	0.0171
T	1000	0.0600
Lamps	150	0.2500
		0.3571

Current used in incoming selector (X523):—

A	from Gravesend	
HA	500 + 23 + 800 + 50	0.0435
V	500 + 1000	0.0400
V	500 + 300	0.0750
RA	350 + 500	0.0706
T	1500	0.0400
		0.2681

Section F.—Alarms at H.O. and Tilbury.

When a fault occurs a lamp glows to indicate its position and type, and a pilot relay causes a lamp on the manual board to glow. The various faults are grouped under two headings, "urgent" an "non-urgent," and actuate either an "urgent" pilot or a "non-urgent" pilot relay. Fig. **5** shows the circuits which are used for extending the alarm to the manual board and the public exchange.

During the day any fault simply causes a lamp to glow on the manual board and the operator advises the maintenance staff of its occurrence.

At night time the existence of urgent faults is made known to the public exchange operator over a junction used ordinarily for traffic, but which can be taken up, if idle, by the fault signalling arrangements.

At night time the existence of non-urgent faults is not *signalled* to the public exchange.

If an operator wishes to find out whether or not a non-urgent fault exists, she can dial a particular number allocated for "faults," and if the number is busy a fault exists.

If everything is in order the operator would receive N.U. tone on that particular number: the busy condition is put on by the break in the C wire, due to operation of either H or B relays.

During the day the key is normal and the operation of a pilot relay lights the lamp on the manual board.

When the PLA operators leave the manual board the key is thrown. A non-urgent fault will then actuate H and put busy on the particular "fault" number.

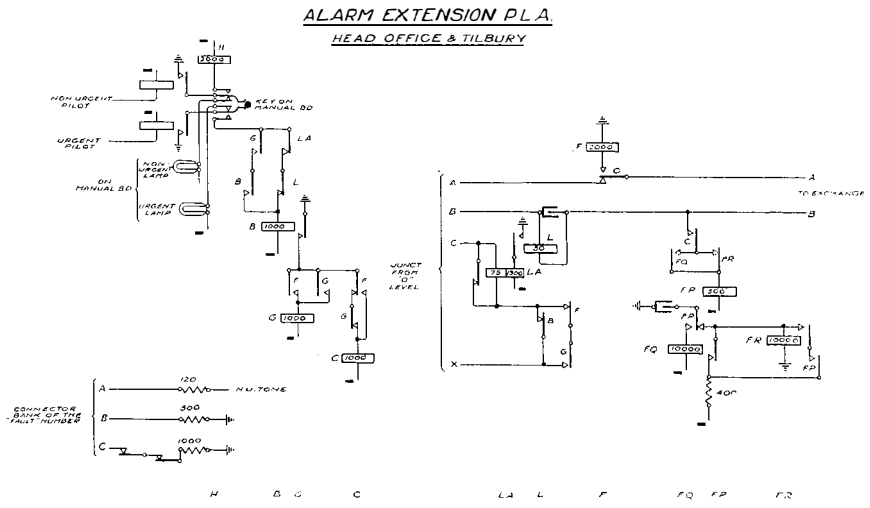

FIG. 5.—ALARM EXTENSION P.L.A. HEAD OFFICE AND TILBURY.

The circuit description of an urgent fault at night is as follows:—

(*e* = energised, *d* = de-energised, V = battery 'L = *via* L armature, normal, L' = *via* L armature operated).

Urgent Alarm. Fig. 5.

Assuming the junction to public exchange is idle.

B *e* V, B 1000, 'L, 'LA, contact of Alarm relay, earth B relay disconnects private of cct. allotted for fault discrimination at B' making it test busy to the operator when she tests.

C *e* V, C 1000, 'G, 'F, B', earth.
C relay disconnects A line to auto. equipment and connects the A line to F 2000.

FP *e* V, FP 500, 'FR, C', B line, Exchange earth.

FQ *e* By condenser charge.

FR *e* When FP is operated, relays FW and FR are operated alternately *via* FR', 'FQ and 'FR, FQ', thus giving an intermittent flash at the exchange.

F *e* When the operator answers she puts battery on the A line and operates F.

The lamp in the B side of the cord circuit will flash.
F relay brings in G relay.
G *e* V, G 1000, F′, B′, earth.
G *h* G relay locks itself; *via* G′ B′, earth.
C *h* C relay is now held *via* F′ instead of ′G.
When the operator withdraws her plug, the lamp flash stops because,
F *d* at withdrawal of plug
C *d* at ′F and this cuts FP off the B line.
The A line is re-connected to the Auto. equipment at ′C: and the junction is available for ordinary traffic.
Relay G is now held operated *via* G′ and B′.
Relay B is operated all the time the fault exists, *i.e.*, whilst the "urgent" Pilot Alarm relay is operated.
The operator can test if the fault is still on, by testing the predetermined extension number which will test busy whilst the fault exists.
Should the junction be engaged when the Alarm originates, then
L *e* *via* the junction loop
LA *e* V, LA 1300, L′, earth: now B relay cannot operate until the junction is free.

