LINE CONCENTRATORS—AN INSTALLATION AT BOX HILL (VICTORIA)

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INTRODUCTION

By far the greatest increase in subscriber development since the war has been the increase in the demand for residential services, and the cost of providing these services must inevitably be greater than that of providing service to business subscribers. Residential areas are usually more distant from the exchange than are business premises and this involves laying larger and longer subscribers' cables to meet demand, needless to add, at considerable cost. Residential development is not easy to foresee and in most cases it is not possible to lay distribution cable as soon as the demand exists with the consequence that a back log of waiting applicants soon arises. Each residential subscriber requires the same amount of exchange equipment per line as the business subscriber though the revenue earned from the residential subscriber is considerably less than from the business subscriber. If tariffs are increased to compensate, demand could fall and this would result in an undesirable drop in revenue.

A need, therefore, exists for some method of providing a service to residential subscribers which is:—

(i) Cheap.
(ii) Flexible so that service may be quickly given to subscribers in areas where distribution pairs would normally be insufficient.
(iii) Capable of serving enough subscribers to enable the postponement of cable relief until future requirements are better known.

Such a method is the line concentrator. Briefly the line concentrator enables a number of subscribers to be served by a lesser number of subscribers' cable pairs and in all respects should provide the same service to the subscribers as if individual cable pairs were used. In other words, the subscriber should be unaware of the presence of the line concentrator.

ECONOMICS

The economics of providing line concentrator equipment is related to the cost of providing the same service by cable relief. As this latter component varies from one location to another, an accurate assessment is hard to make.

An investigation in 1958 showed that, on information available, the initial and maintenance costs of line concentration equipment would have to be considerably less than they were at the time to make it a generally economical proposition. For this reason, line concentrator equipment in future is expected to make use of such developments as transistors, semi-conductor diodes, dry reed glass sealed switches, nickel cadmium batteries and a minimum of moving parts.

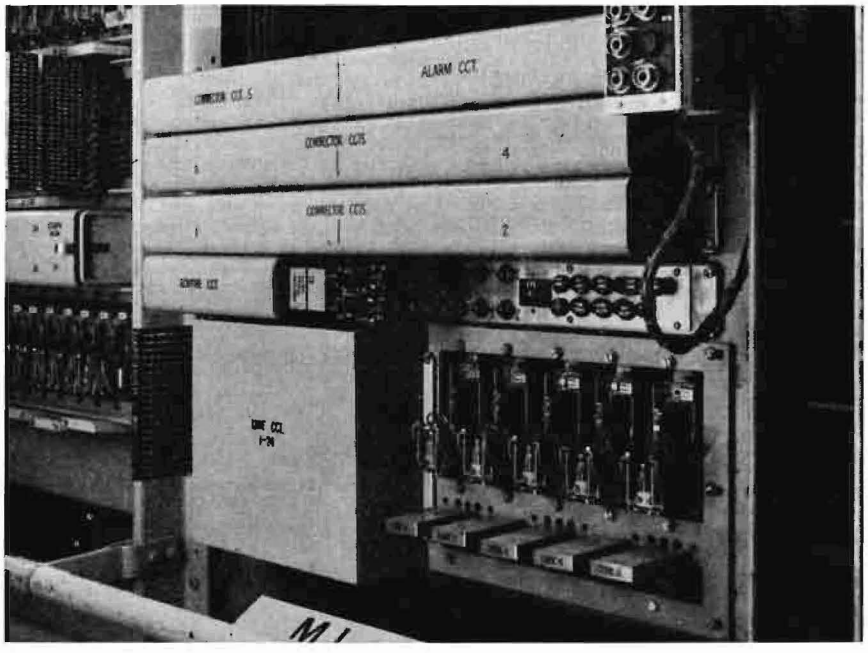

Fig. 2.—Line concentrator exchange unit installed in the Box Hill Exchange.

Though hard to assess economically there are benefits in being able to provide service in advance of costly cable relief and this is of particular importance where the subscribers concerned are grouped together as, for example, in a block of newly erected flats. The cost of maintenance of the equipment is important in the determination of the economics of line concentrators and for this reason, the trend in design is towards improved reliability of components and automatic withdrawal from service of faulty circuits.

