GFELLER LINE CONCENTRATOR UNIT

B. P. DEW and J. D. MATHER, Dip.E.E., Dip.Mech.E., A.M.I.E.Aust.***

INTRODUCTION

A line concentrating device for subscribers' services has been sought by most telephone authorities since the turn of the century. Many telephone authorities in an endeavour to keep the costs of their outside line plant to a minimum adopted a shared or party line system using code ringing or multi-frequency ringing, but this did not give the secrecy required by the subscriber.

After the second world war the Australian Post Office, in its endeavour to meet the heavy demand for telephone service and the need of secrecy for the subscriber as well as conserve line plant, introduced on a wide scale the duplex service. This service gives satisfactory service to the "average" residential, two subscribers using a single cable pair, but in practice it is nearly impossible to find two "average" subscribers whose telephone habits do not clash.

By the early 1950's a Subscriber Auxiliary Unit (S.A.U.) was developed by the Australian Post Office, this unit accommodated 10 subscribers on 2 exchange pairs. The main disadvantage with this unit was that 10 residential subscribers could originate and terminate more traffic that 2 cable pairs could handle at a reasonable standard of service.

Morris (1) has described a concentrator unit which was designed and built by the Australian Post Office in 1959. It consisted of uniselectors and relays commonly used in 2000 type telephone exchanges and had a capacity of 23 subscribers on 5 exchange lines.

Because of the demand for line concentration equipment various telephone equipment manufacturing companies are offering various types of subscriber line concentrators and the Australian Post Office has purchased a number of different types of line concentrators for field testing in selected locations where expensive cable relief would be required to give telephone service to waiting applicants.

The Swiss-made Gfeller line concentrator unit is only one of the types undergoing tests, and to date it appears to be the most attractive type on the market. This article will only deal with the Gfeller Line Concentrator as the A.P.O. have on order a number of these and similar A.T.E. units and it is felt that a circuit description will be of some assistance to the installing and service staffs in the near future.

A Gfeller Line Concentrator Unit capable of serving 49 subscribers and using 11 cable pairs was selected for use in the Hawthorn (Vic.) Exchange area to serve two adjacent blocks of flats, in all a total of 49 new residential flats.

The Gfeller Line Concentrator uses a Trachsel-Gfeller crossbar switch and it is designed to accommodate 49 subscribers using 9 (2 wire) junctions or links and 4 control and marking wires. Both the exchange end unit, Fig. 1, and the subscribers end unit, Fig. 2, can be either wall mounted or rack mounted. The switching and marking equipment is similar in both exchange and subscriber units but there are a larger number of common control relays in the exchange unit.

THE TRACHSEL-GFELLER CROSSBAR SWITCH

The principle of the Trachsel-Gfeller switch is shown diagrammatically in Fig. 3. The switch consists of nine vertical switching bars of a transparent plastic material into which are fitted three nickel silver strips having inclined teeth on one edge to engage the horizontal cross links.

Each subscriber on the concentrator has one cross link or horizontal bar. The subscriber cross link carries three twin nickel silver wires which correspond with the strips in the vertical bars, and the three twin sets of wires are multiplied across the switch nine times and can be engaged by any one of the nine vertical bars.

When all the vertical bars are at rest the teeth are clear of the cross link wires even if a cross link is operated. With the vertical bar in the operated or raised position the wires on the horizontal bar are moved beneath the teeth of the vertical bar, then when the vertical bar is dropped or released the inclined teeth on the vertical bar trap the twin wires on the subscriber's cross link horizontal bar thereby making an effective contact.

LOADING

The connection between the connector bar elements and those of the horizontal bar is a physical connection. This means that at the completion of the call, the horizontal bar wires are maintained in an operated position by the contact with the connector bar, although the horizontal operating magnet coil is not energised. This is termed "LOADING". The horizontal bar remains

*Mr. Dew is Supervising Technician, Equipment Installation, Victoria. See page 421.
**Mr. Mather is Engineer Class 2, Equipment Installation, Victoria. See page 421