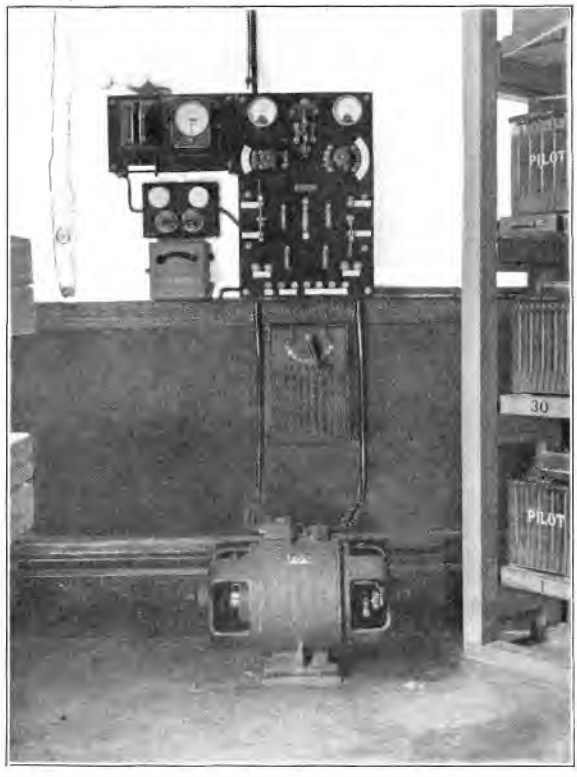

FIG. 6.—CHARGING PLANT AT SURREY COMMERCIAL DOCKS.

SECTION G.—POWER PLANT.

The Power Plant provided for the satellite exchanges is of the standard Post Office type. Fig. 6 shows the installation at Surrey Commercial Docks. It comprises (*a*) the charging machines con-

sisting of a 230-volt motor coupled to a generator giving 20 amperes at 60 volts with voltage regulation from 60 to 82 volts: (*b*) the charging panel, and (*c*) the ampere-hour meter which cuts off the charge when the requisite charge has been given to the cells. The pointer of the A*h* meter is set at a certain point by the officer who starts up the charging machine; when the full charge has been given to the cells, the pointer makes an electrical contact which actuates the no-volt release of the starter and the charging machine stops running.

In every exchange there are duplicate ringing machines, arranged so that if one fails to supply the current, the other machine will start up and supply the ringing current. The machines comprise (*a*) the ringer, (*b*) the interrupters for giving the busy back and number unobtainable tone, and (*c*) the interrupters for supplying impulses at 60 and 30 per second for driving the preselectors and selectors.

It is Messrs. Siemens' usual practice in small exchanges to provide one machine to give all the interrupted currents needed. In large exchanges they provide separate machines to give ringing interruptions and switch drive interruptions.

Section H.—Current Consumption.

This section gives the current consumption for some typical calls, during conversation period. Dialling and ringing periods are not considered.

Consider four types of calls from a satellite, say, Surrey Commercial Docks:—

(*a*) To Public Exchange, "o."
(*b*) To a local extension.
(*c*) To an extension at Head Office.
(*d*) To an extension at India and Millwall Docks.

Consider three types of call at the Head Office:—

(*e*) Incoming from the Public Exchange to Head Office extension.
(*f*) Incoming from the Public Exchange to a Satellite (IM).
(*g*) From a Head Office extension to a Satellite (IM).

The first selector supplies currents backwards to feed the calling extension: the amount of current fed forwards depends upon whether the current goes (*a*) to the Public Exchange, (*b*) to feed another extension, (*c*, *d*) over a junction line to the Head Office.

For (*a*) the exchange line is taken as 100 ohms, and relay to earth in cord circuit as 200 ohms, total resistance is 700 ohms (86 *m*A).

For (*b*) the extension loop is taken as 150 ohms, giving a total 850 ohms (70 *m*A).

For (*c*, *d*) the junction line resistance is taken as 100 ohms, giving a total 973 ohms (62 *m*A), with a 23 ohm repeater in series with 500 ohms.

The C wiper circuit differs in the various cases: for calls going outside the exchange the wiper has to find battery to prove that the junction is idle: battery through 1000 ohm, C wire resistance, is put on the private, which becomes earthed when a selector picks up the junction. For local calls the battery is supplied *via* the private wire of the final selector.

The ampere-hours for 2 minutes duration calls are thus:—

At	*a* SC to Ex.	*b* SC to SC	*c* SC to HO	*d* SC to IM	*e* Ex. to HO	*f* Ex. to IM	*g* HO to IM
Head Office	0	0	.014	.017	.010	.018	.021
Surrey Commercial ...	.013	.015	.012	.012	0	0	0
India & Millwall ...	0	0	0	.012	0	.012	.012