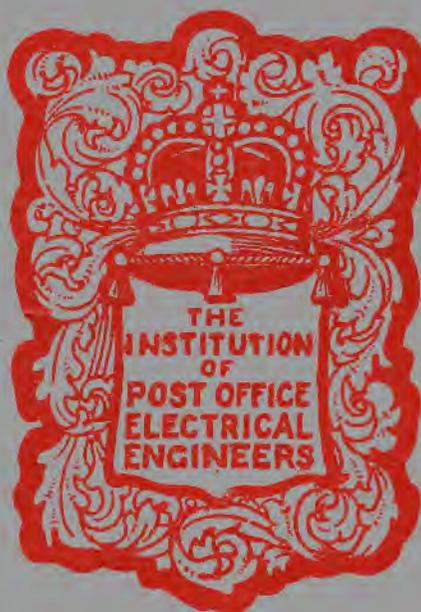


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ADVERTISEMENT INDEX
see page xii.

LONDON COUNTY COUNCIL AUTOMATIC PRIVATE BRANCH EXCHANGE.

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THE provision of Private Branch Exchanges operated by means of automatic switching equipment is rapidly emerging from the stage of novelty into the commonplace, and descriptions of particular exchanges where this method of working is adopted will probably soon suffer the common fate of papers which, while in themselves are more or less interesting, exhibit no outstanding features which may be considered worthy of inclusion in the pages of this Journal.



FIG. 1.—L.C.C. HALL.

In view, however, of the size and importance of the Automatic Private Branch Exchange which has been installed in the New County Hall of the L.C.C. at Westminster—this being the largest P.A.B.X. in the country—it is thought that a brief description of the equipment may not be considered superfluous.

The officers responsible for communication services of the Council considered that the many advantages of automatic working justified the recommendation for its installation in the fine new building (Fig. 1) which now houses the Council and its officers and staff, and negotiations were opened with the Department with this object in view.

As soon as the policy to adopt automatic working was decided upon precise details were obtained of the Council's requirements with regard to traffic and development, and these were incorporated in a specification prepared in the Engineer-in-Chief's Office. The order for the equipment was subsequently placed with the Automatic Telephone Manufacturing Co., of Liverpool, and the exchange was opened for service on September 8th, 1923.

L.C.C. AUTOMATIC PRIVATE BRANCH EXCHANGE.

The equipment provided comprises the following items of plant, viz. :—

Automatic switching equipment (Figs. 2 and 3).

Manual equipment.

Additions and alterations to the existing main frame, which is now a combined main and intermediate distribution frame.

Special apparatus rack.

Fuse board.

Test case.

Power plant, including two sets of cells, charging machine, ringers, power switchboard and fuse panels.

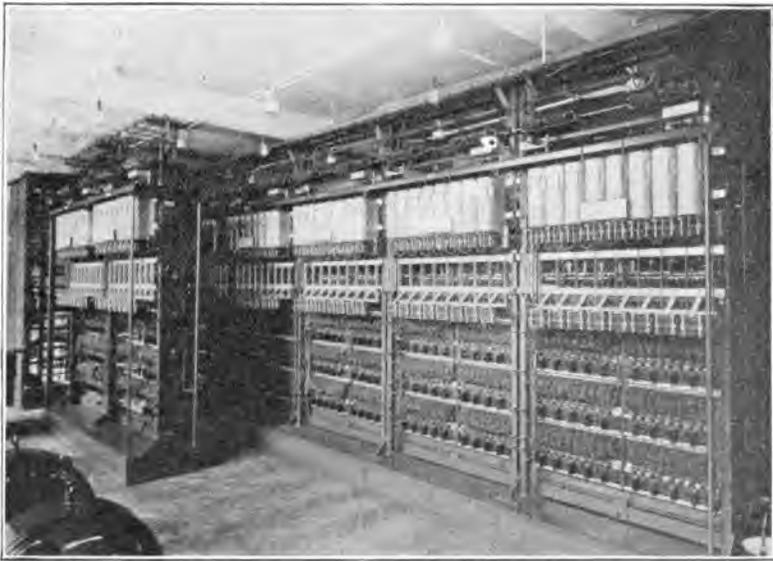


FIG. 2.