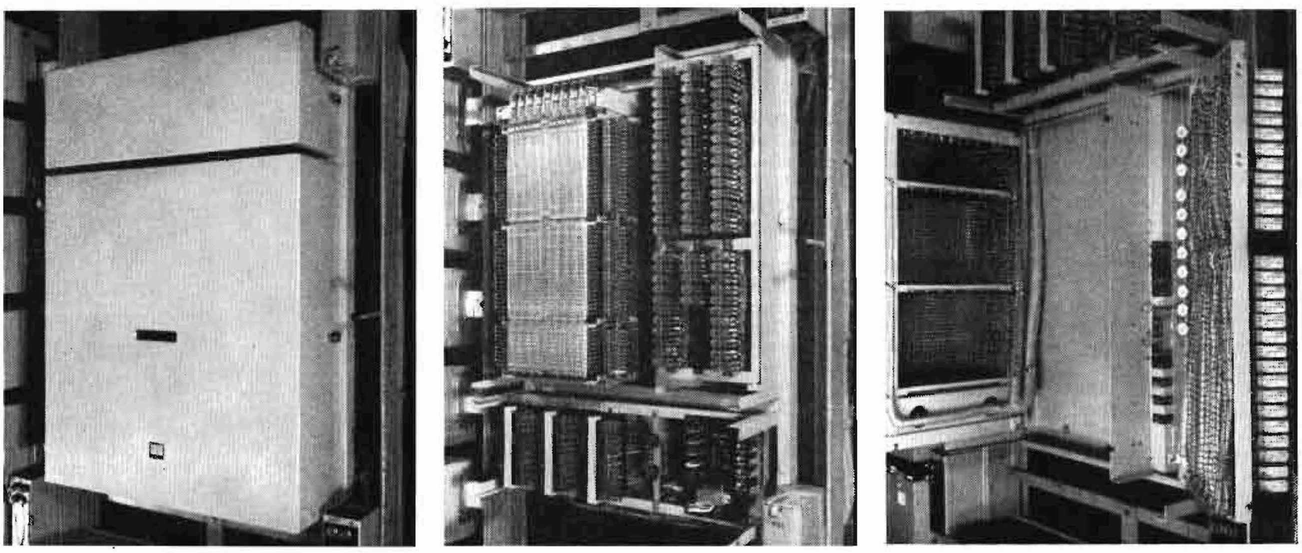

Fig. 1.—Exchange End Unit. Centre: With covers off. Right: With gates open showing how accessible the equipment is for maintenance.

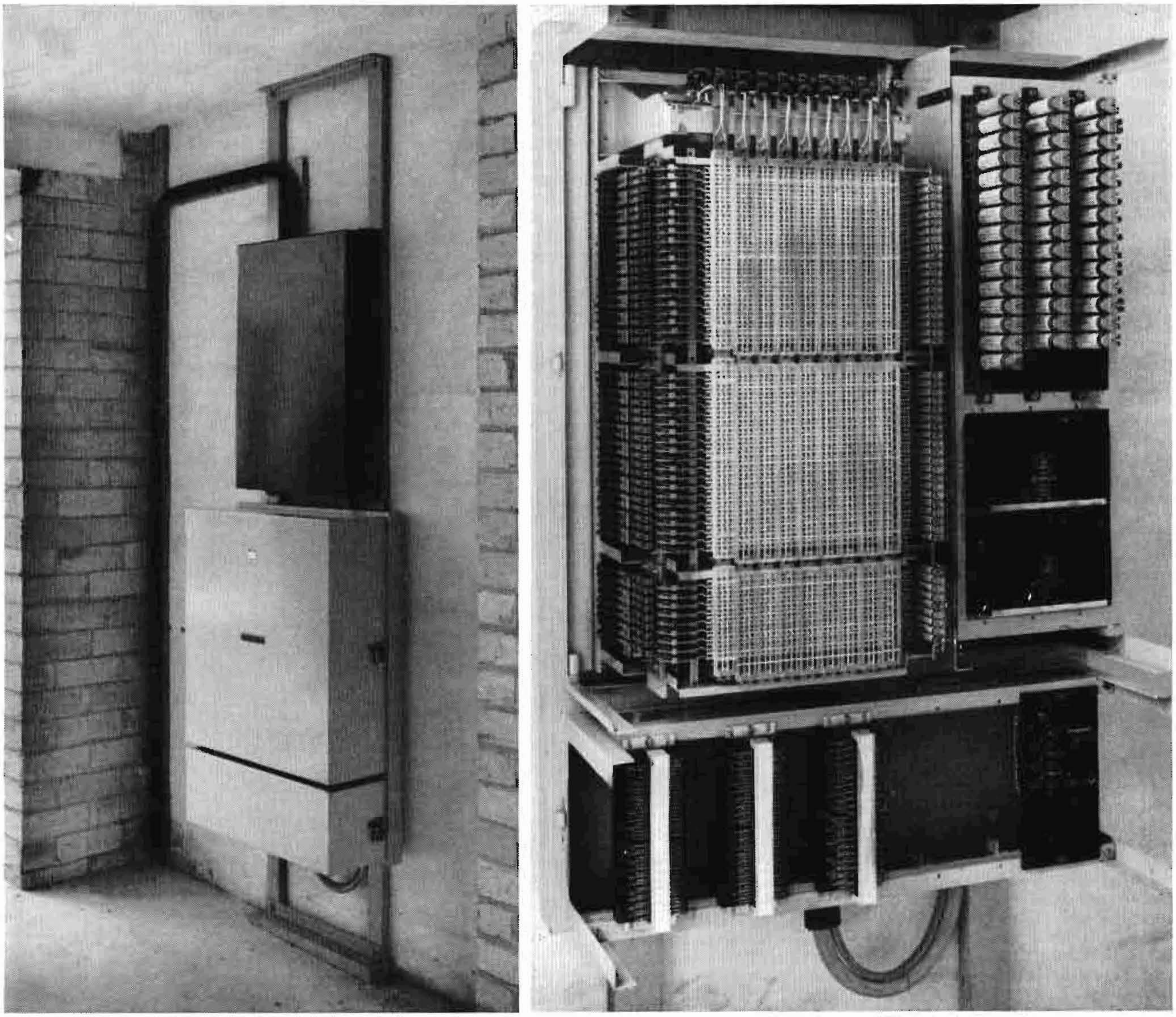

Fig. 2.—Subscribers End Unit. Right: With covers off.

"loaded" to the connector bar until such time as the connector bar is raised when selected by "LINK ALLOCATION".

This loading feature enables a subscriber making frequent calls to use the same link circuit on subsequent calls, thus obviating unnecessary setting up of the equipment.

LINK ALLOCATION AND TESTING

Unless all link circuits are simultaneously busy, a corresponding connector bar in each unit is maintained in a raised position.

