The Telecommunication Journal of Australia

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VOL. 11, No. 4 JUNE, 1958

SIR GILES CHIPPINDALL, C.B.E.

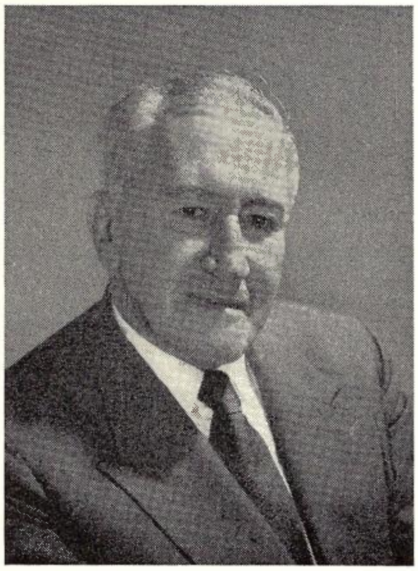
On 20th May, 1958, Sir Giles Chippindall retired from the position of Director-General, Postmaster-General's Department, after a distinguished career marked by outstanding achievement in many fields. Brief details of Sir Giles' earlier activities were given in the February, 1949, issue of the Journal following his appointment as Director-General. Apart from earlier service in various sections of the Postmaster-General's Department and also with other Departments, he has thus served almost 10 years in control of Australia's biggest "business" organisation.

In his term as Director-General, Sir Giles has seen the Department's activities expand to a very large extent. In this regard the total exchange lines in the Commonwealth increased from 650,000 to 1,300,000 in the ten year period from June, 1947, to June, 1957, while in the same period the Department's assets grew from approximately £90,000,000 to £403,000,000. It is also of interest to note that the value of the fixed assets of the Engineering Division are at the present time somewhat greater than the fixed assets of the Broken Hill Proprietary, Snowy Mountains Hydro-Electric Authority, General Motors-Holdens and Imperial Chemical Industries organisations combined.

Although Sir Giles has had the overall responsibility of developing the Post Office during this period, he has never lost his interest in the individual problems which beset the many members of the staff, including those in the Engineering Division. With his wide experience of Australian industry and his knowledge of overseas practice, it is encouraging to hear his often expressed view that "the Australian workman is second to none".

From the Telecommunication Journal viewpoint, his interest has been of a practical value in that he has given official support to its production activities during his term as Director-General. The Postal Electrical Society and the Board of Editors, wish him well in his retirement.

MR. P. E. R. VANTHOFF, O.B.E., M.V.O.



Mr. P. E. R. Vanthoff, O.B.E., M.V.O. has succeeded Sir Giles Chippindall, C.B.E., as Director-General, Posts & Telegraphs. Mr. Vanthoff has had a varied and interesting career in the Post Office which he joined as a Telegraph Messenger at Rushworth, Victoria, in February, 1908. Three years later he was appointed as Assistant in the Melbourne Mail Branch and in 1913 was promoted as a Clerk at Central Office.

He served in the Correspondence, Postal and Engineering Branches until August, 1924, when he transferred to the new Telephone Branch that had been set up at Headquarters. Subsequently, he became Inspector (Commercial) and Inspector (Traffic) and in April, 1944, was promoted as Chief Inspector (Telephones). In June, 1945, Mr. Vanthoff was transferred as Chief Inspector (Postal Services) and in August, 1948, was appointed to the new position of Director (Planning and Organisation) which was created to cope with the Department's abnormal post-war problems. Soon afterwards he was appointed as Deputy Director-General and occupied that position until his recent promotion to the highest position in the Post Office.

During the visit to Australia in 1934 of His Royal Highness, the Duke of Gloucester, Mr. Vanthoff was the liaison officer for the Department and accompanied the Royal Party on the Australian Tour. He was responsible for co-ordinating and implementing the postal and telecommunication arrangements and at the conclusion of the tour, His Majesty King George VI, honoured Mr. Vanthoff by an award of the M.V.O. Her Majesty Queen Elizabeth II, further honoured Mr. Vanthoff in the 1955 New Year's Honours List, when he was awarded the O.B.E.

The Society congratulates Mr. Vanthoff on his appointment to his present position and he can be assured of the loyalty and co-operation of all members in the tasks that lie ahead.

MR. E. M. DOWSE

More than 140 officers and friends attended a function arranged by the Engineering Division and held at Russell Exchange Building on Thursday, April 17, 1958, for the purpose of bidding farewell to Mr. E. M. Dowse on his retirement as Deputy Engineer-in-Chief (Services), of the Australian Post Office.

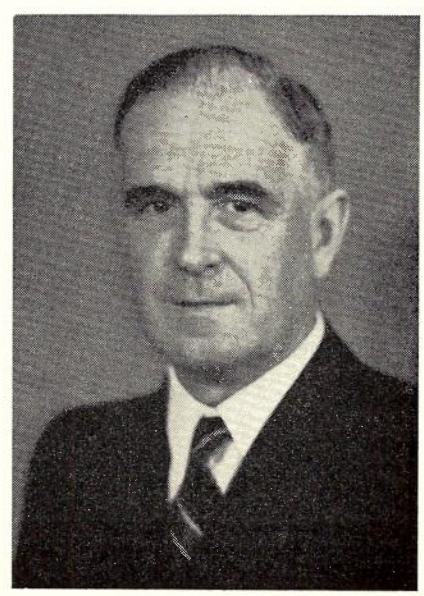
Mr. Dowse has had a very interesting and varied career in the Post Office. He commenced duty as a Junior Instrument Fitter in Queensland in 1910 at the age of 17. Within four years he had passed both the entrance examination to the Professional Division and the technical examination for appointment as Engineer. In 1926 he was promoted as Telephone Equipment Engineer, Brisbane, and in 1936 obtained the position of Assistant Superintending Engineer, Queensland. His keen and active brain led him to the investigation of many problems during this period. Amongst other things he was responsible for the development of an early form of 2 V.F. trunk dialling system and also for the introduction of transit trunk switching into the Cairns trunk network. Mr. Dowse, during this period, took a very keen interest in Post Office publicity matters and was responsible for the development of many novel publicity exhibits in the Brisbane Show. One of these, which was the subject of an interesting article in the June, 1937, issue of the Telecommunication Journal, attracted wide interest throughout the Commonwealth and was featured in all mainland State picture theatres.

Mr. Dowse was promoted to the position of Assistant Superintending Engineer, New South Wales, in 1939. He did not remain in that position for long, however, as he was again promoted as Supervising Engineer, Telephone Equipment Section, Headquarters, in 1940. He was appointed Chief Inspector, Buildings, in 1948, the title being altered to Assistant Director-General, Buildings, in 1949. Further promotion followed in 1950 as Assistant Director-General, Planning and Organisation, and he was appointed Deputy Engineer-in-Chief in June 1956.

During Mr. Dowse's service at Headquarters, his experience and aptitude in many phases of the Department's work resulted in him being selected to carry out many special assignments. For example, in 1941 he was appointed Chairman of a special Costing Committee which conducted an investigation into all phases of accounting, statistical and record work associated with the Engineering Branch. He also prepared technical evidence for presentation to the Arbitration Court in the 40-hour week case, to demonstrate how productivity in the Post Office had increased. The fact that he was selected as the first Chief Officer of the newly created Buildings Branch is also an indication of the confidence his superior officers had in his ability to launch a new venture. His flair for organisation lead to his being selected to investigate the top level management of the Engineering Division on several occasions and resulted in the introduction of important improvements in control.

Mr. Dowse has always taken a keen interest in the activities of the Postal Electrical Society and his article entitled "Post Office Publicity", which was published in the Journal, is still regarded as a model of how a clear description of a subject should be presented.

All our best wishes go to Mr. Dowse in his retirement.



THE MELBOURNE AUTOMATIC WEATHER INFORMATION SERVICE

*T. F. REED, A.M.I.E.E., and D. I. GILLETT**

INTRODUCTION

This service was opened to the public at 9.00 a.m. on Monday, October 21, 1957, and the continued public response has shown that a useful service is being given. Previously, weather information and forecasts were handled at the Melbourne Weather Bureau switchboard and, particularly at times of severe weather conditions, this proved to be a difficult and onerous task for the Bureau staff.

At the instigation of the Weather Bureau, investigation was made into the practicability of handling this traffic by some automatic means. An examination was made of the methods used by other telephone administrations and it was evident that the provision of automatic verbal recording and announcing equipment embodying the magnetic tape recorder principle would best meet the requirements and relieve the Weather Bureau of the bulk of these routine enquiries for weather information. At the time, the only equipment designed specifically for this type of service was made in America and two machines were purchased and installed in City West exchange to establish the service on a trial basis in Melbourne. The weather reports are received from the Melbourne Weather Bureau on a teleprinter installed in the Melbourne Trunk Exchange and trunk telephonists, selected for their suitability for this work, carry out the recordings. Thus, the weather information given to the public is controlled by the Melbourne Weather Bureau and each forecast is recorded and made available to the public within a few minutes of its receipt. The forecasts are normally changed at about three hourly intervals during the day and less frequently at night.

The idea of recording verbal announcements for transmission to telephone subscribers is not new and was tried out experimentally many years ago by various means, but it was not until the close of World War II when details of the magnetic tape recorder, developed in Germany from about 1932 onwards, became available, that much interest in this type of message recorder was shown by telephone administrations. The rapid development of the commercial tape recorder using ferro-magnetic coating on paper or plastic tape followed but its adaptation to this type of service did not meet with any great success since under conditions of continuous operation, the wear on the tape and the magnetic recording and reproducing heads became a serious problem. Similarly, ferro-magnetic coated discs, as used in some offices for typing services, suffered from the same disadvantages. Improved coatings with highly polished surfaces, giving reduced wear, and the use of replaceable pole-tips on the heads has lessened this objection, but tape or disc and head replacements remained a problem for services where the running time was virtually continuous.

