CURRENT COMMENTS

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Melbourne City West Exchange

MELBOURNE, the capital of the State of Victoria, and one of the principal cities in the Commonwealth of Australia, is served by upwards of fifty telephone exchanges. These operate within a single-fee network which covers an area defined by a 15-mile radius from the General Post Office. Of the 93 000 lines that are connected, a large proportion are operated on an automatic basis, but until recently complete modernisation had not reached the lines within the business part of the city, these remaining connected to a central-battery manual exchange. In modernising the service within the business area, revised layouts were prepared on the basis of two sections having approximately equal areas and termed City West and City East respectively, each to be served by an automatic exchange. City West exchange was selected as the first to be installed, whilst the lines ultimately to be connected to City East exchange remain connected to the existing manual switchboard. The order for the equipment for City West was placed with The General Electric Co. Ltd., through The British General Electric Co. Pty Ltd., of Australia, and was executed to the specification of the Postmaster-General's Department.

The exchange is equipped for 6 000 lines, has a final selector multiple for 7 000, and is the largest in the Melbourne network. Subscriber's uniselectors give access to the common switching equipment, in which all two-motion selectors are of the B.P.O. Type 2000.

The use of uniselectors was the result of careful deliberation involving studies of traffic figures and of probable maintenance requirements of both uniselectors and linefinders. The cost of the line switching stage when uniselectors are employed is fixed for an exchange of given capacity because, whatever the traffic may be, there is always a uniselector per line. With linefinders, however, the cost is variable because the number of finders per group of 200 lines depends upon the traffic. A high calling rate means a large number of finders, the cost of which may exceed the cost of the alternative uniselectors. At City West, the average calling rate per line in the busy hour is O.1 TU, a high figure at which uniselectors are more economical than linefinders. A further argument in favour of uniselectors was the occurrence of seasonal peaks of traffic, provision for which is more economically made by the use of uniselectors.

Yet a third argument was the fact that the Company had completed and proved a new design of uniselector This switch itself is described later but it may be said here that its dimensions are such that 25 mount in the standard rack width of 4′ 6″ instead of the usual 20. With B.P.O. Type 600 relays employed, 300 line circuits are accommodated on a rack 10′ 6½″ high.