This is a link circuit which has been tested and found free and so raised to enable its connection to the next subscriber requiring a link circuit. The raised connector bar circuit is said to be "ALLOCATED". Link allocation is dependent on the link being free and the testing always takes place in sequence from the previously allocated link, i.e., if link circuit No. 5 was previously allocated, then, when it is taken into use, the No. 6 circuit would be tested for busy, then No. 7, 8, 9, 1, 2, 3, 4, in that order, till a free link circuit is found, which would then be allocated. In practice, each link circuit, except the allocated circuit, would be loaded onto a subscriber circuit, and so the testing circuit is arranged to regard a link circuit with battery on the private or "C" wire as being free, and an earth or no potential on the "C" wire busies the link. Thus a "loaded" (to sub.) link circuit is tested according to the condition of the loaded subscriber's private wire in the exchange. Testing for free links only takes place in the exchange unit. Since absence of potential on the "C" wire of a link circuit will cause it to be tested as busy, an additional horizontal bar (Bar 50) is provided in the exchange unit, the "C" wire multiple of this is connected via 600 ohms to battery. This bar 50 is always maintained in an operated condition so that during initial setting up of the units or the subsequent "unloading" of any link (for any reason) the link circuits will be loaded onto bar 50 to enable them to be tested as free.

CIRCUIT OPERATION

Link Allocation in Exchange Unit (Fig. 4)

The sequence testing of links is controlled by a chain relay circuit of nine relays VB1-VB9 and interacting relays M and N. Initially, all VB relays are unoperated, and W relay operates via Battery, 3,750 ohm coil W, VB1/1 normal, VB2/1 normal, etc., to VB9/1 normal, 2,000 ohm R15, VB9/2 normal, to earth. VB1 relay operates via battery, 2,000 ohm coil VB1, W/1 operated, M/1 operated to earth. VB1/1 releases W. Initially, all connector bars in the exchange unit are loaded by hand onto "bar 50". Therefore, BSU operates via earth, 12,000 ohm coil BSU, VB1/3 operated, "C" wire of connector bar 1, "C" wire of "bar 50", AK/2 (disconnect key), 600 ohm R.10 to battery. BSU/1 holds relay M. M/3 holds relay N. PD operates via battery, 2,000 ohm coil PD, BSU/2 operated, V/3 normal, C/1 operated, D/2 normal, to earth. PD/1 opens the holding circuit of relay RD in relay group RA-RF (normally operated). Relays RS2 and RS3 operate via earth, RF/1 operated, RE/2 operated, RD/4 released, A2/1 normal, 2,000 ohm coil RS2 and 2,000 ohm coil RS3 in parallel, PD/3 operated, 570 ohm coil PIRS, SCH/2 normal (SCH previously released at RD/4), R2 to battery. Connector bar No. 1 is raised by lifting coil S1 via battery, R5, KO1/1 normal, RC/1 operated, RB/2 operated, RA/4 operated, RS2/1 operated, 56 ohm coil S1, PIRS/2 operated, V/2 normal to earth. The connector bar holds via earth, A2/3 normal, M/2 operated (also from earth, A/2 operated if A relay has operated.) 300 ohm coil S1, S1/3 operated, C/4 operated, 450 ohm R13, 265 ohm coil A1 to battery until required for a call.

Subscriber's Unit (Fig. 5)

When relay RD released in the exchange unit, relay RD released in the subscriber's unit, since they were holding in series. The release of relay RD in the subscriber's unit promotes the marking and operating of the corresponding connector bar in the subscriber's unit thus, RS2 relay operates via earth, RF/1 operated, RE/2 operated, RD/4 released, A/1 normal, RC/3 operated, 3,750 ohm coil, RS2, PIRT/2 normal, SCH/1 released (SCH previously released at RD/4, 50 ohm R2 to battery. Connector bar No. 1 is raised by S1 lifting coil via battery, R1, PIRT/1 normal, RC/1 operated, RB/2 operated, RA/4 operated, RS2/1 operated, 56 ohm coil S1, ABS/1 normal, PIRS/1 operated, A/2 normal, to earth. Connector bar holds via earth, 100 ohm coil A, 300 ohm coil S1, S1/2 operated, "B" side of junction No. 1, 1/2 operated in exchange unit. C/2 operated, MK5 terminals, 600 ohm R14, 60 ohm coil A to battery.

Exchange Unit

The raising of the connector bar breaks the connector bar/bar 50 contact and releases BSU relay. BSU/1 releases M relay. BB2 operates via earth, M/1 released, VB1/2 operated, 2,000 ohm coil VB2 to battery. VB2/1 releases VB1 relay which had been holding via battery, 2,000 ohm coil VB1, VB1/1 operated, and chain contacts VB2/1 to VB9/1 normal, 2,000 ohm R15, VB9/2 to earth. VB2 relay holds via the same chain contact route as VB1 through VB2/1 operated. BSG relay operates via earth, 12,000 ohm coils BSG, VB/2 operated, "C" wire of connector bar No. 2, "C" wire of bar 50, AK/2, 600 ohm R10 to battery. N relay holds via battery, 7,800 ohm coil N, X/2 normal BSG/1 operated to earth. At this stage, link No. 1 has been tested, found free, and the corresponding connector bars raised in both units, while link No. 2 has been tested and found free. Relays N, BSG, and VB2 are holding while M relay remains released. If link No. 2 had tested as busy, i.e. if BSG failed to operate, then N relay would have released when contact M/3 opened during release of M. M would then reoperate via N/1 released. N would reoperate via M/3 operated, and at N/1 open the circuit of M. VB3 would operate via earth, M/1 operated, VB2/2 operated, 2,000 ohm coil VB3 to battery. BSU relay would test link No. 3 for busy via earth 12,000 ohm BSU, VB3/3 operated, "C" wire of connector bar 3, "C" wire of bar 50, AK/2, 200 ohm R10 to battery. From this it is seen that the VB relays under the control of interacting relays M and N will test the link circuits in sequence until testing is stopped by the operation of either BSU or BSG. When a link is allocated, relay A1 holds in series with the 300 ohm holding coil of that S magnet. Relay V holds via earth, A1/1 operated, V relay to battery. Since release timing of V controls the delay between subsequent operations of connector bar lifting coils, it has a slow release controlled by 100 μF capacitor and 500 ohm resistor R3. This delay ensures that the 3,500 μF capacitor in the subscriber's unit is sufficiently charged before each lifting coil operation. When the allocated link is taken into use, C/4 opens the circuit of A1 relay and S magnet holding coil. A1/1 releasing, opens the holding circuit of V which releases slowly via V/1 and capacitor/resistor circuit. Until V releases, the relay group PA-PD is inoperative, being open at V/3 so no marking of the next free link can take place.