Savings by use of concentrators are more likely to be incurred as the route distance from the exchange increases.

LINE CONCENTRATOR PRINCIPLES

It is well known in telephony that a subscriber uses the phone for only a fraction of the time that the service is available and this principle of exchange trunking can be extended to the connection of subscribers to the exchange. For example, the line concentrator equipment at Box Hill (Vic.) is capable of serving 23 subscribers via 5 cable pairs. Units of other manufacture can serve 50 subscribers with 10 pairs and 11 subscribers with 3 pairs. The duplex system is an application of the same principle where two subscribers are served by one cable pair With such small numbers of subscribers and pairs it is important that the subscribers served have a low to average calling rate otherwise congestion will result.

The principles of operation can be understood by reference to Fig. 1. The equipment consists of two units, one in the exchange and the other called the remote unit, in the vicinity of the subscribers concerned These subscribers are connected to the remote equipment. A smaller number of cable pairs connects the remote unit to the exchange unit. Since the maximum number of simultaneous originating calls cannot exceed the number of pairs, only one exchange line circuit per pair is required but provision is made to connect the appropriate subscriber's meter when a call is originated. The final selector appearances of the connected subscribers are also connected to the exchange equipment of the line concentrator.

Originating Call. By lifting the handset, one of the 23 subscribers is connected, in the remote unit, to one of the cable pairs connecting the remote and exchange units In the exchange unit, an exchange line circuit is available to each of the pairs and the subscriber is now connected to the exchange line cir-

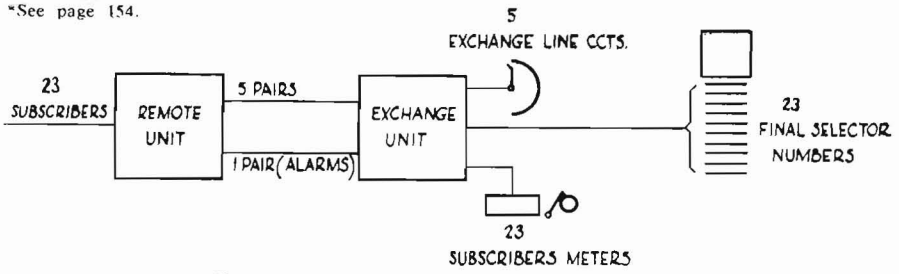

Fig. 1.—Basic application of the line concentrator.

*See page 154.

cuit associated with the pair selected. The subscriber now receives dial tone and may proceed with the call. With the connection of the line circuit, the exchange unit connects the appropriate subscriber's meter so that an effective call may be registered. When the caller restores the handset, the equipment restores to normal.

Terminating Call. When the last digit of one of the 23 subscribers has been dialled and if the number is free, the final selector will send ring tone back to the calling subscriber and ringing current forward to the exchange unit. The exchange unit selects a pair which is then connected to the final selector bank appearance of the number being called. At the same time, the remote unit connects the remote end of the selected pair to the required subscriber. The ringing current is now connected to the line of the called subscriber and the call proceeds normally.

OTHER ASPECTS

There are certain other aspects of a line concentrator which are of importance and these are listed below.

Components. These should be reliable and fault free. Low cost may be achieved by good design lending itself to ease of manufacture but good quality material in important places is sound design, e.g., moving parts and contacts.

Circuit Design. Good circuit design incorporates the automatic withdrawal from service of faulty parts, low current drain, little or no shunt or series components introduced into the subscriber's line and high speed of operation. A minimum of components will assist in achieving a compact and light unit.

Physical. Minimum size of exchange and remote units is important, particularly the latter unit where weight is also important. These factors facilitate rapid and easy installation and improve the possibilities of finding a suitable location for the remote unit.

Power Supplies. It is better if the remote unit obtains its power from the exchange. This gives greater flexibility as location of sites can be made without regard to the availability of commercial supply. It also helps to reduce the size of the remote unit and also eliminates the maintenance required by batteries.

Testing. It should be possible to remotely test the switching functions of the remote unit. It is also important to be able to test, from the exchange, the cable pairs of the subscribers connected to the remote unit.

Alarms. Indication is required at the exchange of faulty equipment and whether or not service is affected.