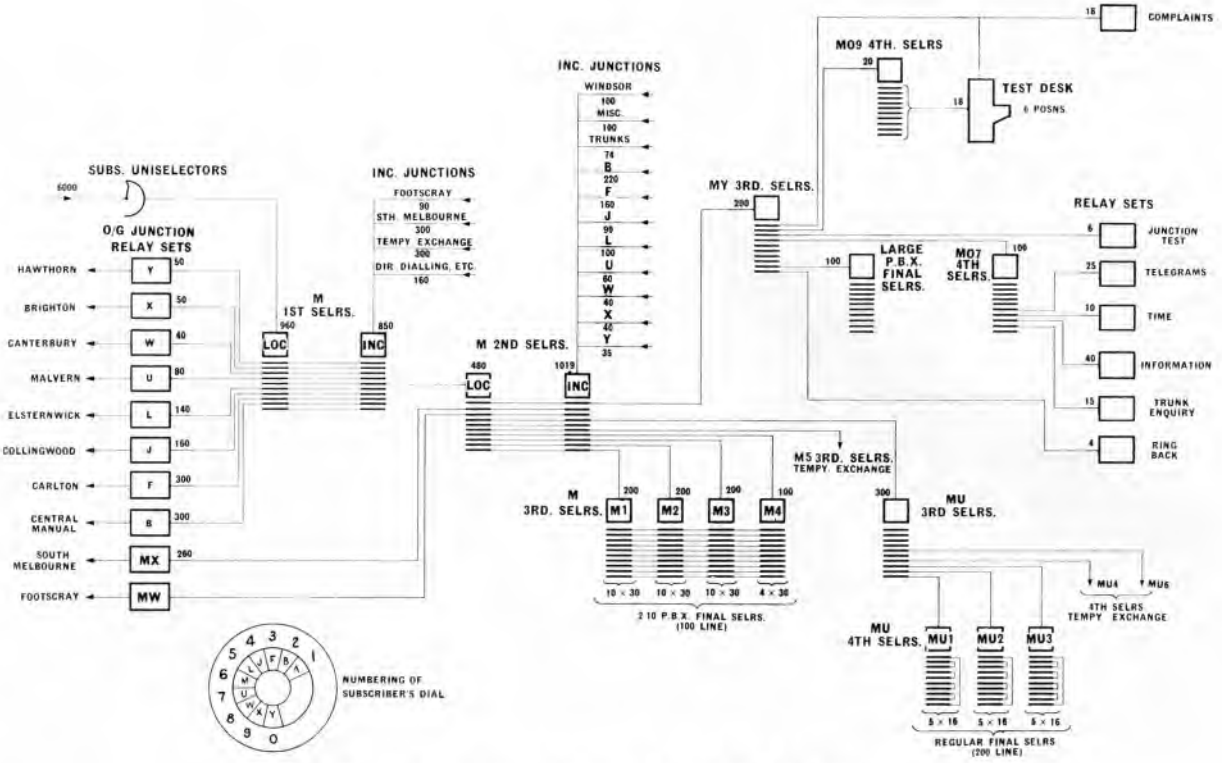


Fig. 1.—Trunking diagram, City West Exchange.

Equipment and Trunking

The equipment installed consists of :—

6 000 Subscriber's line circuits.
4 974 Group selectors.
240 Regular final selectors.
1 120 P.B.X. final selectors.
1 530 Outgoing junction relay sets.

This is arranged as shown in the trunking diagram given in Fig. 1.

It has long been the practice in Australia when planning the conversion of a city exchange to automatic working to identify it by a letter, which then forms the first digit in the numbers on the exchange. If necessary, two such initial letters have been allotted. This makes use of the well-known fact that a telephone number consisting of a letter and say, four numerals is easier to read from the directory and to memorise for dialling than one consisting entirely of numerals. In the Melbourne area, City West exchange is allotted the letters *M* and *MU*, whilst its two satellite exchanges —Footscray and South Melbourne—are allotted the letters *MW* and *MX* respectively

From the trunking diagram, it will be seen that regular subscribers' lines are numbered *MU1000* to *MU3000*, with provision for extension up to *MU8000*. To give this capacity, a rank of 4th selectors is included. Numbers in the series *M1000* to *M4000* are allotted to 2/10 P.B.X. subscribers, calls to these subscribers being completed via 1st, 2nd and 3rd group selectors. Special provision is made for the larger groups comprising more than ten P.B.X. lines. These lines are connected to special P.B.X. final selectors which ter-

Fig. 2.—Exchange building.

minate ten lines on each level, with suitable grading to serve the number of lines included in the groups. The groups are numbered *MY210, MY220,* etc., the last digit in each number being ineffective (by virtue of its absorption by the A relay) and included only to maintain five-digit numbers. Special services are numbered in an *MO* series as shown.

Much of the traffic at Footscray and South Melbourne is outgoing and therefore all calls are routed to 1st selectors at City West. These accept the first digit dialled on a call and extend the call to another exchange or to 2nd selectors in City West, whence the call may proceed to a subsequent rank or back to the originating exchange for a local connexion.

Incoming junctions from other automatic exchanges terminate on 2nd selectors, the first digit dialled being used at the originating exchange to route the call to City West. Incoming junctions from the manual exchanges of Windsor and Trunks also terminate on second selectors because, since the operators have direct junctions, the first digit, *i.e.*, the exchange selection digit, is not required.

Group selectors of the 200-outlet type are used in all ranks except the *MO7* and *MO9*, where the traffic does not necessitate more than ten outlets per level. Regular final selectors are of 200-line capacity, and of the 20 banks provided per 200 lines, 16 are equipped with switches. P.B.X. final selectors are of 100-line capacity, and 40 banks and 30 switches are provided per 100 lines.

A group of first selectors, consisting of 240 switches, is offered the traffic from 1 500 line circuits, the grading permitting an even distribution over the group. Four groups thus serve the initial 6 000 lines. Outlets from the 1st selectors are graded into auto-to-auto outgoing junction relay sets. The number of these sets installed is indicative of the extent of the junction working with which City West is concerned.