Basically, the VB relays controlled by interacting relays M and N cause BSU and BSG to test link circuits in sequence till a free link is found, when a combination of operated BSU or BSG, together with an operated VB relay, operates relays in the group PA-PD. These relays in turn release relays in the group RA-RF. Relays in the group RS1-RS3 operate, and these, together with relays RA-RC, determine the path for the operation of the lifting magnet coil of the required link circuit.

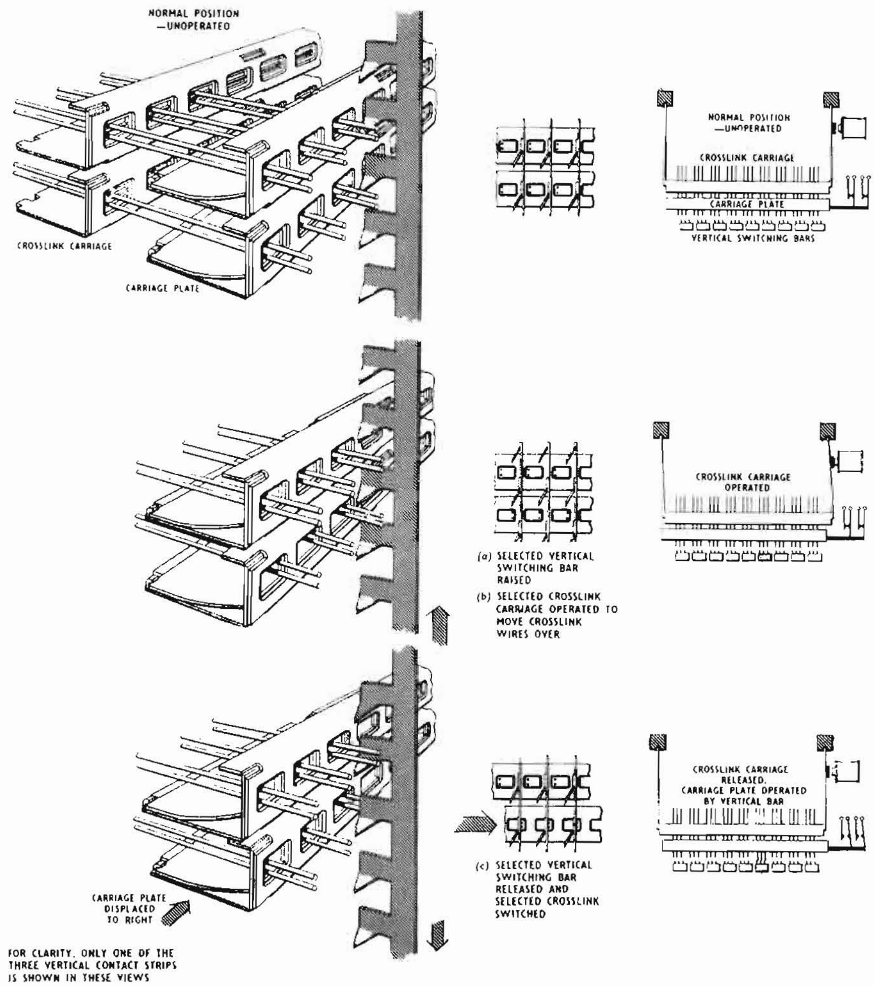

Fig. 3.—Diagrammatic Representation of Trachsel-Gfeller Crossbar Switch.