In 1952, however, the American Bell Company in developing equipment of this type for their Information Services gave considerable attention to the problem of wear on the tape and heads and eventually evolved a recording band of synthetic rubber impregnated with magnetic iron oxide that had low abrasive properties and ensured long life. In actual life tests several million message repetitions were made on this material with insignificant wear of the recording band and of the magnetic heads and with no measurable deterioration of the level and quality of the recordings. These factors had considerable influence in deciding the purchase of this type of equipment for the Melbourne service.

TRAFFIC

The response to the service in Melbourne was immediate and to some extent overwhelming. At first, only 30 trunks were connected as this was stated to be a maximum loading of the equipment amplifiers but tests showed that with a changed output transformer a greater number of trunks could be handled safely without appreciable loss in level, and within 48 hours the number of trunks was increased to 40. To meet the rapid increase in traffic that can arise with abnormal weather conditions, further increase in the trunking is contemplated. It is interesting to note here that the experience with such a service in New York in 1952 resulted in an increase from the normal rate of 71,000 calls per day to something like 270,000 per day under conditions of severe weather — an increase of nearly four times.

Despite the limited number of trunks available in Melbourne initially, the traffic to this service on the first three days averaged about 26,000 calls per day and then decreased steadily to about 10,000 calls per day at the end of three weeks. A graph of the calls per day during the first four weeks of operation is given in Fig. 1 from which the effect of unusual weather conditions can be seen by the steep rise on days when the temperature in the city rose to over 90 degrees F.

The trunking provision to be made to cater for the peaks of traffic that can arise under unusual weather conditions, at which time the telephone public will be relying on the service for information, is likely to be somewhat higher than that provided under normal "grade of service". It has been determined that an increase in the number of trunks to 116 is necessary to cater for these traffic peaks.

DESCRIPTION OF THE EQUIPMENT

In the recorder, commercial tape recording and reproduction is achieved by drawing the ferro-magnetic coated tape at a constant speed over the face of a small ring type electro-magnet provided with a very fine gap in the pole face arranged at right angles to the length of the tape. In the machines

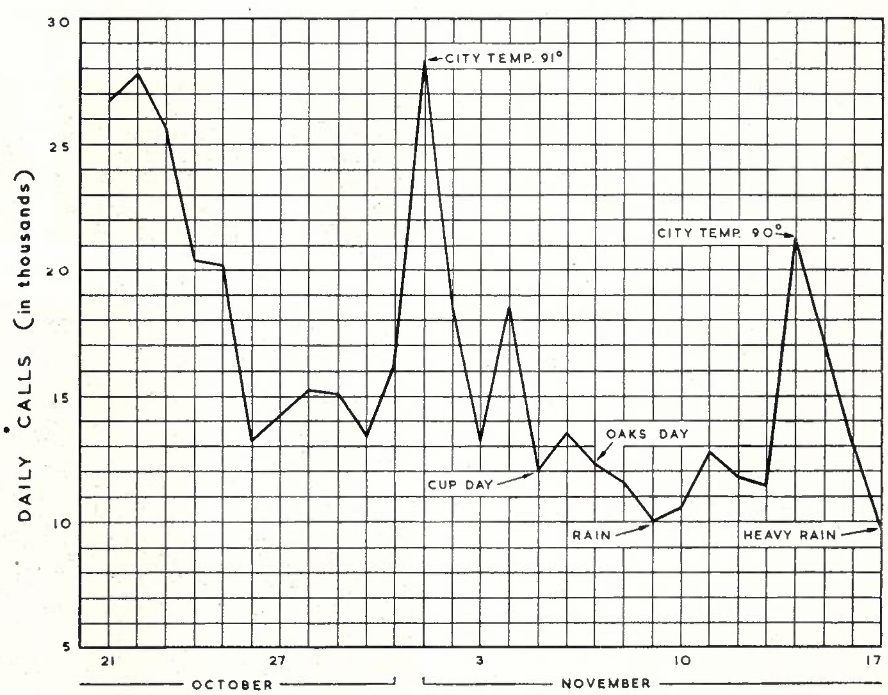


Fig. 1.—Showing Calls per Day over First Four Weeks.

*Mr. Reed is a Divisional Engineer and Mr. Gillett, a Group Engineer, in the Telephone Equipment Section at Headquarters.

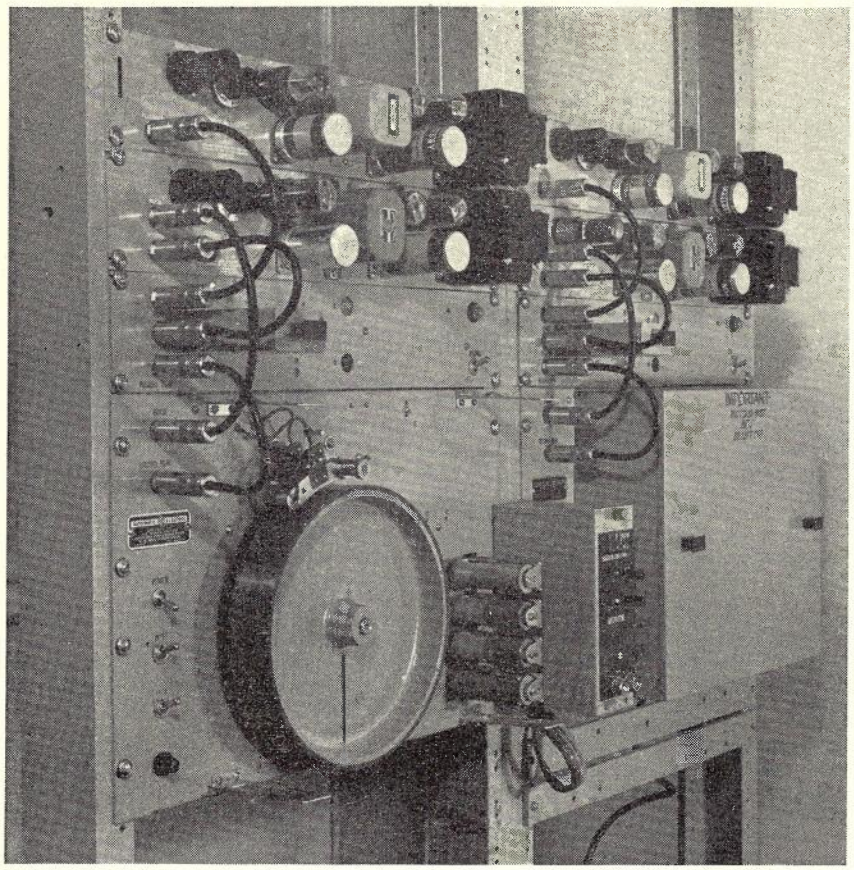


Fig. 2—View showing the Amplifiers, Recording Drum and Heads.

installed for the Weather Information Service a similar arrangement is used except that the electro-magnetic head rides on the surface of an impregnated "Neoprene" band fixed to the periphery of a wheel 8 inches in diameter and about 1¼ inches wide. This wheel is driven by a small capacitor-start induction motor through a gear train. Rubber-tyred wheels and a rubber tyre on the inner edge of the recording wheel are used to provide a vibration-free drive.

The recording and erase heads are mounted on a carriage and when operating are moved across the recording medium to describe a helical track on the drum representing, at a speed of about 4 inches per second, a playing time of about 80 seconds. This gives ample margin for normal weather information announcements which seldom exceed 30 seconds in duration. The recording head which also serves as the reproducing or play-back head trails an erase head which during recording removes any previous message recorded on the drum. The recording amplifier comprises three stages giving an overall gain of about 50 db and includes an oscillator delivering HF current at approximately 30 kcs for erasing and bias. The play-back amplifier comprises a four stage high gain amplifier giving approximately 87 db gain overall and delivers about 2 watts of audio power into the distribution circuits.

The recording drum and heads can be seen in Fig. 2. The amplifiers are mounted above the recording mechanism panel. The head carriage mechanism is so arranged that it returns to the start automatically at the end of the message and not from the end of the whole track. Thus "dead" time between message repetitions is considerably reduced. If this were not done the "dead" time would in most cases exceed 40 seconds and would be intolerable in practice.

The American equipment as supplied was designed for normal operation at the rack using only one set of equipment, and for withdrawal of the service while the new recording was being made. In the Melbourne installation, to safeguard the service as far as practicable against equipment failure, duplicate machines were purchased and installed and arranged for recording without interruption of service. A separate recording room was provided and was acoustically treated to reduce the ambient noise level to below 50 db which ensured a low recorded background noise. The recording console for the use of the recording telephonist was designed and installed in this room and is shown in Fig. 3. The face panel is provided with keys and lamps controlling the recording and checking of messages and the changeover of machines. To ensure that only authorised personnel can make recordings the panel is fitted with a Yale type control lock, and a key is issued to the recording telephonist. To further reduce the possibility of recorded room noise and to maintain, as far as practicable, a constant level of recording, the microphone distance was fixed by the use of a telephone handset. One of the latest 400 type telephone handsets, modified to accommodate the variable reluctance microphone which was supplied with the equipment was used, but it was found necessary to remove the annular rim and the perforated centre to reduce hiss due to air turbulence over the edge of

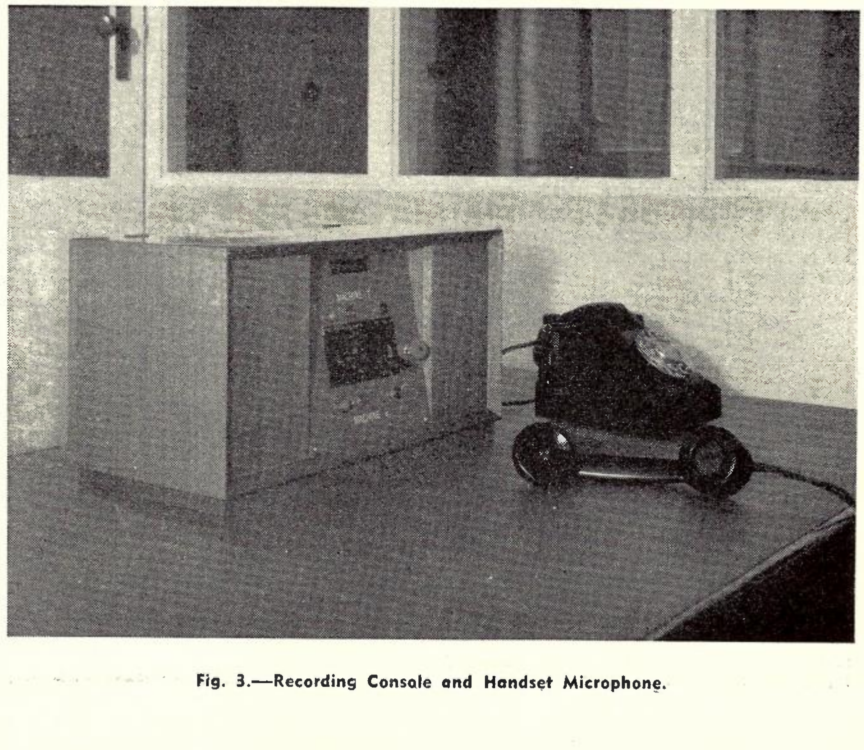


Fig. 3.—Recording Console and Handset Microphone.

the rim and against the perforations. The normal earpiece is used by the telephonist to check the recording she has made and the play-back is attenuated to simulate the level heard by a subscriber at the edge of the metropolitan network and is approximately minus 15 dbm.