Building, Layout and Cabling

The building accommodates the City West equipment on three of its eight floors, with the charging machines in the basement. The manual board for the Melbourne area is to be installed on the fifth floor, with its associated switching equipment on the floor beneath. The floors are of mushroom construction, giving the feature, particularly welcome from the point of view of the installer, that the ceilings are clear of the impediments to good cabling that frequently occur when other forms of construction are employed. Mushroom

Fig. 3.—Group selector racks.

construction dispenses with I-beams and employs instead rod reinforcement branching radially from the floor columns.

The layout of the equipment on the three floors approaches the ideal, permitting as it does inter-rack cabling to follow progressively the routing of a call. The M.D.F is located on the ground floor, with the I.D.F immediately above on the first floor The cables between the frames pass through holes prepared in the floor at points between pairs of uprights. The uniselectors and final selectors adjoin the I.D.F., whilst 4th selectors are next to the finals, and are themselves adjacent to the 3rd selectors. The meters, too, are on this floor, adjacent to the I.D.F On the second floor, the 1st selectors (local and incoming) have as neighbours on one side the outgoing junction relay sets and on the other side the 2nd selectors. If this description of the layout be read with reference to the trunking diagram the simplicity of the layout will be appreciated.

The runways for carrying the cables between racks are of special design introduced by The G.E.C. some time ago to facilitate erection and to ensure that local conditions are met more satisfactorily than is generally the case when complete runways are made in the factory They consist of tyre-section runners in which slide nuts for the fixing screws that secure the cross straps. The straps may thus be fixed in any position to suit the cable runs, bends and drops without the need for drilling the runners.

*Uniselectors, G.E.C Code No. C.*3100.

Mention has already been made of the fact that a new rack was designed to carry 300 line circuits. The uniselector employed in the line circuit is illustrated in Fig. 4, and represents the latest technique in rotary-switch design. It is a development of the original standard of the British Post Office and is free of those features which years of experience with the original had shown it was desirable to eliminate. Although these are minor, their removal results in a better switch and, since additional features have also been incorporated, the new uniselector is an improvement in almost every respect. It is similar in appearance to its predecessor but its reduced dimensions result in mounting centre of $1\frac{3}{4}''$ instead of 2" Only one operating coil is employed and this is included in a magnetic circuit of higher efficiency, which means that the permissible voltage limits for a given nominal voltage

Fig. 4.—Uniselector, Code C.3100.

are wider The knife-edge suspension of the armature is adjustable to provide more positive adjustment of the armature stroke than was obtainable with the previous design, in which the operating coils themselves had to be moved to adjust armature travel.

Traffic Recorder

In any exchange a precise knowledge of traffic figures is essential if the highest occupancy of circuits is to be assured. In City West, this was felt particularly keenly in respect of junction working, and an automatic traffic recorder was specified as part of the equipment to be provided. The recorder is applied to incoming and outgoing junctions and all the selector ranks. It is arranged to measure simultaneously traffic into and out of each rank of selectors and thus to give an indication of the efficiency of the switching system.

Circuit Features.

Many of the circuit features are standard. For example, the transmission bridge incorporates ballast resistors in the feed to the called party , tones are fed to the calling party by means of a third winding on the balanced A relay , positive battery metering is employed, etc. There are, however, a number of circuit features of special interest , these are described under the following headings.

Line Circuit.

The line circuit conforms to the practice, which is general in Australia, of arranging for the uniselector to step over open outlets and also, when all outlets are busy, to step to the last contact and return busy tone. As a result of this last feature, wear on the uniselector is reduced because it does not continue to rotate at times when all outlets are engaged, and a positive indication is given to the subscriber that for the moment a call cannot be completed. The number of available outlets is, of course, reduced to 23, but this is considered to be more than offset by the advantages of the arrangement.