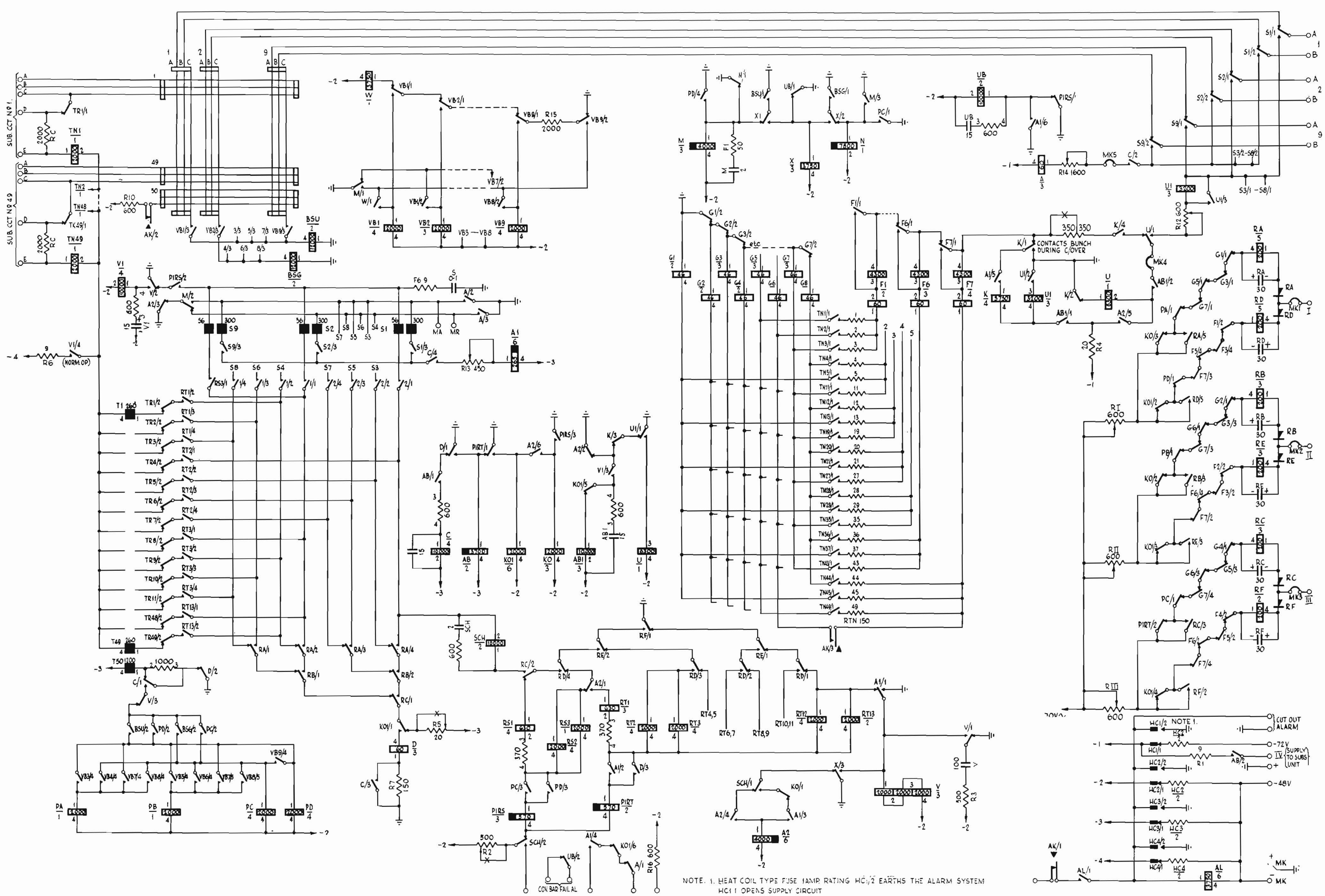

Fig. 4.—Exchange End Unit Circuit.