The equipment is located in the basement of the building in three rooms, containing respectively the automatic equipment and power plant, the manual board and the batteries.

Automatic Switching Equipment.—Seven 100-line units have been provided, 6 of which are equipped with 100 rotary pre-selectors, or line switches, and 1 with 50 pre-selectors.

These units are of the combined line switch and final selector type, the line switches being fitted on one side of each unit and the final selector switches on the other.

The 650 lines are divided into 2 groups, one for 350 extensions and the other for 300.

Each of these groups is provided with a suitable number of junctions or outlets to groups of first selector switches, which in turn are provided with outlets to the final selectors.

L.C.C. AUTOMATIC PRIVATE BRANCH EXCHANGE.

Standard traffic facilities, including dialling, ringing, busy and number unobtainable tones are provided.

A three-figure system was adopted for the initial equipment, the numbers allotted being 200 to 899, *i.e.*, the outlets from levels 2 to 8 inclusive of the first group selectors are taken direct to final selectors, and as the anticipated ultimate development is 900 extensions, provision will be made in due course for expanding the numerical scheme into a four-figure system in respect of the last 200 extensions. This will be effected by interposing second selectors in the outlets from level 9 of the first selectors, the outlets

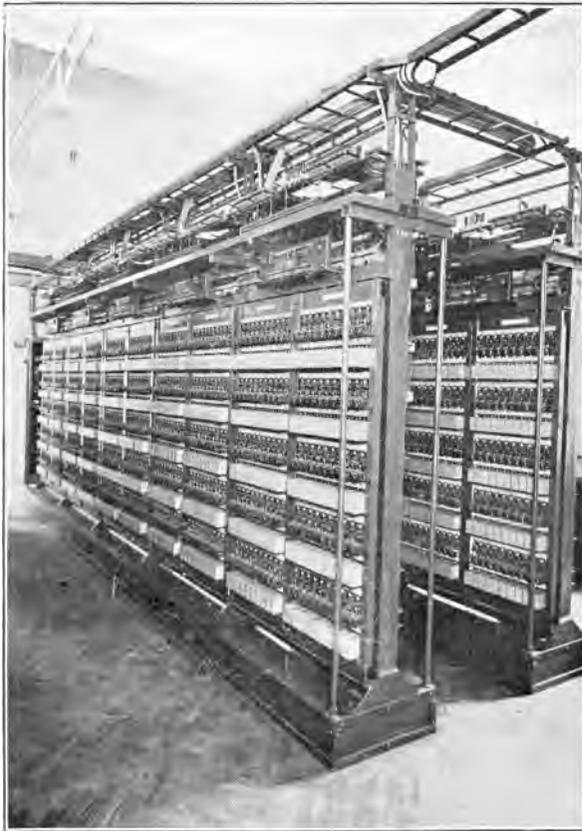


FIG. 3.

from levels 0 and 1 of these second selectors being wired to final selectors in the two last groups.

Manual Switchboard.—Automatic working at Private Branch Exchanges has not yet reached the stage where the P.B.X. manual operator can be dispensed with, although, in passing, it should be mentioned that the facility has recently been authorised whereby, under certain conditions, automatic extensions are enabled to

dial out direct to the public exchange for originating exchange calls.

For calls incoming from the public exchange, however, the retention of the manual operator is at present regarded as indispensable.

In the case of the L.C.C. P.A.B.X., both originating and incoming exchange calls are dealt with by the manual operator, and in order to operate these calls a multiple of the automatic extension lines is provided on the manual board, together with individual answering equipment. Provision has also been made on the manual board for 50 extensions to be worked manually.

The arrangements are briefly as follows:—

Incoming Exchange and Tie Line Calls.—These calls are dealt with by the P.B.X. operator, who completes them by ringing on a cord circuit, the calling plug of which is inserted in the multiple jack of the required extension.

Originating Exchange and Tie Line Calls.—These are dealt with by the P.B.X. operator.