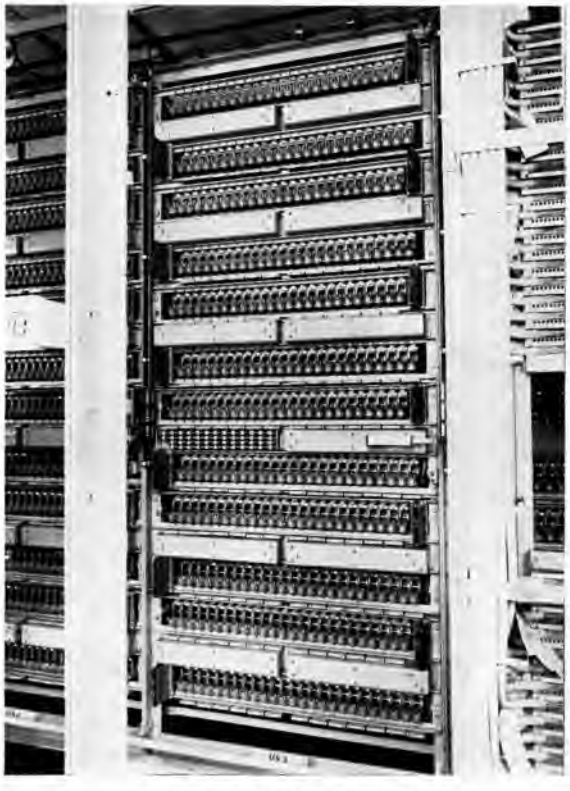


Fig. 5.—Uniselector rack.

Fig. 6.—Uniselector racks.

Outgoing Junction Relay Sets.

A through call to another exchange may take into use as many as three outgoing junction auto-to-auto relay sets, which are then required to operate in tandem. To meet this condition a special circuit was evolved, using ballast resistors, an A relay of high impedance and low resistance, and a dry-plate rectifier across the shunt-field relay, together with other measures calculated to result in a circuit capable of efficient operation over the range of junction resistance encountered in the area, without the need for special adjustment in individual cases.

In anticipation of the conversion of manual exchanges to automatic operation, certain relay sets at present designed for auto-to-manual working are arranged for ready conversion to auto-to-auto working.

Special Service on Faulty Lines

Equipment is provided to maintain service on faulty lines. On a line which is disconnected on one side, service is given by connecting the open line to earth at the subscriber's premises and plugging an auxiliary relay set into the faulty line, which thus becomes a single-wire earth-return circuit. On a short-circuited line, service is given by opening one side of the line at the exchange and earthing the line at the subscriber's instrument.

Dialled impulses are received over one wire of the line, which is so plugged up that the auxiliary relay set is connected to the sound wire. Relay A in the relay set repeats the dialled impulses to the exchange equipment.

When calling from the exchange, the ringing condition closes a ringing circuit to the subscriber's line over the sound wire.

Ring-back Relay Set.

Relay sets are installed to provide revertive calls on two-party lines. A subscriber wishing to make such a call dials the ring-back number *MO1* and then replaces his handset. Connexion is established from a 3rd selector to a relay set, which then feeds ringing current to the line. Both bells ring and the calling party waits for cessation of ringing, which denotes that the called party has answered, before lifting his handset again. Battery feed is supplied by the relay set.

Centralised Observation Circuit.

This circuit enables observations of subscriber's service to be made at City West for the Melbourne area. Up to twenty line-tapping circuits are associated

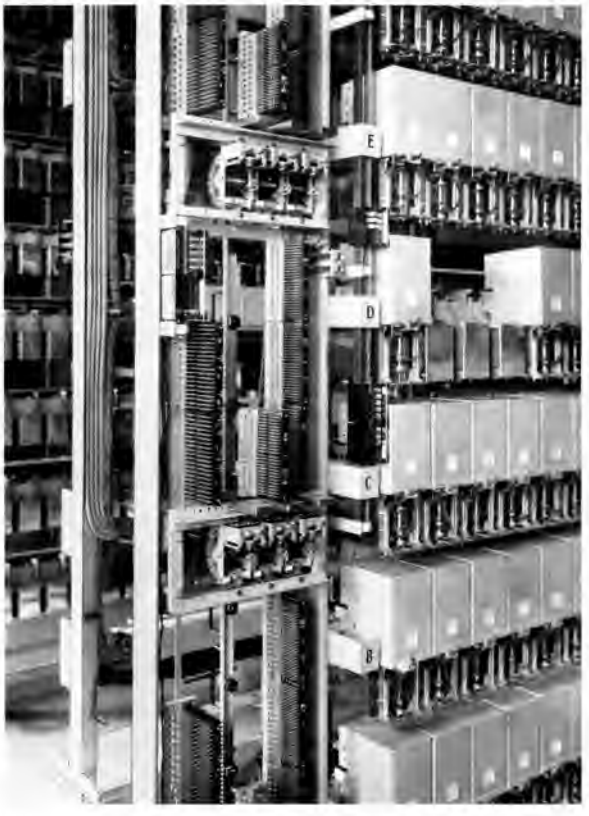


Fig. 7.—1st Selectors with traffic-recorder access equipment.