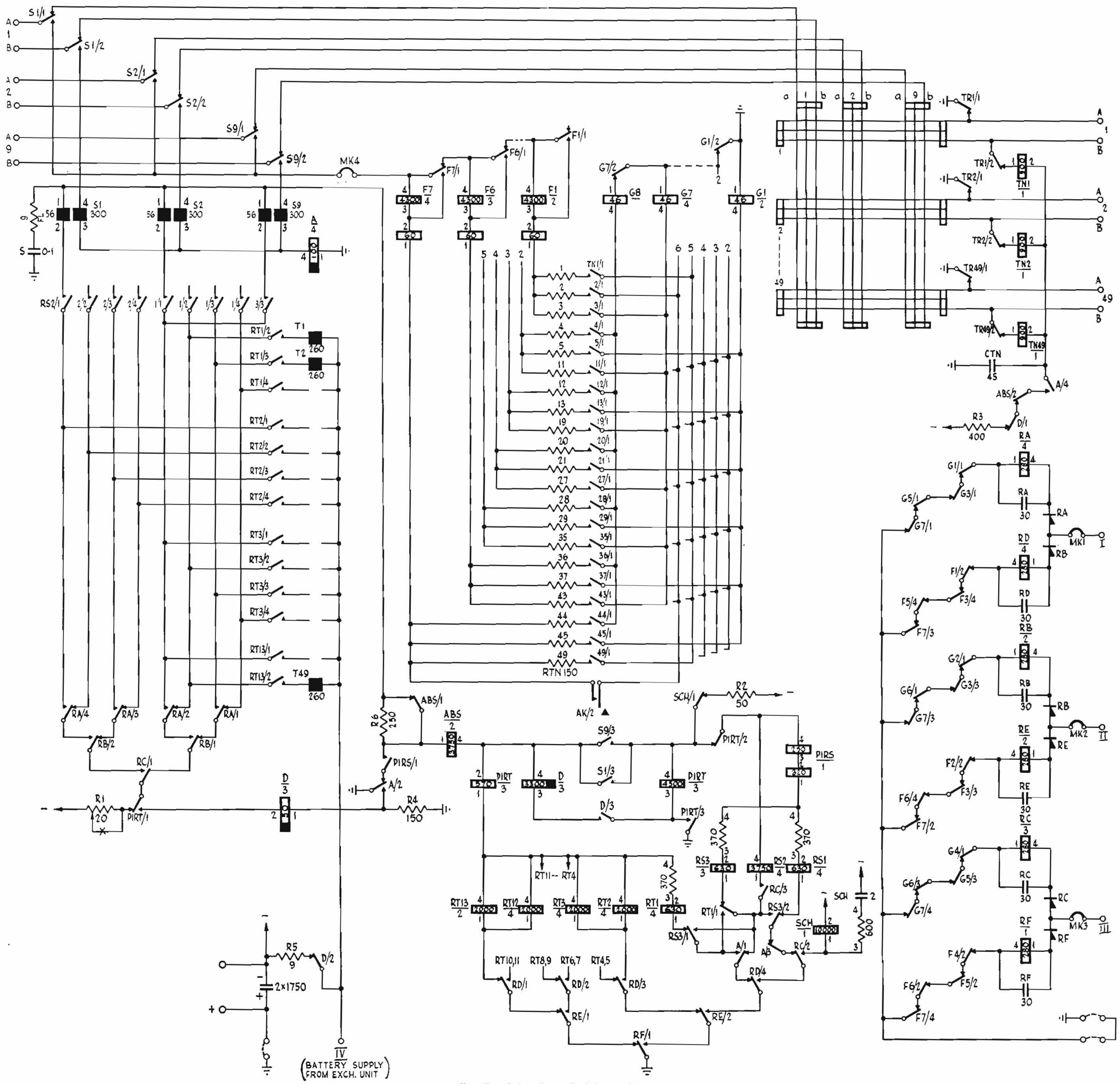

Fig. 5.—Subscribers End Unit Circuit.

Call Through Parent Exchange to Concentrator Subscriber

The calling final selector earths the private wire of the called subscriber's final selector multiple. This earth is extended to the "C" wire of the corresponding concentrator subscriber's circuit. If the subscriber is not already loaded to a link, then a TN relay (individual to subscriber) will operate. Assuming concentrator subscriber No. 1 was called, then TN1 relay operates via earth on "C" wire, horizontal off normal springs TR1/1 normal, 2,000 ohm RC, 2,000 ohm coil TN1, V1/4 operated, 9 ohm R6 to battery. Relay K operates via earth, chain contacts G1/2 to G4/2 normal, 46 ohm coil G5, TN1/1 operated, 150 ohm RTN1, 60 ohm and 4,300 ohm coils F1, chain contacts F2/1 to F7/1 normal, K/1 normal, A1/5 operated, 3,750 ohm coil K, AB1/1 operated 20 ohm R4 to battery. K operates and locks via K1 to earth. K/4 extends F and G circuit via U/1 normal, MK 4 terminals, AB1/2 operated, A2/5 operated, 20 ohm R4 to battery. This low resistance path allows G5 and F1 to operate. Three relay holding circuits are opened, viz. RA at G5/1, RD at F1/2, RC at G5/3, RT1 operates via earth, RF/1 operated, RE/2 operated, RD/4 released, A2/1 operated, 630 ohm coil and 370 ohm resistance of RT1, A1/2 operated, 570 ohm PIRT, SCH/2 released, R2 to battery. Horizontal magnet T1 operates via earth, C/3 operated 60 ohm coil D, KO1/1 operated, RC/1 released, RB/1 operated, RA/2 released, RT1/2 operated, TR1/2 normal, 260 ohm coil T1, V1/4 operated, 9 ohm R6 to battery.

Subscriber's Unit

Following release of RA, RC and RD, RT1 operates via earth, RF/1 operated, RE/2 operated, RD/4 released, A/1 operated, RS3/1 normal, 630 ohm coil and 370 ohm resistance of RT/1, 570 ohm coil PIRT, contact S1/3 to S9/3 (dependent on which link is allocated), SCH/1 released, 50 ohm R2 to battery. Horizontal magnet T1 operates via earth, 150 ohm R4, 50 ohm coil D, PIRT/1 operated, RC/1 released, RB/1 operated, RA/2 released, RT1/2 operated, 260 ohm coil, T1, to battery from MK4 and 3,500 μF capacitor through D/2 and 9 ohm R5. Relay D operates in series with T1, and holds on 3,300 ohm winding via earth, PIRT/3 operated, D/3 operated, 3,300 ohm D, S1/3 to S9/3, SCH/1 released, 50 ahm R2 to battery.

Exchange Unit

Relay D operates in series with T1, Relay C releases when D/1 operates. The allocated link releases when C/4 releases. T50 releases when D/2 operates. The allocated link in the subscriber's unit releases when C/2 releases. The two connector bars release simultaneously, and load to the operated subscriber's horizontal bar. This action causes the operation of the horizontal bar "off normal" springs. TN1 relay circuit is opened at TR1/1. The T1 magnet coil circuit is opened at TR1/2. The loaded subscriber's multiple restores, except for the loaded contact wires held by the connector bar elements. D relay releases when TR1/2 opens, and D/1 allows "C" relay to reoperate. D/2 allows T50 (bar 50) to reoperate. The release of the connector bar releases relays A and A1, A1/1 opens circuit of relay V (slow release). A1/5 opens circuit of relay K. A1/2 opens circuit of relays RT1 and PIRT. The circuit of F and G relays is opened at K/4 and A2/5, and they release. This reoperates RA, RC and RD. SCH reoperates via earth, RF/1 operated, RE/2 operated, RD/4 operated, RC/2 operated, 10,000 ohm coil SCH, RA/4 operated, RB/2 operated, RC/1 operated, KO1/1 released, R5 to battery. SCH/1 releases relay A2. When V releases, the allocation of the next free link takes place as previously described.

Subscriber's Unit

The subscriber's unit connector bar released when its holding circuit was opened at C/2 in the exchange unit. Relays RA, RC and RD reoperate in series with RA, RC and RD in the exchange unit. RF/1, RE/2 and RD/4 reoperated, release RT1, and together with RC/2, reoperate SCH. RC/1 and RA/2 reoperated, release T1 magnet and relay D. The next free link allocation takes place as described, under the control of the exchange unit.