Fig. 4 shows the equipment mounted on standard 19-inch panels with a play-back amplifier, record and erase amplifier, control relay panel and recording mechanism panel on each rack. The lower portion of the second rack accommodates the control and alarm relay sets and a 100 watt 48 volt to 240 volt 50 c/s converter of the vibrator type with an automatic changeover relay incorporated, and safeguards the service in the event of mains failure. The changeover of this vibrator type unit is so fast that no change in the announcement can be detected, when the mains supply is switched off. A loud speaker is provided for monitoring purposes by the technician as required and connections between the various panels are arranged with patch cords. Although not shown in the photographs, provision is being included for a monitoring and meter panel which will enable all valves to be checked and also provides for checking the output level. The output from the play-back amplifiers is fed to a transformer with a low impedance secondary winding which can serve up to 100 simultaneous connections and the output level is adjusted to give an average speech level of about -3 dbm at the distribution point.

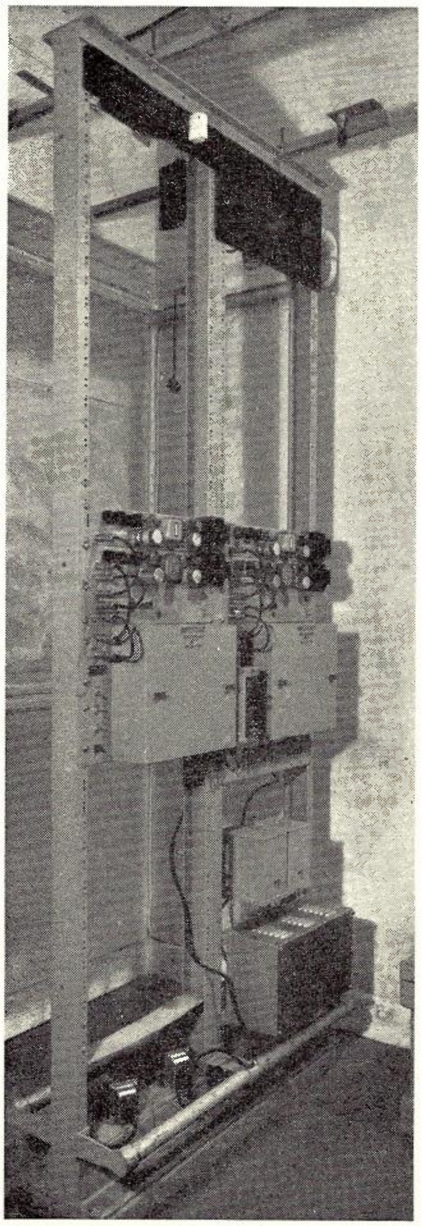


Fig. 4.—Complete Rack Mounted Equipment.

In the Melbourne installation the switching level used is M064 and the incoming trunks terminate on relay sets to Drawing CE.11031. These relay sets are similar to those used on the Time Service and are interchangeable with them. The speech circuit of each relay set is decoupled from the common output by 200 ohm resistors in each leg of the circuit and this, with the low impedance output winding of the transformer, ensures freedom from crosstalk between subscribers when simultaneously connected to the service. Provision is made for NU tone to be connected should the output from the machines fail and a forced release condition is applied to disconnect any caller after about six repetitions of the message to reduce holding time of the circuits.

Both machines carry the same message and either machine can be placed in service with the other standing by. Changeover to the standby machine is automatic and is controlled by the announcement fail circuit which operates to give an alarm and change the machines over on a fall in recorded level below 6 db over a time interval of about 10 seconds. Experience so far, has shown the provision of a third machine to be desirable to enable either of the duty machines to be taken out of service for maintenance, overhaul or servicing due to failures, and in future installations a spare machine will be provided.

EQUIPMENT PERFORMANCE

For telephone purposes high quality reproduction is not normally required although freedom from excessive noise and distortion is necessary. A signal-to-noise ratio of 30 db and harmonic distortion of 5% represent satisfactory values.

As with other magnetic recording systems, some measure of equalisation is necessary to compensate for the falling response at both high and low frequencies and therefore the upper frequencies are accentuated on recording while the lower frequencies are increased on play-back. This was incorporated in the equipment when received, but tests showed that for services of this type using both male and female voices further equalisation would be beneficial.

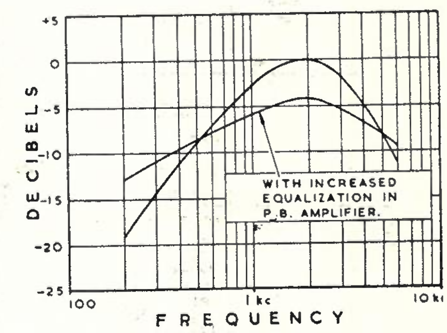


Fig. 5.—Overall Frequency Response.

The general shape of the overall response curves before and after additional equalisation are shown in Fig. 5. The level is about 10 db lower than that obtainable with commercial tapes due largely to the fact that the magnetic oxide concentration in the recording band is less, on a volume basis. This is not a serious matter however, since with a good level of recording the output from the medium is sufficient to permit of amplification without encountering difficulty due to noise.

The recording amplifier, as supplied, was found to have insufficient gain to give a good recording level, and a pre-amplifier stage was added which enabled the play-back amplifier gain to be reduced for the same speech output level. This gave a considerable improvement in the signal-to-noise ratio which previously was unacceptable due to first valve noise and induced hum with the play-back amplifier set at high gain. Apart from the reduction in gain of the play-back amplifier, the hum difficulty was overcome by removing the mains transformers supplied to convert the 240 volt mains voltage, to the 115 volt American standard, to the lower part of the rack and rotating them to minimise hum induced into the play-back heads. First valve noise was reduced by careful selection of valves for the first stage. A measured noise level, of 45 db, giving an overall signal-to-noise ratio of 33 db, was obtained.

In magnetic recording the signal is largely confined to a thin surface layer and commercial tapes are not usually coated to more than 1 mil thickness. With thick recording bands of the types used on these machines there is a certain amount of penetration into the depth of material at low frequencies, which is not completely removed by the H.F. erase head. In the course of time this increasing residue causes background noise, and it is therefore necessary to adopt a routine of complete erasure at regular intervals to maintain a satisfactory noise level. A 50 c/s high level bulk eraser is therefore used at least once a week to remove all traces of signal and noise residue from the recording bands. At the same time the machines are lubricated and the bands cleaned. The bands are lubricated with a thin silicone lubricant applied very sparingly and then polished with a lint free cloth.