with a common 4-wire junction circuit. A call is indicated by means of lamps on the centralised position, together with an indication of the particular line-tapping circuit in use, and means are provided for the observation operator to listen in on the call. Any number of junctions may be connected to a central position but as only one at a time can be observed, any junction, after the indication has been given that a call is in progress, will be released unless the observing equipment is free at the time the call is originated.

When a junction is seized by an outgoing call, the call lamp at the observation equipment will glow if the indicating equipment is free. The equipment at the originating exchange transmits impulses to the observation centre, where a lamp glows to indicate the line-tapping circuit on which the call has originated.

The impulses dialled by the subscriber are transmitted over the junction and indicated by means of lamps on the observation position. By operating the observation key, the observer may listen-in on the conversation at any time. The call may be released right back to the line-tapping circuit by means of the release key If the circuit is found to be faulty, the hold key is operated and the circuit thereby held until the maintenance officer at the exchange concerned is advised and the call taken over by him. Any junction can be cut off the position by means of the isolation key

Centralised Interception Circuit.

Subscriber's lines can be intercepted at the M.D.F and incoming calls extended to a central position.

Calls outgoing from an intercepted line are connected to the exchange equipment via an impulse repeating circuit.

An incoming call for an intercepted line is extended to the centralised interception position if the position is free, and the call is indicated by means of a lamp. If the junction is already in use, busy tone is given to the caller

The interception operator ascertains the requirements of the caller and deals with the call in one of two ways :—

(*a*) By operating the "through" key, the call is then connected through to the called subscriber's line and the junction made free.

(*b*) By operating the "lock-off" key to release the interception and junction circuits, pending the release of the connexion by the caller

Test Desk Circuits.

(a) Measuring weight, speed and number of impulses from subscriber's dials.

These tests are made by means of circuits that produce readings on the test desk voltmeter, which is fitted with additional appropriately-calibrated scales. The voltmeter is thus common to all the tests, the appropriate circuit conditions for any test being established by the operation of keys. These conditions are shown in the diagrams to which reference is made in the following descriptions :—

The impulse-weight circuit (Fig. 8) is used for measuring percentage make ratio of the received impulses. The value of the shunt resistance RW3 is arranged to permit a deflection of 100 on the appropriate scale when 46 volts are applied.

When a line is connected to the test circuit, RX is varied until the voltmeter gives a full deflection, this corresponding to 100 per cent make. The dial of the subscriber's telephone is held off-normal whilst the voltmeter is being set, to avoid the incorrect reading that would otherwise be obtained. The reset key is next operated momentarily and this removes the shunt from relay AW and resistance RW4. Relay AW operates and the additional resistance introduced moves the voltmeter pointer to a position corresponding to 30 per cent make, thereby reducing the movement of the pointer during impulsing and enabling a steady reading to be obtained sooner than would be the case if the pointer had to drop from a full-deflection position.

With the receipt of the first impulse, relay AW releases and the deflection is then dependent upon the average current in the voltmeter circuit during impulsing, which

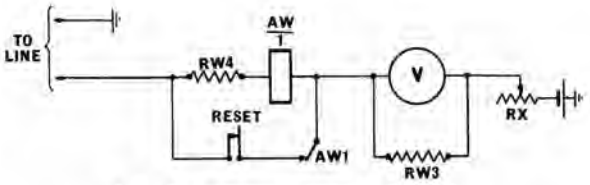


Fig. 8.—Impulse-weight circuit.

is directly proportional to the impulse weight, *i.e.* since a full scale deflection corresponds to 100 per cent make, a deflection of 33 will correspond to 33 per cent make. During the impulse train the pointer therefore moves to a position corresponding to the make ratio, which is read directly from the voltmeter scale.