Basically, the calling final selector earths the private of the called sub, operates a TN relay which causes a combination of G and F relays to operate. G and F operating, release marking relays in the group RA-RF. These relays released, permit operation of an RT relay in the group RT1 to RT13 and the subsequent operation of the desired subscriber's circuit horizontal magnet.

CALL FROM CONCENTRATOR SUBSCRIBER VIA PARENT EXCHANGE

Assume Subscriber No. 1 Calling

TN1 operates via earth, TR1/1 normal, subscriber's loop, TR1/2 normal, 900 ohm coil TN1, A/4 operated ABS/2 normal, D/1 normal, 400 ohm R3 to battery. G5 and F1 operate via earth, chain contacts G1/2 to G4/2 normal, 46 ohm coil G5, TN1/1 operated, 150 ohm RTN1, 60 ohm and 4,300 ohm coil F1 in series, chain contacts F2/1 to F7/1, MK.4 terms. S-/1 contacts of allocated link, "A" side of link, S-/1 contacts of allocated link in exchange unit, 3,200 ohm coil U1, 600 ohm R12, U/1 operated, MK.4 terms, AB1/2 operated, A2/5 operated, 20 ohm R4 to battery. In marking group RA-RF, RA is opened at G5/1, RC at G5/3 and RD at F1/2. Relays RA, RC and RD are also released in the exchange unit, and the subsequent operation is similar to that for an incoming call to subscriber.

A subscriber remains loaded onto a link circuit at the completion of a call, until the link is reallocated. A call to or from the loaded subscriber cannot actuate a TN relay circuit, since they are opened in both units by the subscriber's horizontal off normal springs.

Terminating Call

Since the loading of a subscriber to a link commences when the final selector earths the private, a slight delay (500 m.s. approximately) will be present between the time the final selector switches and feeds ring forward and the actual time when the subscriber receives the ring. This is, however, of little significance, since a normal subscriber may have a delay of two seconds for the same conditions, due to the "quiet" period in the ring cycle.

Originating Call

Also due to the loading time, (500 milliseconds) a concentrator subscriber would experience a similar delay when calling out, between the time of lifting off and the time of receiving dial tone, as compared to a normal subscriber.

In the case of the call to or from an already loaded subscriber, no switching takes place in the concentrator, and no additional delay would exist, as compared to a normal subscriber.

GENERAL

No special treatment of exchange equipment is required for the operation of this system, apart from the extension of the required subscriber's Final Selector multiple P, — ve, and + ve wires to the exchange unit. Testing (from a test desk) of the subscriber's equipment can proceed normally, as the test final selector earths the private of the required subscriber, causing the unit to connect via a link circuit to the distant end.

Concentrator subscribers may call each other, although this requires the use of the two links (trombone trunking). If simultaneous calls are made through the system, chain relay contacts (G1/2. F1/1 etc.) prevent incorrect marking and also give preference to one of the required subscriber's circuits.

The maximum junction (link) loop resistance between exchange and subscriber's unit is 780 ohm. The theoretical maximum loop resistance between the subscriber's unit and the subscriber may be 3,500 ohm. However, the combined subscriber's and junction loop must not exceed the normal limits laid down for subscribers and exchange equipment, i.e., a combined resistance of 1,000 ohms with a 400 type telephone and 2,000 type exchange.

If all junctions (links) are busy, the following applies:—

(1) A subscriber calling out will not receive dial tone until a link becomes free.

(2) An incoming caller will receive ring tone from final selector, but ring will not be fed to the called subscriber till a link becomes free. This second condition could lead to D.N.A. complaints and a modification can be made to busy idle subscribers under all links busy condition.

In the above two cases when a link circuit becomes free, it is immediately loaded to the concentrator subscriber required for the uncompleted call, which then proceeds normally. Contacts in the exchange unit are extended to two meters mounted externally, which record the number of times the "all links busy" condition exists, and also the duration of the condition. The occupancy meter is fed by six second pulses. Thus 10 meterings indicates a total "all links busy" duration of one minute. Alarms are connected to the unit to indicate:—

(1) Fuse alarm (4 heat coil type fuses are in the exchange unit).

(2) Open condition of any one of the three marking wires, MK I, II, III.

(3) Open condition of the pilot wire supplying 72 volt D.C. to the subscriber's unit or failure of a subscriber's unit connector bar to operate and hold. (This could be due to the corresponding link pair being open).

(4) Failure of an exchange unit connector bar to operate and hold.

Power Supply

The exchange unit is supplied with 48 volt D.C., 72 volt D.C. and 70 volt A.C. The 70 volt A.C. is used to operate the marking relays RA-RF in both units, but is supplied directly only to the exchange unit. The 48 volt is distributed via 3 (1 amp) fuses in the exchange unit. The 72 volt D.C. is fed from the exchange unit over a pilot wire (MK IV) to the subscriber's unit, where it is used to operate the lifting coils of the connector bars. Since this pilot wire could be of considerable resistance and the lifting coil requires a relatively high operate current, the pilot wire at the subscriber's unit connects both to the lifting coil circuit and also a 3,500 μF capacitor (2 x 1,750 μF in parallel.) This capacitor charges over the pilot wire and provides a "reservoir" to be tapped during short periods of high current drain.