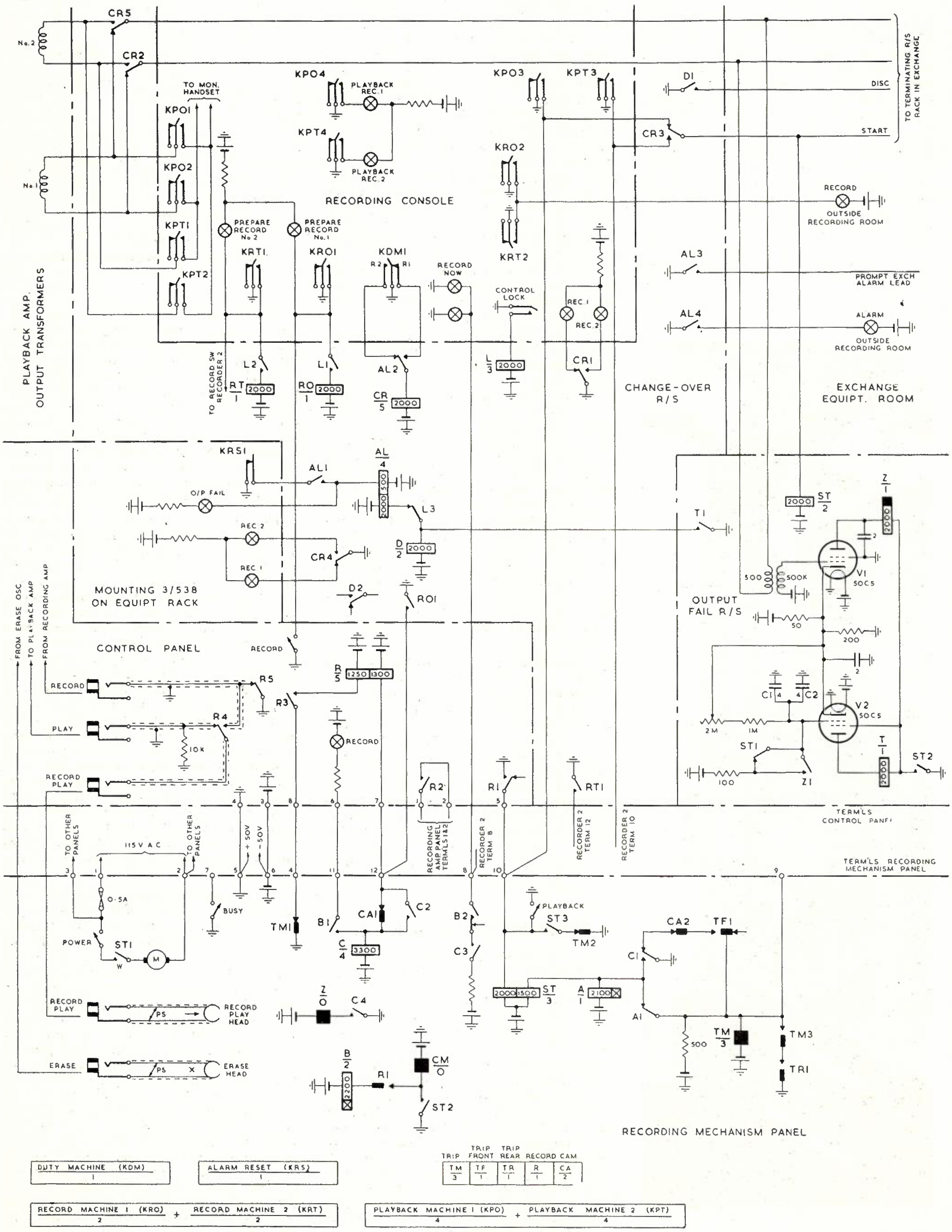


Fig. 6.—Schematic Circuit of Recording Control and Alarm Equipment.

Tests made on the equipment immediately after installation revealed the presence of considerable flutter, and it was necessary to give attention to the bearings and other mechanical details to reduce it to an acceptable amount. Some difficulty was also experienced with varying output level at the higher frequencies amounting at times to as much as 15 db. This was eventually traced to the too liberal use of lubricant applied to the recording band. Although the film of lubricant was extremely thin, probably less than 1/1000 of an inch, it was sufficient to separate the head from intimate contact with the recording medium and so lowered the level of play-back at those parts of the surface where the lubricant was present. Removal of all but the merest trace of lubricant and polishing the surface brought the variation at 1000 c/s within a few db. This serves to emphasise the need for maintaining intimate contact between the heads and the recording medium, particularly when it is appreciated that the loss due to spacing is approximately 55 (d/λ) db where d is the spacing, and λ is the wave length.

At a frequency of 4 kc/s and at the track speed used, this is of the order of 55db per thousandth of an inch spacing.

With the comparatively low track speed and a drum diameter of 8 inches, the time for one revolution of the drum is about 6½ seconds and this time, added to any the telephonist may incur in delaying the start of her message or in restoring her record key at the end of the message, could give rise to a "dead" time between repetitions of some considerable length which may lead to some apprehension or confusion with the subscriber. The latter delays have been reduced by careful training of the operators, but the delay due to the equipment can only be reduced by an increase in speed of the drum or a reduction in its diameter, or by some means to ensure that the recording operator synchronises the end of the message as closely as possible to the instant the cam springs operate. This latter method of controlled recording is difficult to achieve with changing personnel and since the drum diameter is fixed, an attempt was made to increase the speed ensuring that a reasonable recording time was available and at the same time avoiding overshoot of the start position due to the increased speed. This has been achieved by increasing the diameter of the drive capstan and the maximum delay time due to the equipment has been reduced to about 4½ seconds. Apart from reducing this delay, the increase in drum speed has slightly improved frequency response and output level.

The circuits on the recording console have been arranged with a view to making the operation of the equipment such that it could safely be used by the recording staff without the need for technical staff assistance during recording. To this end also, in addition to the use of a telephone handset to maintain a fairly constant level as mentioned previously, it was considered desirable to include some degree of automatic gain control in the recording amplifier to correct for the

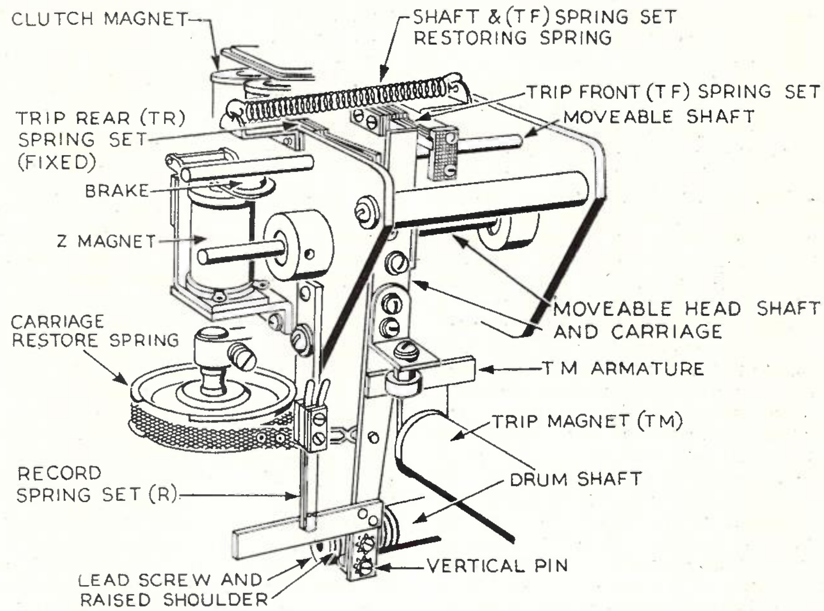


Fig. 7.—Rear View showing Essential Mechanical Details of Recording Panel.

natural differences in speech level between male and female voices, thereby obviating the need for adjustment of amplifier gain by technical staff on each recording and for each individual recording operator. The design of a suitable automatic gain control circuit has been undertaken and will be tried out later. At present however, having regard also to the need to ensure recordings having a satisfactory "dead" time interval, technical assistance on each recording is given.

OPERATION AND CIRCUIT DETAILS

A simplified schematic circuit of the recording, control, and alarm equipment is shown in Fig. 6, and the essential mechanical details may be seen in Fig. 7. The movable head carriage in addition to providing for the correct tracking of the record-play head also operates the record (R), trip rear (TR), and trip front (TF) spring sets; the latter two spring sets control the tripping mechanism. The tracking of the head carriage is controlled by a vertical pin which engages in a lead screw on the drum shaft, such that when the drum is rotating the carriage is moved towards the front edge of the drum.

In the stationary position the vertical pin rests on a raised shoulder on the worm which keeps the head raised from the surface of the drum and the record and trip rear springs opened. When a start signal is applied to the motor the clutch magnet (CM) operation engages the motor drive with the record drum shaft, and after approximately one quarter revolution of the latter the pin drops into the thread of the lead screw and lowers the record-play head to the drum surface and closes the record springset. The movement of a projection on the head carriage which normally holds the trip rear springs open now allows these springs to close. The record-play head is tracked over the drum as described earlier.

To the armature of the Z magnet is attached a rubber bushing which acts as a brake on a movable shaft supporting the trip front springs, so that the shaft is free to move only while recordings are being made. When the Z relay operates, the shaft and TF springs are returned to the normal position by a shaft restoring spring. During recording the shaft is moved by a projection on the head carriage until the completion of the recording, when the release of the Z magnet holds the shaft and TF springs in a fixed position. On subsequent replay the operation of the TF springs actuates a tripping mechanism which mechanically lifts the vertical pin from the lead screw, the head from the drum, and also opens the record springs. A standard typewriter carriage restore spring returns the head carriage to the normal position whence the trip rear springs are opened by a projection on the carriage.

The sequence of operation of the mechanically operated springsets is as follows:—

(1) The record (R) and trip rear (TR) springs close when the pin associated with the head carriage fully engages in the lead screw.
(2) The trip front (TF) springs operate at the conclusion of a recording, and
(3) The cam spring assembly (CA), actuated by a cam on the periphery of the record drum, operates for approximately 250 milliseconds during each revolution.

In operation the output of one of the machines is connected to the exchange whilst the other serves as a standby. Considering recorder 2 as the duty machine, then the operation of the CR relay at CR3 connects the exchange start lead to machine 2 and CR2 and 5 switch the output of machine 2 to the exchange. A lamp indication of the duty machine is given on the equipment rack and the recording console by contacts CR4 and 1 respectively.

When the key is turned in the control lock the L relay operates to prepare a circuit for either the RO or DT relays. The operator first records the new message on the standby machine and the operation of key Record No. 1 (KRO) energises relay RO in the changeover relay set and lights the "Prepare Record No. 1" lamp. A second key springset (KRO2) lights a warning lamp outside the door to the room, indicating that recording is in progress. RO1 extends an earth via terminal 12 of the recording mechanism panel and the cam springs (CA1) to operate relay C, and also relay R in the control panel. C4 operates the Z magnet which frees the trip front springs (TF1) and prepares for them to be positioned by a projection on the head carriage as described previously. C1 operates relays A and ST and C3 prepares to light the "Record Now" lamp on the recording console. A1 opens the trip magnet (TM) circuit. ST1 via a tungsten contact connects power to the motor, ST2 operates the clutch magnet (CM) which sets the record drum in motion and ST3 locks ST so that on play-back the whole of the recorded message is repeated. This ensures that the head does not rest on one portion of the drum for prolonged periods which would result in flat spots being formed on the recording surface and ultimately distortion in the message.

Meanwhile the operation of R relay in the control panel performs the following functions. R2 completes an earth circuit to the cathode of the erase oscillator in the recording amplifier panel which feeds HF current to the erase head to remove the previous recording, R3 locks relay R and R4 switches the record-play head from the play-back amplifier to the recording amplifier. After approximately one quarter revolution of the record drum the record and trip rear springs close and the record-play head is lowered on to the drum surface. The record springs allow relay B to operate which at B1 extends an earth to light the "Record" lamp on the control panel, while B2 lights the "Record Now" lamp on the recording console. The recording may commence immediately the "Record Now" lamp glows.