The impulse speed circuit (Fig. 9) is arranged so that the value of resistance RS2 and the capacity of condensers QA and QB give deflections on the appropriate voltmeter scale in accordance with the impulse speed when RX is adjusted to give 46 volts. The value of RS3 is determined in conjunction with the voltmeter to give a deflection of 10. The adjustment of relay CS is such as to prevent surging when relay AS releases for the first impulse in the train.

When the dial circuit is closed, relay AS operates and releases relay CS. Contact AS1 charges condenser QA. When relay AS releases, condenser QB is charged. The discharge from both condensers is passed through the shunted voltmeter, condenser QA discharging while QB is charging and vice versa. The charging of QA and QB may be assumed to be instantaneous processes and therefore quite independent of the impulse weight. The discharge is also independent of the impulse weight, provided the time constant is such as will permit the discharge to be effected in a few milli-seconds.

For a train of 10 impulses, the quantity of electricity discharged is constant, but the average current due to the discharge is proportional to the rate of impulsing, *i.e.* it depends upon the time interval in effecting the discharge, which in turn depends upon the rate of impulsing.

In the impulse counting circuit (Fig. 10) a uniselector is employed to count the impulses and to vary accordingly the shunt across the voltmeter With the adjust key operated and resistor RX suitably set, a deflection of 11 is obtained on the scale. The resistor remains at that setting and the adjust key is released. Receipt of the impulses steps the uniselector and the shunt it applies governs the voltmeter reading.

(*b*) *Release of Switches Held by Faulty Lines.*

This circuit is associated with the test circuit and enables the test clerk to release a switch held by a faulty line.

The line under test is dialled in the usual way over the test distributor and final selector If the voltmeter test indicates that battery-feed relays are across the line, the circuit is challenged and if no response to verbal enquiry is obtained, the release

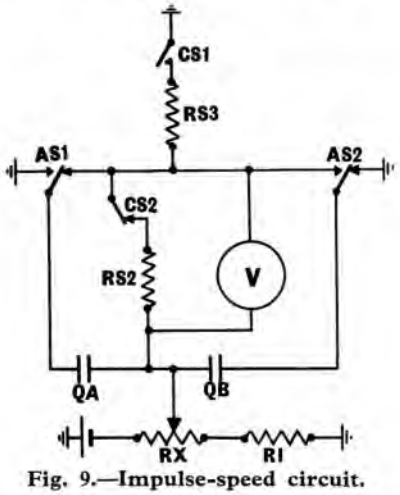


Fig. 9.—Impulse-speed circuit.

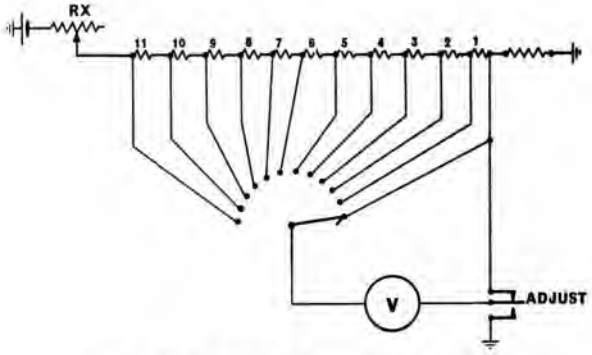


Fig. 10.—Impulse counting circuit.

key is operated. Earth is connected to one side of the line under test, whereupon the earth-connected winding of relay A in the selector is short-circuited. A booster battery of approximately 54 volts is connected to the other side of the line via the low-resistance winding of relay A in the release circuit. This battery causes a slight reversal of current in the battery-connected winding of the selector A relay, which consequently releases. Relay B in the selector is also released and earth is removed from the P wire. The faulty line can now be tested free from exchange connexions.

The release-circuit A relay acts as a guard relay, and its function is to prevent the booster battery from being connected to a line which is earthed or short-circuited close to the M.D.F In such cases the booster battery current would be excessively high and relay A is therefore adjusted so that it will operate to a low-resistance earth. It then holds through its 1 000-ohm winding and its contacts light the pilot lamp to indicate that the selector must be released by hand.

(*c*) *Complaint Trunk Circuit.*

Subscribers experiencing difficulty in the operation of their telephone services

are instructed to dial M00. The circuits from the 3rd selector levels terminate on the banks of a group of finder switches which are equivalent to answering circuits. A pilot lamp, which is provided on each complaints position, glows when a complaint call is received and remains lighted so long as a call remains to be answered. Callers waiting to be answered receive ringing tone, which is disconnected when the complaints clerk answers.