BOX HILL LINE CONCENTRATOR

The Box Hill line concentrator was installed as a trial of a locally designed and produced unit. Due to it being a 'one only' product and its initial cost high, it does nothing to demonstrate the economics of the use of line concentrators; neither does it employ components specially designed to be conducive to low fault incidence and low maintenance charges. Despite these shortcomings, it has provided service to a number of subscribers who would otherwise be without it for a number of years and it is also providing information on the finer points of facilities required in such units, particularly those associated with testing.

The equipment was manufactured in the Melbourne Postal Workshops to a circuit designed in the Headquarters Circuit Laboratory to provide line concentrator facilities with standard automatic exchange components. The unit was cut into service in November, 1959, with eight subscribers served by three finder circuits and has given satisfactory service so far.

The circuit components comprise 3,000 type and 600 type relays and uniselectors employed in finder circuits. The exchange unit shown in Fig. 2, is mounted on a shelf 2 ft. 9 in. wide. The remote unit, shown in Fig. 3, is accommodated in an 1800 pair cable cross-connection cabinet case and is mounted on hinged frames for easy access to the rear of the equipment. The upper part of the cabinet housing the equipment also contains the rectifier and this part is hermetically sealed. The battery, comprised of sealed type nickel cadmium accumulators, stands on a drawer tray in the lower part of the cabinet and this section is ventilated.

The unit has a capacity of 23 subscriber's with an additional subscriber's number used for testing. Five connectors are available, requiring five pairs between the remote and exchange unit and a further pair is used for alarms and testing.

OPERATION

The facilities of the unit are the same as those described in the principles of operation. Of particular interest is the method whereby the remote and ex-