At the conclusion of the recorded message restoration of the record key at KRO1 releases the RO relay which in turn releases relay C and opens the operate winding of relay R. The R relay is held locked on its second winding to an earth at TM1 to provide erase current until the tripping mechanism is actuated. C4 releases the Z magnet which marks the end of the recorded message and prepares for the operation of the trip front (TF) springs as described earlier. C1 opens the original operating circuit of ST relay which remains locked, and releases relay A. C1 in changing over extends an earth via CA2 and TF1 springs to operate the TM magnet which locks to the earth at TR1. TM1 releases the R relay which opens the output of the recording amplifier and re-connects the record-play head and the play-back amplifier. R2 causes the erase oscillator to be biased to cutoff and R1 and TM2 each remove ST relay holding earths which releases.

The operation of the TM magnet also causes the head carriage to be mechanically restored to normal where the R1 and the TF1 springs open. Relay B releases and B1 opens the "Record" lamp on the control panel. In the normal position, the TR springs open which releases the TM magnet.

Facilities are provided for monitoring the output of either machine. To check on the completed recording, the operation of key play-back machine No. 1 (KPO), at KPO3 extends an earth via terminal 10 of the recording mechanism panel to energise the ST relay. ST3 locks ST, ST1 connects power to the motor and ST2 operates the CM magnet which engages the clutch and rotates the record drum. After approximately one quarter revolution of the record drum, the TR1 and R1 springs close and the head is lowered on to the drum surface. The recorded signal is fed from the head via patching cords to the input of the play-back amplifier. Across the secondary winding of the output transformer are tappings which enable connection via key contacts KPO1 and 2 to the operator's monitoring handset. When the operator is satisfied that a good recording has been made, and at the completion of the announcement of the machine connected to the exchange, the key KDM is restored which releases the CR relay. CR3 switches the start lead to machine 1, CR2 and 5 connect the output of machine 1 to the exchange, and CR1 and 4 light appropriate lamps on the recording console and the equipment rack. The output of machine 1 is now connected to the exchange and recorder 2 is free. The operator now makes another recording, identical to that described above, on the second machine.

The output fail relay set is connected across the output lead to the exchange equipment. The cathode of V1 and V2 are maintained at a potential of 40 volts negative. At periods when there are no callers to the service relay ST (connected to the exchange start lead) is normal and hence the T and Z relays are unable to operate. ST1 however, holds the capacitors C1 and C2 in a charged state.

During operation relay ST is held operated by an earth on the start lead. Speech peaks applied to the grid of V1 cause plate current to flow to operate relay Z which at Z1 holds the grid of V2 at a potential of 50 volts negative to prevent T relay from operating. The negative grid bias to V2 is maintained during speech pauses, and in the intervals between announcements by the capacitors C1 and C2, which discharge to earth via the 1 megohm resistor and the 2 megohm potentiometer. The discharge circuit has an adjustable time constant of approximately 5 to 18 seconds, dependent upon the potentiometer setting. Therefore with normal output level the Z relay pulses to the speech peaks and T remains released. However, if the speech level falls appreciably the plate current of V1 falls below the non-operate current value of relay Z and after the delay period, relay T operates and energises the AL and D relays in the changeover relay set. AL1 locks AL, AL3 extends an earth to the exchange prompt alarm system, and AL4 lights an alarm lamp outside the recording room. AL2 either releases relay CR or operates CR dependent upon which is the duty machine. The result is in both cases to switch to the standby machine. An exception to this procedure would apply when failure of the duty machine occurs while a recording is being made on the standby equipment. It can be appreciated that automatic changeover to an incomplete announcement would be undesirable, and to prevent this, contact L3 opens the operate circuit of the AL relay. The T1 contact however provides a circuit for the D relay, which at D1 operates a relay on the recorded announcements relay set rack to feed N.U. tone to the subscribers until the recording on the standby machine has been completed. The tone is applied to the 570 ohm winding of a standard 200/200/570 ohm relay in the recorded announcements relay set and induced into the double 200 ohm windings to give a balanced tone feed.

CONCLUSION

The success met with in this service will doubtless open up the field for extension of such services to other capital cities and possibly for other types of information services to telephone subscribers. So far as the equipment itself is concerned, experience to date has shown the need for attention to detail in the mechanical construction of the machines and has vindicated the choice of machines of the drum type using thick impregnated rubber recording bands which are capable of withstanding a great many recording and reproduction cycles without undue wear or degradation of the announcements while requiring a minimum of maintenance attention. The technical experience gained will also be invaluable in the future integration of magnetic recording and reproducing devices into the telephone system to replace the human element, particularly in handling routine advices.

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WHY THE AUSTRALIAN POST OFFICE WILL ELIMINATE LETTERS FROM TELEPHONE NUMBERS

*B. MARROWS, M.Sc., B.A.**

INTRODUCTION

A long term plan for the development of the Australian telephone network is now being prepared by a Committee known as the A.N.S.O. (Automatic Network and Switching Objectives) Committee. The ultimate objective of the plan is nation-wide Subscriber Trunk Dialling. This means that every subscriber in the Commonwealth will be able to dial every other subscriber in the Commonwealth. Its completion demands several features such as:—

(1) Automatic service for every subscriber.
(2) Equipment to control the routing and charging of calls.
(3) Equipment to switch calls at the originating, the terminating and all intermediate exchanges.
(4) A great increase in the number of telephone channels.
(5) Signalling facilities to operate over the various types of trunk channels provided.
(6) A transmission plan to ensure that subscribers will be able to hear satisfactorily.

All facilities must be available at reasonable cost, offer a high degree of reliability and must inter-work with existing plant. Clearly this is not the sort of programme that can be completed within a few years, nor even within a decade, but once the plan is outlined all future moves can be made in conformity with this plan and Subscriber Trunk Dialling introduced wherever conditions are favourable. Already subscribers at several automatic exchanges a short distance beyond metropolitan networks have been provided with the facility to dial the nearby capital, the trunk line charges being automatically recorded on the subscriber's meter.

THE NATIONAL NUMBERING PLAN

One further essential of the national plan is a numbering scheme which will provide a separate number for each subscriber in the Commonwealth—a number which is reasonably short and which will minimise the possibility of incorrect dialling. The numbering scheme must be big enough to cater for anticipated growth at least to the end of the century; it must provide special codes for such services as operator assistance and information; it must allow for wastage of numbers at exchanges which will not require exactly 100, 1,000 or 10,000 numbers. These considerations necessitate a numbering scheme which has a nominal capacity of 100,000,000. Normally, an 8 digit number would be sufficient to select any one of 100,000,000 numbers, but national numbers will generally consist of 9 digits including an initial digit 0.

Use of the distinguishing 0 in the front of all national numbers arises as a result of local 'closed' numbering areas which are already established in metropolitan networks and at many provincial centres. Most calls originating within these areas do not go beyond the boundaries of the area concerned. It is easier for subscribers and cheaper for the Department to arrange that such calls can be completed simply by dialling the existing local number. Only calls beyond the area will then require the full national number. Ultimately, local "closed" numbering areas or districts will be established throughout the country.

0 in the front of the national number will serve to tell the equipment that this is a national call and not a district call. When a subscriber wants to dial another subscriber in the same district he will only have to dial the district number, for example MU 1234 or 744 2468. If he wishes to dial a subscriber in a different numbering district he will have to dial the full national number such as 02 - 523 7890 or 066 - 45 6789.

THE ALL-NUMERICAL PRESENTATION OF TELEPHONE NUMBERS

That brings us to the main point of this article. The national numbering plan for Australia is based on the all-numerical presentation of telephone numbers. Letters used at present will be replaced by the corresponding numbers; A. will be replaced by 1, B by 2, F by 3, etc. No change in routing will be required and a correct connection will be obtained whether the letter code or the number code for the called exchange is dialled. The introduction of this system will be gradual.

Firstly those exchanges in the Sydney and Melbourne networks which must be converted to 7 digit operation because of shortage of 6 digit exchange codes, will be given all-numerical codes. Cronulla subscribers in New South Wales have been listed in this manner since 1957, for example 523 4321. Similarly Clayton and Springvale exchanges in the Melbourne network will be given exchange codes 744 and 746 respectively in the 1958 directory. Secondly, all new subscribers, and subscribers who experience a number change due to removal or cut-over, will be given the all-number treatment. Finally, directories which must be completely re-set either because of change in format (for example Brisbane 1958), or replacement of worn type (for example Perth and Hobart 1958), will be converted to the all-numerical presentation. In this manner the changeover will be effected without cost to the Department.

Here are the main reasons for the change:

More Accurate Dialling: One of the most annoying things that can happen when making a phone call is to get a wrong number. It is even more annoying for the subscriber wrongly called. Tests have shown that the percentage of wrong numbers dialled increases with the length of the number and also with the number of symbols corresponding to each aperture of the dial. Although steps are being taken to keep numbers as short as possible, it will be necessary in Sydney and Melbourne networks to use 7 digit numbers in order to meet development, while as mentioned previously, national numbers will generally consist of 9 digits. However we can reduce the number of symbols corresponding to each aperture of the dial very easily by eliminating the letters from telephone numbers and eventually from the dial itself.

Letters and numbers which sound alike are another source of wrong numbers. Some of the more commonly confused letters and numbers are F and X, J. A and 8, B and 3, UU and W. Errors due to the similarity of these sounds occur when the numbers are being passed by word of mouth from friend to friend, from secretary to executive and from subscriber to operator. Here again errors can be reduced by eliminating the 10 letters at present in use.

Faster Dialling: All-numerical dialling is faster than dialling using letters. This is because it is easier to find a number, say 7—which you know is opposite the seventh aperture and can find even in the dark—than to find a letter, say 'U' which you must look for. The best way to prove this is to watch someone dial—you will note a marked increase in speed once the numbers are reached. It is not surprising that dialling time increases also with the number of symbols corresponding to each aperture, since the fewer symbols shown on the dial, the easier it is to find the one you want. To the individual subscriber a saving of say half a second in dialling time is of little consequence, but collectively the saving of half a second on each of the 1,000,000,000 calls that the nation now dials in a year is equivalent to a saving of 72 men working 48 weeks of 40 hours.