When an extension desires to originate a call to the public exchange, or to the Tie lines, the digit "O" is dialled, and the call arrives at the manual board on individual answering equipment comprising a jack and lamp. The operator then answers and completes the call by means of a cord circuit in the usual manner.

The automatic equipment which has been taken into use for the call is released immediately the call arrives, as described later, and is thus free to deal with other calls.

Local Calls.—These are calls from extension to extension and are completed entirely automatically, thus affording the subscriber a rapid and efficient inter-communication service.

"Back release" facilities are provided for local calls, so that either the calling or the called extension may release the connection by simply hanging up the receiver.

Engaged Conditions.—The engagement of an extension line on a line switch, or on the final selector multiple, *i.e.*, for originating and incoming calls respectively, places the engaged test on the associated multiple jacks on the manual board. Similarly, the engagement of an extension line on the manual board places the engaged test condition on the associated contact in the final selector multiple.

The arrangements are such that the manual operator may plug into the multiple jack of an extension which is engaged on the automatic equipment without breaking down the connection on the automatic switch. This facility is afforded for the purpose of enabling the operator to offer an exchange or other call.

It has been previously mentioned that standard tones are pro-

vided, and as these are well known they will not be further described here.

On calls from the extensions to the manual board, the arrangements are such that the calling extension is able to release the connection, if desired, before the operator plugs in, and also that the insertion of the plug places the extension under the control of the operator and prevents the connection being released until the plug is withdrawn from the jack.

Through signalling is not provided between the extension telephone and the public exchange, *i.e.*, the manual operator controls the connection and the extension is able to flash in the operator.

Night Service.—The night service requirements are catered for by the provision on a small subsidiary manual switchboard as the main manual board is not continuously staffed.

A suitable number of exchange lines and certain selected extensions are connected to the subsidiary board, which is located in a position where one of the Council's staff is in attendance during the night and at week-ends.

Alarm Signals.—A system of alarm signals has been provided in order that the plant operating conditions may be efficiently supervised and to ensure that failures of plant may be promptly brought to notice. These alarm signals are extended to the manual board by the operation of switching keys, at times when engineering officers are not in attendance.

Circuit Operations.—The space at disposal does not permit of an exhaustive description of the circuit arrangements, but the essential features of a few of the fundamental circuits will be briefly reviewed (Fig. 4).

Rotary Line Switch.—Each extension line terminates in the exchange on a rotary line switch, and is also multiplied to its associated contacts on the final selector multiple. This switch functions as follows:—

1. Automatically rotates its wipers on to an idle trunk to a first selector.
2. Switches its wipers through to the idle trunk.
3. Closes the discriminating circuit.

The switch is arranged to remain on the outgoing trunk it last used, whether the trunk has been taken by another extension or not. When the extension removes the receiver to make a call, the extension line will be immediately extended to the outgoing trunk upon which the line switch wipers rest if it is idle. If, however, this trunk has been taken by another extension, the wipers of the line switch of the calling extension will be automatically rotated until they rest on the first idle trunk to a first selector.

When the receiver at the extension is removed, the line relay

L.C.C. AUTOMATIC PRIVATE BRANCH EXCHANGE.

operates, extending the rotary magnet circuit on to the private wiper *via* the operated contacts of the line relay and normal contacts of the B.C.O. relay.

The line relay operates a mechanical link or latch, which normally forms a stop to prevent the full operation of the B.C.O. relay. The B.C.O. relay is therefore left free to operate fully as soon as an idle trunk is found.