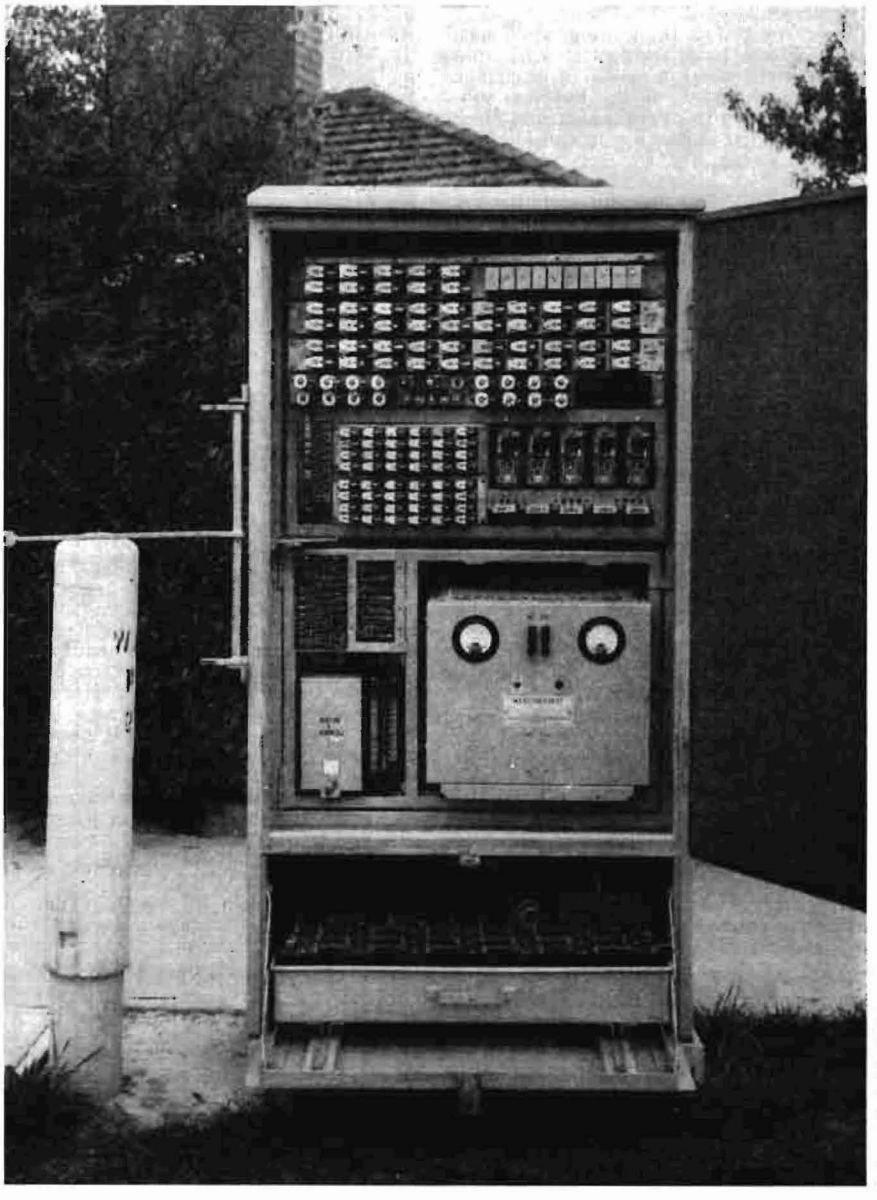

Fig. 3.—Line concentrator remote unit. Adjacent to the cabinet can be seen the pillar on which is terminated the connection to the remote unit as well as the cable pairs to the exchange and the connected subscribers.

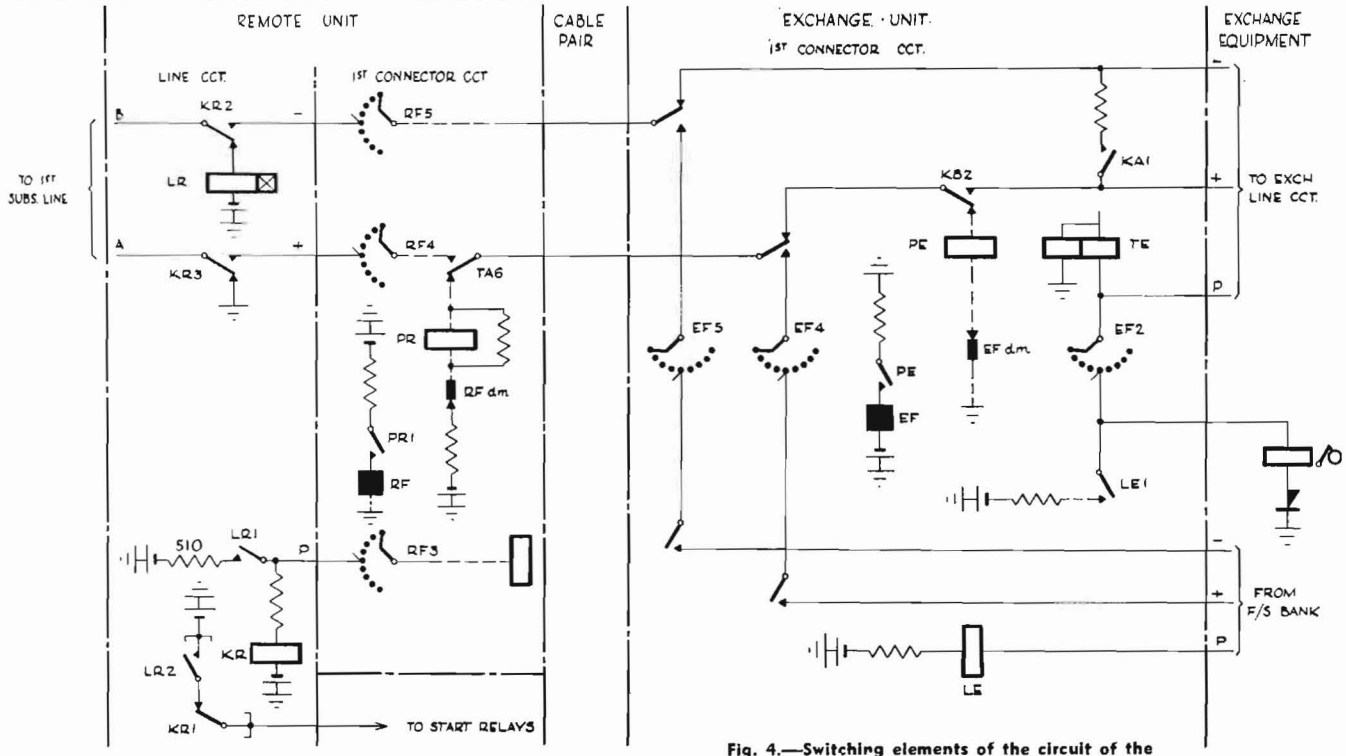

Fig. 4.—Switching elements of the circuit of the Box Hill line concentrator.