To the Department this time will be even more valuable since an integral part of the national plan is the extensive use of exchange registers which offer the following advantages:

(1) Channel costs are reduced by the selection of the most direct route for most calls and the use of highly efficient alternate routes for overflow traffic.

(2) Equipment costs are reduced by eliminating intermediate switching stages on a large percentage of calls.

(3) The most extensive and flexible use of the numbering plan is obtained.

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A register is an expensive and complex piece of equipment which is seized by a subscriber when the receiver is lifted. It acts like an operator, accepting the call, routing it over the most suitable trunks and often selecting the appropriate charge rate for the call. Then it is freed for another call. Consequently the holding time of a register is only about 10 seconds and a saving in dialling time of even half a second would produce a substantial reduction in the number and hence the cost of registers required at an exchange.

Wider Number Range Available: Now that it is necessary to use both 6 and 7 digit numbering in the Sydney and Melbourne networks, many codes involving the use of U and W would be too confusing to use in the letter form. There are also many 3 letter combinations which form unusuable words. No such restrictions apply to all-numerical codes. Complete elimination of letters prolongs the life of the national numbering plan. Alternatively, it permits a numbering plan of no more than 9 digits, whereas restrictions enforced by large scale use of letters might well force us into a 10 digit national numbering plan.

Accounting Simplification: Many processes associated with trunk line dockets and the preparation of subscribers' telephone accounts lend themselves to automatic treatment. The all-numerical presentation of telephone numbers greatly facilitates the use of automatic accounting equipment, particularly systems which use punched card equipment or electronic computers.

MEMORY

Most of the public believes that the all-numerical form of telephone numbers will be harder to remember than the present letter-number form. There is no doubt that having remembered many telephone numbers in one form it will take a little time before the same numbers can be remembered in a different form, and it may be that even on a long term basis some people will be able to remember the combination of letters and numbers more easily than the all-numerical equivalent. But extensive tests conducted by Doctor Conrad of the British Medical Council's Applied Psychology Research Unit, on the ability of telephone operators to correctly remember long telephone numbers of 8, 9 and 10 digits, show that all-numerical combinations are greatly superior to letter-number combinations when heard, and only slightly inferior to letter-number combinations when read. Dr. Conrad's conclusion was that ". . . There is no real advantage in using relatively non-meaningful letter arrangements."

The most disturbing aspect of the tests however, was that in practically all cases the telephone operators believed they had remembered all telephone numbers correctly, even though in some cases of all-letter combinations, as many as 70% were in fact incorrectly remembered. This accentuates the importance of not trying to remember telephone numbers but referring to a telephone list of some kind before and during dialling. In common with most other organisations which use long series of numbers, and in common with other telephone administrations which are forced into the use of long telephone numbers, the Australian Post Office will find it necessary to discourage the attempt to remember telephone numbers.

As a first step in this direction all local telephone numbers will be broken into two groups of digits with 4 digits in the second group and a space between the two groups like this:—

5 1234
78 2468
or 625 1357

Corresponding national numbers might be:—

0567 - 5 1234
066 - 78 2468
and 03 - 625 1357

Fewer errors will occur if a subscriber dials only a small group of numbers before referring again to the written number.

THE 24 LETTER DIAL

From people who are familiar with the London director system, there sometimes comes the suggestion that we should introduce the British Post Office 24 letter dial which is illustrated in Fig. 1.

Fig. 1—London Dial

A sample of London telephone directory entries is given below:—

Eel Brook common S.W.6
.... RENown 2602
Emslie Horniman Pleasance W.10
.... LADbroke 2166
Finsbury park N.4. (Tennis Courts)
.... STAmfd Hl 9309

There is no doubt that such a system can be arranged to greatly assist in the memory of telephone numbers by using the first 3 letters of the exchange name, for example, CAM for Camberwell and AMH for Amhurst. This system was introduced in London when there was already a large network of manual exchanges existing at the time automatic switching was introduced. The manual names were retained in order to soften the impact of the change to automatic working.

Those disadvantages of using letters already mentioned are considerably aggravated with a 24 letter dial. Confusion of sounds is increased by the additional 14 symbols which are used. The letter I and the number 1 appear at different places on the dial and if one is mistaken for the other a wrong number will result. The letter 0 is out of place. Dialling speed and accuracy is further reduced because it is now necessary to have as many as four symbols corresponding to one aperture. Further restrictions are placed upon the number of exchange codes available. Many numerical combinations such as 666 or 999 have no possible place-name equivalent. On the other hand many place-names having the same numerical equivalents cannot all be used for example, Camberwell and Canterbury, Ashwood and Brighton. In London ony 352 three-digit codes are suitable for use as exchange names. Even if such a system were considered desirable, it would not be possible to introduce it in this country without first changing to an all-numerical system, since the location of letters on our present dial is not compatible with any arrangement suitable for a 24 letter dial.

THE 25 LETTER DIAL

Canada and the U.S.A. use the 25 letter dial illustrated in Fig. 2 with entries in telephone directories similar to the following.

Chalter Edw coml artst 1265 Bway
.... LExngtn 2.9603
Chaltin Carol 346W84
.... TRaflgr 3.5189
Chaltin Helene R 417 5Av
.... MUryhil 4.5035

Generally speaking the 25 letter dial has the same characteristics as the 24 letter dial, but with the added confusion caused by the location of the letter O and the number 0 in different places. Mistaking one for the other—and this is very easy to do—will produce a wrong number.

By utilising only the first two letters of the exchange number and forsaking the idea of using geographical names for exchanges, the system obtains 480 usable three digit exchange codes. Typical examples would be Capitol 5, University 2 and National 6 with corresponding

Fig. 2.—New York Dial

dialling codes CA5, UN2 and NA6. However, there have been moves to eliminate the full exchange name in favour of the first 2 letters so that Detroit directory in 1958 and Chicago in 1959 are scheduled for printing with only the first 2 letters of the exchange name.

A trial is also being made of the all-numerical presentation of telephone numbers in Wichita Falls, Texas. There is frequent expression of the opinion in the U.S.A. that letters on dials are the cause of many of their wrong number calls. The following statement made by the Technical Editorial Director of "Telephony" is typical.

> "We are firm in our belief that eventually letters will be eliminated from our telephone numbers and that this action will eliminate many wrong number calls and will thereby contribute much towards the betterment of telephone service".

CONCLUSION

Fortunately the use of letters in Australia has not been extensive and the change to all-numerical presentation can be effected smoothly without the provision of any additional equipment. When letters are finally eliminated from all telephone numbers, the removal of letters from the dial will be a comparatively simple matter of replacing the present cardboard inset.

It will then be possible to have a simple, attractive dial such as the one illustrated in Fig. 3 and along with most other countries of the World — New Zealand, Honolulu, Argentina, Mexico, Eire, Germany, Sweden, Hungary, Egypt, Pakistan, India, Japan and South Africa to name a few—we will have adopted the only possible international numbering system, all numerals. At the same time, because of faster and more accurate dialling, this will improve service and reduce costs.

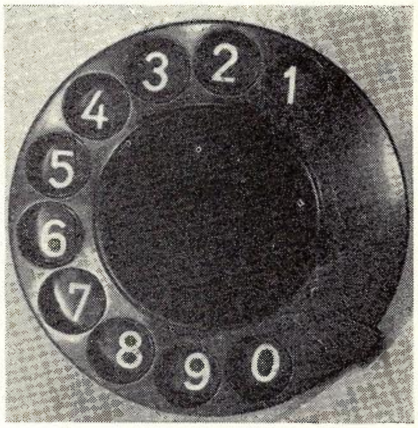

Fig. 3—Future Australian Dial

POSTAL ELECTRICAL SOCIETY OF VICTORIA

ANNUAL REPORT 1957/1958

During the past year the lecture programme included talks by Messrs. H. Wragge, L. Estberger, of the L. M. Ericsson Telephone Co., C. Lindsay and W. Keating on a number of subjects of interest to members. Through the courtesy of the Department, members were able to visit the Research Laboratories and see some of the work which is being done there, while a visit was also arranged to the cable factory of Austral Standard Cables Pty. Ltd., to whose management the Society must extend its thanks for the occasion.

Apart from these two visits, all meetings were held in the Radio Theatre, Royal Melbourne Technical College, and our thanks must, once more, be extended to the Principal and his staff for the facilities which have been placed at our disposal.

The publication of "The Telecommunication Journal of Australia" has been continued, and, thanks to the efforts of the Editors, it has been possible to overtake a good deal of the lag in its publication, as foreshadowed in the last Annual Report. As we commenced the year with a considerable lag in publication, and this naturally persisted for some months, the full benefit of the improved position has not been felt, but it should give greater satisfaction to subscribers during the coming year when we may look forward to the issue of journals at the published date and during the current year of subscription. At the end of the year we have nearly 1,800 current subscriptions, of which 143 are on behalf of people in overseas countries. The delays referred to above have resulted in the renewal of some 300 subscriptions being outstanding at this time, but, on past experience it may be expected that the great majority of these will be brought up-to-date.

In connection with the collection of subscriptions the Committee of the Society considered that introduction, on a trial basis during the past year, of the payment of commission to a limited number of collectors who deal with the collection of subscriptions from, and the distribution of Journals to more than 40 subscribers each year. The Society is very much indebted to these gentlemen, Messrs. O. Polmear (N.S.W.), J. Mead (W.A.), J. Dockerty (Vic.), and B. Biebrick (S.A.), for their efforts on its behalf. All told, they deal with some 700 subscriptions annually.

In conclusion, it is the wish of the Committee that its thanks be extended to the many members who have assisted in the collection of subscriptions in a smaller way, to the authors of articles, and members of the drafting staff who have prepared illustrations, during the 1957/58 year.