Calls may be extended and metering effected by the clerk.

The answering key connects the call to the complaints clerk's telephone circuit. The testing key connects the calling subscriber's line to the test circuit. The dialling key enables the clerk to extend a call. The release key is operated if it is necessary to release an extended call owing to a dialling error The registration-control key is operated to meter the call against the calling subscriber The guard lamp commences to glow when the clerk is connected with a caller

If only one call is waiting, the pilot lamp will cease to glow when the call is taken over In the event of two or more clerks attempting to take over the only waiting call, the guard lamp lights on the answering circuit securing the call and the extinction of the pilot lamp together with no glow on the guard lamp informs the other clerks that the call has been taken over elsewhere. The guard lamp glows until the caller replaces his handset. The called supervisory lamp is used on extended calls. It glows immediately a first selector is obtained and is extinguished when the called subscriber answers.

(*d*) *Rectifier Circuit for 400-Volts Supply*

A 400-volt direct current supply to the test circuit, enabling the test clerk to perform insulation tests, is provided by means of dry-plate rectifiers arranged in a voltage-doubler circuit.

Power Plant.

The power plant conforms to the practice that has for some time been standard in Australia of employing the floating system for batteries. In this system the exchange load is taken by a generator or generators, with a battery floating. The battery provides efficient smoothing of the generator output and stands in readiness for service should the mains fail. At City West two generators, each of 750 amps. capacity, are installed initially and may take the load singly or together The voltage of the machines and, therefore, the voltage on the exchange bus-bars, is controlled by an automatic regulator Two 26-cell, 4 500-amp.-hr batteries are provided and are connected alternately, each being in service for one week before being replaced by the other

For general convenience, the control equipment for the power plant is mounted on two power boards, one termed the "charge" board and the other the "discharge" board. The former is installed in the machine room and is provided with a separate meter panel mounted at right angles in order that readings shall be visible to the attendant when standing in front of any of the power board panels. The discharge board is installed in the apparatus room on the first floor Certain meters on the charge board are duplicated on the discharge board in order that readings of

Fig. 11.—Charge power board.

battery current and voltage may readily be ascertained by an attendant at the latter board.

When a battery is floating, the main feed to the exchange is closed to a tapping at the 24th cell. At times of low load, however, the generators may not be run and the battery is then required to serve the exchange. Similarly, should the mains fail, the battery takes the load. The main feed must then be connected to the 26th cell to bring the voltage above the minimum limit. This on-load change is made by means of a motor-driven switch which is controlled from a small switch on the discharge power board. The switch is capable of carrying the maximum ultimate load of 3 100 amps., and its motor operates on current drawn from the battery in order that mains failure shall not render it ineffective.

Losses incurred in a battery whilst in service are made good from one or other of the generators during the period in which the other battery is connected to the exchange.

Current from the mains for operating the motor-generator sets is drawn from either of duplicate 6 600-volt feeders, which may be switched to any one of three 500 kVA transformers.

Power distribution to the exchange equipment is made by means of copper busbars supported from the ceiling. Circuit breakers are included in the negative feeds to the two floors initially equipped.