If the wipers are resting on a busy trunk, the private wiper finds earth on the private bank contact. The B.C.O. relay is therefore shunted and a circuit is closed for the rotary magnet which operates, opening its own circuit at the rotary interrupter

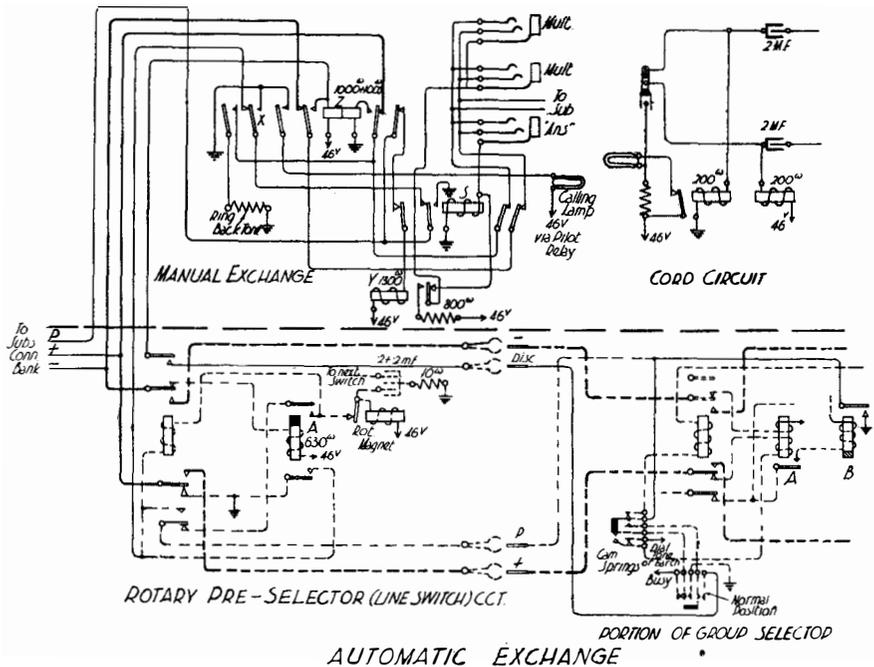


FIG. 4.—L.C.C. A.P.B.X.

springs. In falling back it moves the wipers on to the next trunk. If this trunk is also engaged, the above cycle is repeated until an idle trunk is found.

If the wipers are resting on an idle trunk, or as soon as an idle trunk is found, as explained above, the private wiper does not find earth and the B.C.O. relay is therefore not shunted, but operates to close the line wiper circuit, switching the extension line through to the outgoing trunk and connecting the discriminating wiper to the special service trunk.

The B.C.O. relay also disconnects the line relay, but this relay, being slow to release, maintains the earth on the winding of the

B.C.O. relay until earth has been placed on the release trunk by the switch ahead.

This earth "busies" the trunk on which the wipers stand, and thus prevents another line switch from using that trunk; it locks up the B.C.O. relay during the whole period of the call, and it places the busy condition on the contacts of the calling extension in the final selector multiple, thus busying the calling extension to other extensions.

When the switches ahead are released, the B.C.O. restores. The line switch wipers, however, remain on the bank contacts of the trunk, but this has no effect since the extension line is broken at the contacts of the B.C.O. relay. The trunk may be used again by the same extension, if in the meantime it has not been taken into use and thus made busy by another extension.

When an extension is called by another extension, the final selector places earth on the private bank contact and also on to the B.C.O. relay of the line switch of the called extension.

The B.C.O. relay is energised, but owing to the mechanical link or arm previously referred to it does not operate fully, but breaks its normal contacts without making, or closing, its operated contacts. The called extension line is therefore not extended to an outgoing trunk, as would have been the case if the B.C.O. relay had fully operated.

First Selector and Final Selector.—When the line of the calling extension has been extended to an idle trunk to a first selector, the subsequent operations of the first and final selector, due to dialling, are the standard automatic operations, but special provision has been made to enable the extensions to call the manual board, by dialling "O," and to be called by the telephonist for incoming exchange or tie line calls.

On a local call, the earth placed on the release trunk by the selector energises relay Y on the manual board, *via* the operated contacts of the extension's B.C.O. relay and the normal contacts of relays Z and S. Relay Y operating places battery *via* its operated contacts on to the bushes of the calling subscriber's multiple jacks, thus providing engaged test conditions.