To ensure that this capacitor is reasonably charged between subsequent calls, a slow releasing relay V is used in the exchange unit to provide a delay between successive calls. The slow release is effected by using V relay with three windings in series and a release shunt path of a 100 μF capacitor in series with a 500 ohm resistor.

Subscriber Circuits Not in Use

In the units these circuits have the "C" wire strapped to battery via 600 ohm resistor RJ6 in the exchange unit. This strapping is done on the terminal strips in the exchange unit only. This ensures that a connector bar being accidentally or incorrectly loaded to a spare circuit, may be tested as free and "allocated" by the presence of the "C" wire battery during testing.

Link or junction circuits may be busied by opening the testing circuit of the particular link. To busy link No. 1, insulate contacts VB1/3 to busy link No. 2, insulate contacts VB2/3 to busy link No. 3, insulate contacts VB3/3, etc It is important before busying a link circuit, to unload it from any subscriber. This must be done electrically, thus, links should be taken into use until the junction to be busied is "allocated", this unloads the subscriber. The appropriate VB contact is then insulated and the "disconnect" button operated. This releases the link and another free link is then allocated.

Once a subscriber is loaded to a link circuit, no electrical component or potential of any kind is applied to either wire (A or B) of the subscriber's speaking circuit, nor to the private wire in the exchange by the concentrator. The through connection consists only of two relay type contacts (connector bar off normal springs, S-/1, S-/2), and the connector bar to horizontal bar connection in each unit. The subscriber may therefore be regarded as working normally over a temporarily allotted cable pair.

JUNCTION (LINK) FAULT CONDITIONS

As the "A" and "B" legs of the preselected (allocated) link are used for marking and holding purposes, various fault conditions on the link pairs will cause differing reactions in concentrator operations. Examples are discussed below.

Link Pair—Open "B" Side. Open "A" and "B"

Under these condtions, the holding (B) leg is open and the link when allocated fails to hold and step on occurs, that is, the sequence testing progresses to the next link circuit. If a calling subscriber's circuit is loaded to the faulty junction before the fault occurs, the subscriber cannot make or receive calls until such time as the sequence allocation raises the connector bars of the faulty link and releases the subscriber's horizontal bars.

Open "A"

With this condition, the link may be allocated, and will hold (on B side) but a concentrator subscriber calling out cannot obtain battery over the "A" leg to operate the F and G marking relays. Therefore, the allocated link will not be loaded to the calling subscriber. This means that no concentrator subscriber can call out except those already loaded to other links.

However, a call through the parent exchange to a concentrator subscriber other than those already loaded will cause loading of the faulty link to the called subscriber. This will cause sequence allocation of the next free link and calls will proceed normally until the faulty link is again allocated. Any subscriber loaded to the faulty junction will be out of service until freed by link allocation.

Ground "B" Side. Short Circuit. Ground "A" and "B" Side

Under these conditions the subscriber loaded to the faulty link becomes a "P.G" in the parent exchange and the busy condition on the private ("C") wire prevents sequence allocation of the faulty link. Thus the loaded subscriber remains out of service until the link is artificially unloaded.

Ground "A" Side

A subscriber loaded to this link would be out of service until the link was allocated again in sequence. Dependent upon the combined resistance of the earth fault and the wire resistance to that point, various conditions occur:—

(i) If above approximately 20 ohms the line may appear noisy to the subscriber and may prevent subscriber tripping incoming ring.

(ii) If a very low resistance fault, e.g., a heat coil on the "A" side of the link in the exchange, then the subscriber's fuse (1 amp) in the exchange unit may operate. The nature of the fault on the "A" will determine:— Whether the circuit is noisy but usable. Whether the ground will shunt the battery supply to the subscriber's F. and G. relays and prevent calls out. Whether the incoming ring cannot be tripped, because of the shunting effect on the ring return battery.

CONCLUSION

Concentrator working permits a number of low calling rate subscribers to have access to the parent exchange, using a greatly reduced number of cable pairs to the parent exchange than would be necessary under normal subscriber working.

It is felt that the use of line concentrators should not be planned for in exchange line networks, but concentrators will prove a suitable method of providing telephone service in areas where severe line congestion exists and rapid residential development is taking place.

The concentrators should then be used as an interim measure to provide service to potential subscribers who would otherwise be denied a telephone service for many years.

Connection of subscribers to concentrator units must be closely supervised to prevent overloading of the units and should overloading occur, selected heavy users should be removed from the concentrator and given an exclusive service which can be accomplished without a change of numbers.

Line concentrators should preferably be mounted in weatherproof cabinets adjacent to line distributing pillars rather than within buildings. This arrangement would permit the reallocation of concentrators to other areas without disturbing the subscriber's premises, and the cost of subsequent reinstallation would be much less. The Gfeller Line Concentrator was extensively tested to determine its reliability in service and a total of 115,000 simulated terminating and originating calls were made through the concentrator requiring a complete switching operation for each call. These calls were distributed evenly over 10 of the 49 subscriber circuits and the 9 link circuits, which represented a wear equivalent to approximately 10 years' service assuming an average of 3 calls per subscriber per day.

There were no detected failures in the unit and the only noticeable effect resulting from the test was a discoloration and very slight pitting of some relay contacts which was corrected by a light burnishing with a contact cleaning tool.

REFERENCES

1. G. Morris, "Line Concentrators—An Installation at Box Hill (Victoria)"; The Telecommunication Journal of Aust., Vo. 13, No. 2, page 137.

2. H. V. Paris, "Subscriber Line Concentration"; A.T.E. Journal, Vol. 15, No. 4, page 313.