R. D. KERR,
Hon. Secretary.

THE DEVELOPMENT OF TELEPRINTER EXCHANGE SERVICE IN AUSTRALIA

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D. Y. McFADDEN, A.M.T.C., A.M.I.E. Aust.

INTRODUCTION

In an article by R. D. Kerr(1) in a previous issue of the Journal, some of the technical problems involved in the establishment of a telegraph switching system in Australia were discussed and the lines upon which these problems were being attacked was described. It is intended in this article to describe the progress which has been made so far in Australia and the future lines of development of direct switching telegraph systems.

The chief application of a direct switching telegraph system has been in the provision of a subscribers' switched telegraph service analogous to the public telephone switching network. This service, known as telex service, has shown high rates of development overseas and rapid development has occurred in Australia during the short time the service has been in operation.

Fig. 1 shows the extremely rapid development of telex traffic in the European system, a development which shows no

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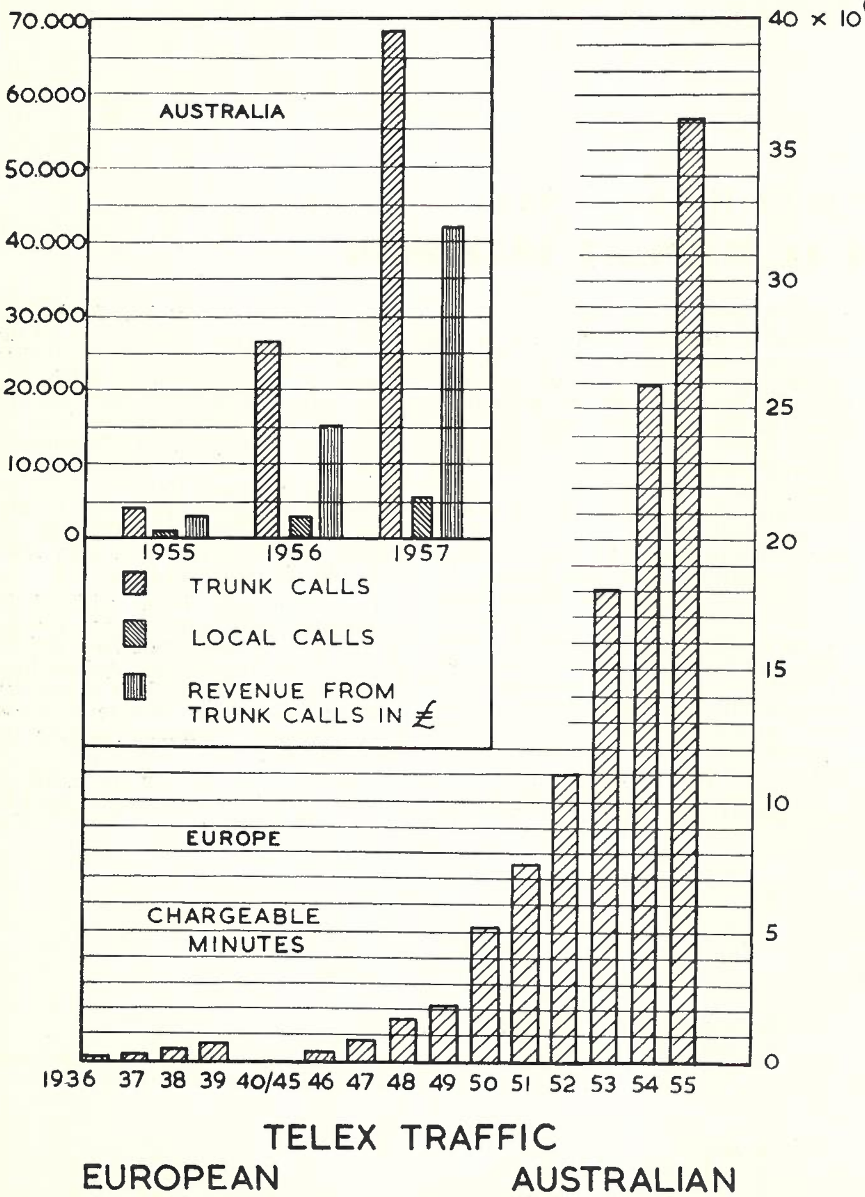

Fig. 1.—Growth in Telex Traffic in Europe and Australia. Note European Figures are in Chargeable Minutes of Call and Australian Figures are in Number of Calls.

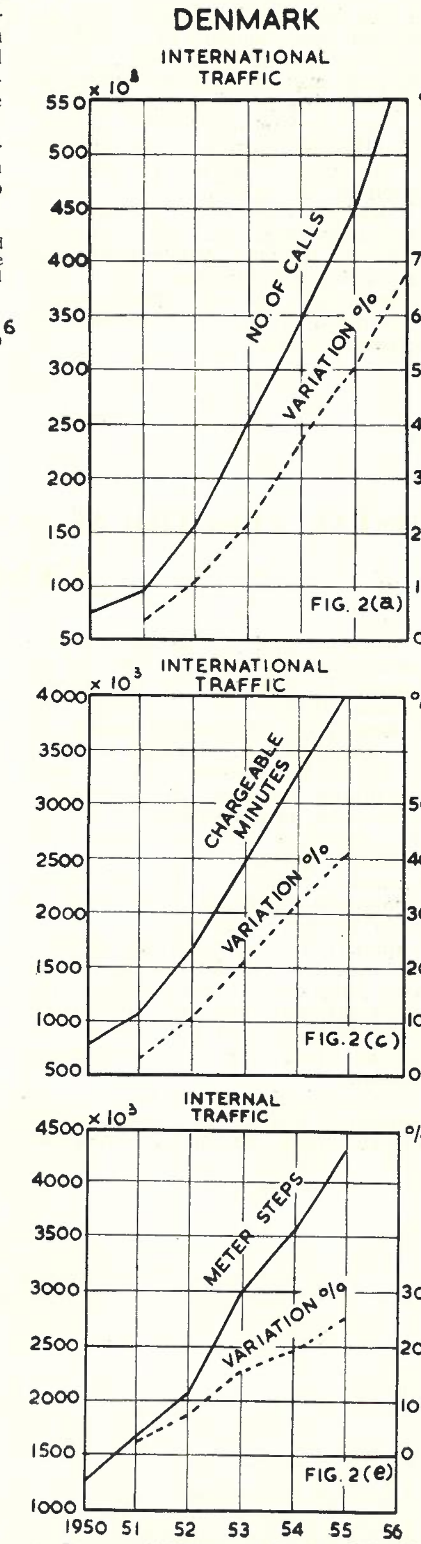

Fig. 2.—Statistics For Danish Network.

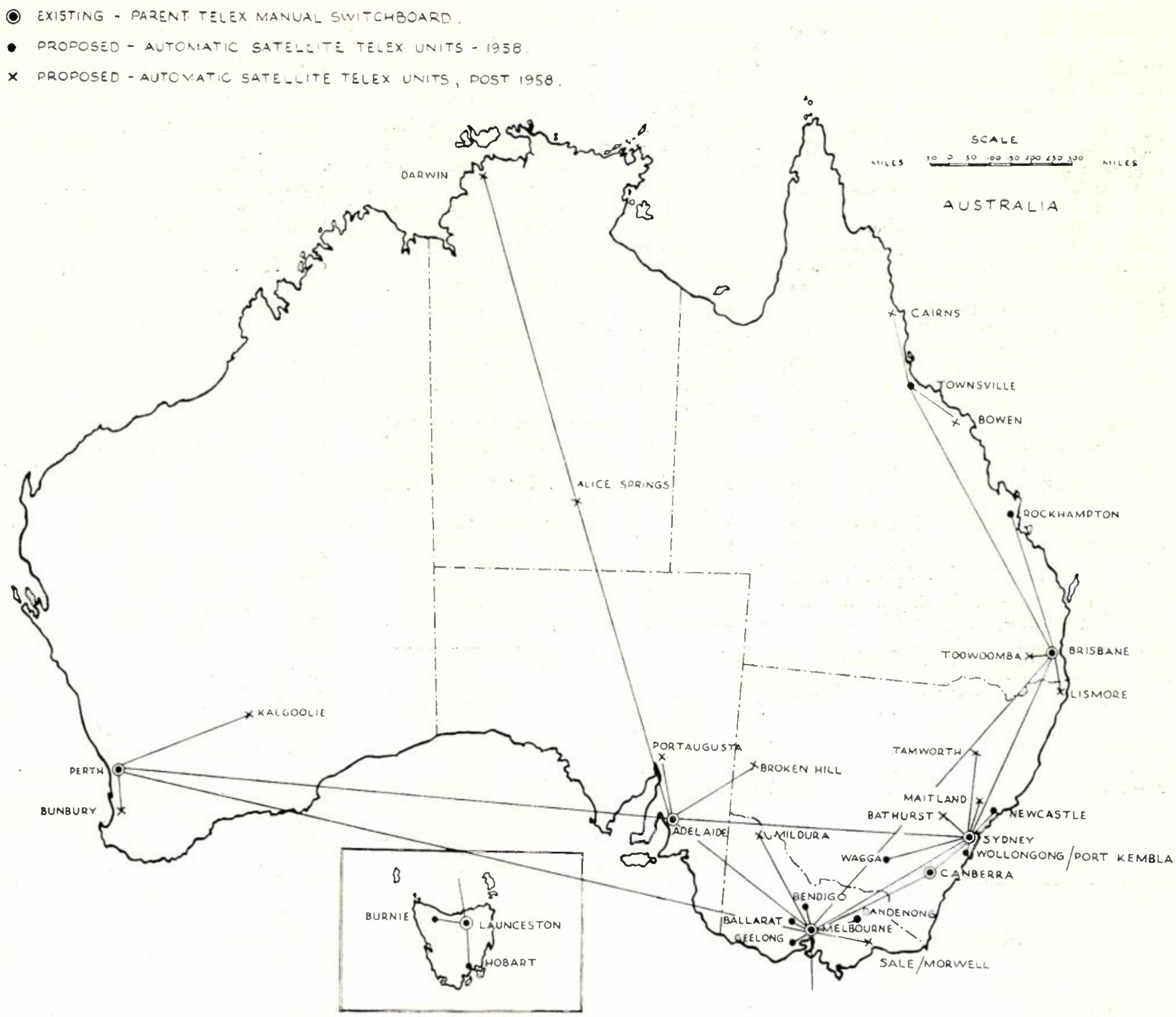

Fig. 3.—Australian Exchange Network.