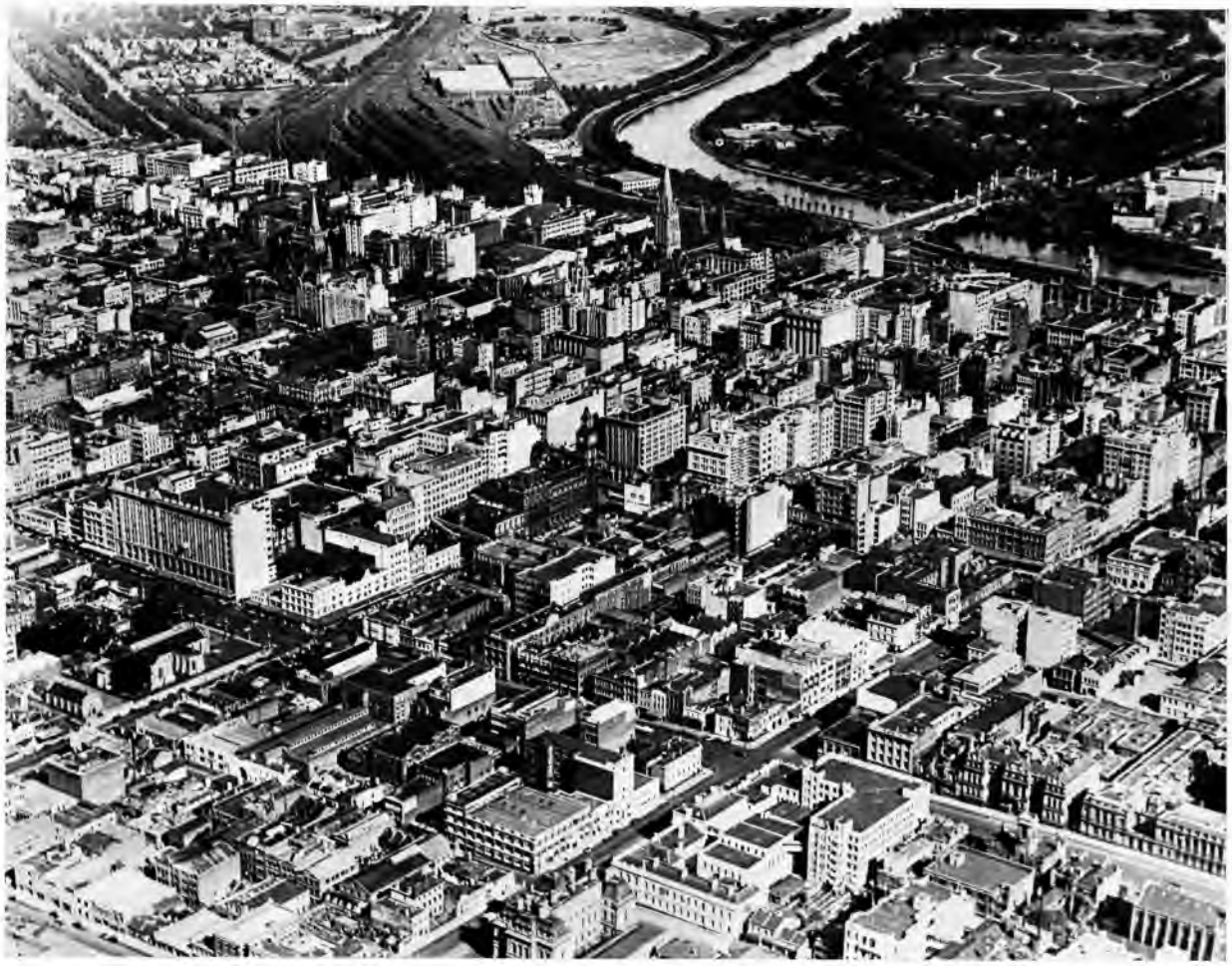
Ringing current is obtained from duplicate alternators, each of which has an output of 300 watts at 75 volts. One operates from the mains and the other from the exchange battery, the latter machine being automatically brought into service should there be a failure of output from the mains-driven ringer Inductor tone generators, mounted on the ringer shafts, provide the necessary tones.

Cut-over

The introduction of City West exchange, and the establishment of South Melbourne as its satellite, necessitated certain changes in the Melbourne network. The call letter *M* had previously been allotted to South Melbourne and the new allocation of *MX* involved changes in numbering. This fact governed the times at which the changes could be made effective, because considerable directory number changes

could be made only at the times of issue of new directories, namely, in May and November South Melbourne was converted to six-figure working in November, 1937, the necessary provision of incoming 1st selectors, 2nd selectors, and outgoing junction relay sets having been made at City West in advance of the rest of the equipment. Junctions to South Melbourne from main exchanges in the area were replaced by others to City West 2nd selectors, a feat which was accomplished by the engineers of the P.M.G 's Department without any interruption of the service.

The first cut-over of subscribers on City West itself was made in May, 1938, with a further transfer in November of the same year It was then calculated that approximately 230 000 calls per day were originated in City West and its satellite exchanges.



The business centre of Melbourne, with the River Yarra in the background.