When an extension calls the manual board by dialling "O," the first selector wipers are stepped up to the tenth level. As all the private contacts in this level are permanently earthed, the wipers will be automatically rotated to the eleventh step, where the following circuit is closed through the normal post springs on the eleventh step cam springs:—

Selector release trunk—earth—operated contacts of the 11th step cam springs and of normal post springs—discriminating trunk—extension's line switch wiper—operated contacts of B.C.O. relay—one winding of relay "Z" to battery.

Relay "Z" therefore operates and performs the following functions:—

- (a) Disconnects extension loop from the automatic switches, and places its own winding across the extension line. The automatic switches restore immediately the loop is broken.
- (b) Places "ring back tone" on to the extension line.
- (c) Lights calling lamp associated with answering multiple jack.
- (d) Places busy earth on the extension private bank contacts of the extension to busy the extension to other extensions.
- (e) Disconnects the calling extension B.C.O. relay in order to take earth off the release trunk. This earth would otherwise busy the trunk upon which the line switch wiper is resting.

The calling lamp glows while the extension is on the line owing to relay "Z" being maintained in its operated position by the extension line loop, but should the extension restore before the telephonist answers the connection will release and he will then be free to make another call.

On seeing the extension calling lamp glowing, the telephonist inserts the answering plug into the answering jack of the extension, thus placing the engaged test battery on the bushes of the extension multiple jacks, to busy the line on the manual board.

The calling extension loop completes a circuit for relay "A" of the cord circuit. Relay "A" energises and disconnects the answering supervisory lamp circuit. The cut-off relay "S" is also operated by the battery on the sleeve of the answering cord to perform the following functions:—

- (a) Places earth on the private final selector bank contacts to busy the extension line to other extensions.
- (b) Keeps the extension's B.C.O. relay disconnected.
- (c) Disconnects the extension loop from the windings of relay "Z," which therefrom restores. When relay "Z" restores, it disconnects the calling lamp circuit and the "ring back tone" circuit, and allows the extension line switch to restore to normal.

The telephonist now completes the call manually. When the extension hangs up the receiver at the end of the conversation, relay "A" in the answering cord circuit restores and causes the supervisory lamp to glow.

Manual telephonist calls the automatic extension.

A. *Extension line disengaged.*—After having tested and found the extension line disengaged, the telephonist inserts the

calling plug into the multiple jack and calls the extension by operating the ringing key.

The insertion of the calling plug into the multiple jack places the cord sleeve battery on to the bushes of the other multiple jacks, to "busy" the extension to other telephonists. The extension's cut-off relay "S" is also energised in order to:—

1. Disconnect the extension line from the automatic apparatus.
2. Place busy earth on to the extension's private final selector bank to busy the extension to other extensions.
3. Disconnect circuit of relay "Y" to prevent it from operating unnecessarily.

B. *Extension line engaged.*—Should the telephonist find, upon testing the called extension line, that it is engaged on another call, she inserts the plug into the called extension multiple jack and offers the call.

If the extension should be engaged on an automatic conversation, the telephonist requests him to hang up his receiver, when the automatic switches immediately release, and as soon as the earth on the extension private final selector bank contacts is removed by the release of the automatic final selector switch, relay "Y," which has been operated on the automatic call, immediately releases. Relay "Y" releasing, completes the circuit *via* its back contacts to the extension's cut-off relay "S," which now energises from battery on the sleeve of the cord circuit. Immediately relay "S" operates, the extension line is disconnected from the automatic equipment. The telephonist will then recall the extension by operating the ringing key.

Should the called extension be engaged on another exchange call, *via* the manual board, and decide to take the call now offered, the telephonist asks him to hang up his receiver and she immediately communicates with the telephonist controlling the existing call and asks her to take down the connection. Then the telephonist, controlling the offered call, recalls the extension and completes the connection in the normal manner.

The writer is indebted to the A.T.M. Coy. for the loan of the blocks illustrating this article. The circuit diagram is a composite one and has been included in order that the foregoing circuit descriptions may be more easily followed.

It should be mentioned in conclusion that the release of the automatic equipment immediately on the arrival of an originating exchange call at the manual board is not now insisted upon and, under certain conditions, contractors are permitted to arrange their circuits for the release of the automatic equipment when the operator plugs in.