change units select one of the interconnecting pairs and arrange for the connection of the subscriber to the exchange equipment. It is in this respect that various systems differ and in which the field for ingenuity is wide. A matter of terminology arises which must be stated before proceeding. Up till now the pairs connecting the remote and exchange units have been referred to as pairs. This is satisfactory when thinking in terms of the block diagram. On closer scrutiny we become more interested in the manner in which connection is made to these pairs and we come to refer to the interconnection by the name of the circuit which performs it. For example, in crossbar equipment the interconnection is made via links, so we speak of the common circuits as links. In the Box Hill unit the interconnection is made by connectors (operating as line finders) and we shall now refer to these elements as connectors.

The following description of the searching stepping process may be followed by referring to Fig. 4 which contains only those components required to understand these operations. Further detail is considered unnecessary to the understanding of these operations and would tend to confuse.

Originating Call. When the subscriber lifts the handset, the completion of the line loop operates relay LR in the remote unit. The start relay of the first available connector is operated. The remote unit starts the exchange unit circuit of the selected connector via a circuit using the negative leg of the connecting cable pair. The exchange line circuit is pre-looped at KA1 so that dial tone will be on the line by the time the finder circuits have operated and connected the subscriber to the selected connector circuit. With the earth returned on the private of the line circuit, a circuit is completed for the operation of pulsing relays PR in the remote unit and PE in the exchange unit via the positive leg of the connecting cable pair. The associated connector finder magnets operate and the interrupter contacts open causing the release of both PR and PE. This results in the release of the finder magnets and both finders take one step. The interaction continues until the remote finder steps to the contact of the calling subscriber, whereupon the drive is cut due to the private bank of the remote finder being marked with a 510 ohm battery. In the exchange unit, the meter of the calling subscriber is connected to the private of the line circuit via a bank contact of the exchange finder. The private of the final selector appearance of the number is earthed to render the number busy to incoming calls. The calling subscriber's line is switched through to the line circuit and the call proceeds in the normal manner. At the completion of the call the finders return to the home position and are available for another call.

Terminating Call. After the last digit of the called subscriber's number is dialled, the final selector applies earth to the P wire to guard against intrusion. Ringing current and ring return battery are applied to the negative and positive wipers and ringing tone is returned to the calling subscriber. Call indicating relay LE in the exchange unit operates to the earth on the private. Using the negative leg of **each** unoccupied connector circuit to initiate the action, the pulsing relays of each unoccupied connector circuit are switched to the positive legs of the connector circuits and all unoccupied connectors in both exchange and remote unit begin to search. The first exchange finder to reach the final selector appearance being called stops, the others continue to drive to the home position and are available for other calls. Drive is cut by the operation of drive cutting relay TE to the battery on the appropriate contact of exchange finder bank EF2. The ring is extended through to the subscriber and the call proceeds in the normal manner. At the conclusion of the call, the finders restore to the home position and are again available for use.

CONCLUSION

A need exists for a cheap and rapid means of providing service to residential subscribers and, whilst the Box Hill unit has not satisfied the first of these requirements, it has achieved a further objective of quickly providing service to an area where none was previously available. It has provided information and experience, which will be of benefit in assessing the suitability of line concentrator units of other types and manufacture. We may expect interesting developments in this type of equipment in attempts to reduce the initial and maintenance costs and to improve its reliability.

REFERENCES

1. R. C. Hunt, Economics of Line Concentrators, Telephony Oct. 22 1960 P. 106.
2. F. E. Lee, Line Concentrators. Telephony Aug. 27 1960 P. 21.
3. H. V. Paris, Subscriber Line Concentration, ATE Journal Vol. 15 No. 4 P. 313.
4. E. R. Banks & R. H. Cole, Economic Application of Line Concentrator Equipment. A.P.O. Planning Information Bulletin No. 11.