sign of slackening on the most recent figures available (1955). The same figure shows development of the Australian service since it began between Melbourne and Sydney on the 1st August, 1954. The European and Australian figures cannot, strictly, be used for comparison purposes because the European figures use "chargeable minutes" as the traffic measure whereas Australian statistics available are in number of calls. Fig. 2 gives statistics for the Danish network showing that for their international traffic, roughly equivalent in type to our present largely inter-capital city trunk telex traffic, the two measures are not very different, a small decrease in the average length of call occurring as the number of calls increase. It may also be noted from Fig. 2 that this country which has a population of approximately half Australia's 10 million is handling over 10 times the number of calls handled in the Australian system, and secondly that telex service is not overwhelmingly a long distance trunk service, though early development in Australia has covered that requirement first. Development in other countries in Europe presents a pattern similar to that in Denmark. Probably the most interesting conclusions which can be drawn from these figures is that there is quite a large field yet to be tapped in short and medium haul telex traffic in Australia and secondly that long distance telex traffic in Australia will continue to expand rapidly. The first conclusion has prompted the development of automatic line concentrator units, referred to later in this article, trunked off parent manual boards to provide service from provincial centres. Fig. 3 shows the present Australian network and extensions planned for 1958.

A question of importance in future planning of Australian telecommunication services is the effect of telex traffic on the older public telegraph and the telephone service. Partly due to the effect of the development of an efficient long distance telephone service, public telegraph traffic in Australia is decreasing and the development of telex service is likely to make that decrease more rapid. The past seven years provide data for the European systems showing that the decline in the amount of traffic handled by the public telegraph systems has become more pronounced the more rapidly the telex service has been developed, but that long distance telephone traffic has shown a stable increase. For the Netherlands the number of telex calls has already passed the number of telegrams per annum. Fig 4 (a) shows the traffic trends for telephone, telegram and telex traffic between Denmark and the Netherlands over the post-war years. It is noteworthy that the number of telex calls now exceeds the number of telephone calls (though the number of telephone calls has continued a general slow upward trend) and that telex traffic has increased rapidly while public telegram traffic has shown a general decline and is now declining at the rate of about 7% per annum. Similarly Fig. 4 (b) indicates that inland Danish telex traffic has shown a 250% increase on 1950 figures at the end of 1955, while public telegraph traffic showed a 28% decrease and trunk telephone traffic about 12% increase on 1950 figures.

Figures for growth in number of subscribers are difficult to interpret because of the short history of telex in most countries, but in the United States where the Bell System has provided their TWX service since the early 1930's, by 1936 there were 10,000 subscribers, in 1942 20,000, in 1951 30,000 and in 1957 38,000. In Germany where a telex network over telegraph channels has been in operation since 1935, there are now over 18,000 subscribers; the most recent annual figures available show that there was a 29.6% increase in 1955. Australia in mid 1957 had about 330 subscribers, approximately 70 trunks connected, and about 70 printergram positions provided. Growth in the Australian telex service so far as lines connected is concerned is shown in the following table:—

	No. of subscribers	No. of printergram positions	No. of trunks	Remarks
30.6.55	95	37	5	Melbourne - Sydney service commenced 1.8.1954.
30.6.56	159	51	10	Service extended to Brisbane 8.8.55.
30.6.57	330	70	70	Service extended to Adelaide on 9.7.56, Canberra on 23.7.56, Perth 12.12.56, Launceston 25.6.57. Figures include departmental administrative subscribers.

The figures given below demonstrate that in other countries with modern communication services telex growth has been extremely rapid and that during the short period telex service has been offered in Australia rapid growth has also taken place. However, prediction of future rates of growth is difficult for the following reasons:—

(a) Until 1957 telex service could not be given over large areas of Australia and can not now be given very profitably to provincial centres; automatic telex line concentrators to these centres will be installed during the next year. The changing nature of the exchange network means that previous rates of growth do not give much guidance to expected future rates.

(b) European figures must be assessed against the European background and cannot be directly translated to the Australian network, for example the language differences in Europe favour written rather than spoken communication. A number of telegraph adminstrations also favour a subscriber operated service as against the public telegraph services. These conditions do not apply within Australia.

(c) The existence in Australia of a large network of private wire fixed (that is non-switched) services providing exclusive subscriber operated telegraph service for the major telegraph communication users, for example, airlines, weather, press, industrial and commercial undertakings. These services produced in 1956/57 about ten times the total revenue (machine rental plus channel charges) produced by telex services (machine rental plus call fees). Future growth of these fixed services will be affected by the existence of a full telex network but conversely their advanced state of development reduces the field available for expansion of telex services. In the European countries the early introduction of telex service did not give fixed services this initial advantage to the same extent.

(d) The comparative communication tariff structure and the place of the telex tariff in it as between Australia and U.S., Australia and Germany, Australia and Sweden, etc., is very difficult to assess because it is really a question of assessment of a complex of tariff structures; for example, telephone as against public telegraph, public telegraph as against telex, public telegraph as against airmail, telex as against fixed private wire must all be taken into account within each country and then compared as between countries.

(e) The commencement of international telex service to Australia during 1958, which will open the extensive European and United States networks to Australian subscribers is a factor which will tend to increase telex

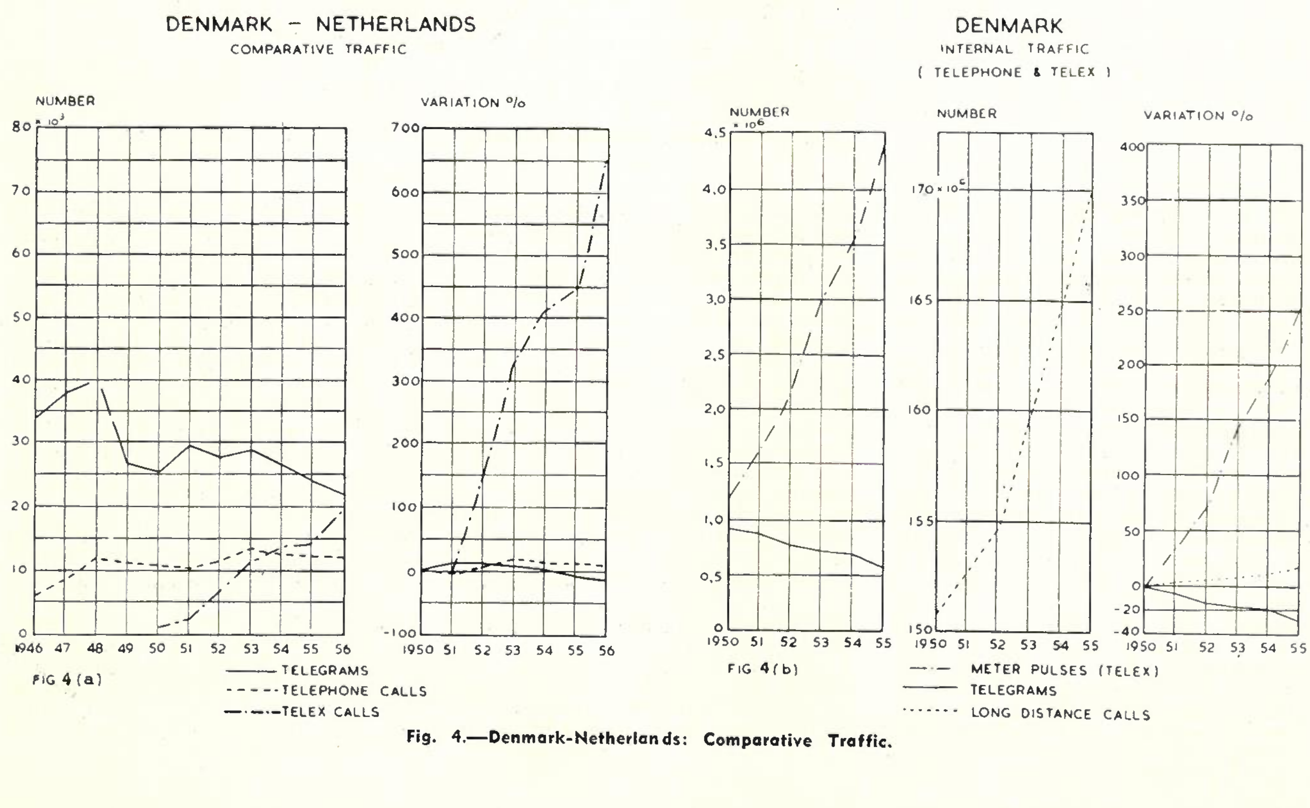

Fig. 4.—Denmark-Netherlands: Comparative Traffic.

development in Australia but it is difficult to predict quantitatively. Time differences here favour written as against spoken communication and the language question as between countries having different languages favours written communication. Figures for two countries having a big time difference and a different national language are available, namely, between the Netherlands and the United States and present the following picture:

Ratio of international telex traffic (in %) to telephone traffic for the Netherlands

	October 1950	October 1951	October 1952	October 1953	October 1954
Netherlands - U.S.	—	69.8%	105.6%	114.2%	169.7%

(f) The future rate of growth of business activity in Australia will strongly affect telex growth but is itself difficult to predict.

With these difficulties in mind, short term predictions only are of value and give figures of the following order for Australia in 1962.

(1) Number of subscribers from 900 to 1,400.
(2) Number of trunks provided from 200 to 350.
(3) Number of printergram positions from 100 to 130.
(4) Number of trunk calls from 350,000 to 550,000.
(5) Number of chargeable minutes of trunk calls from 3m to 5m.

These figures imply exchange sizes of the order 500-800 lines at Melbourne and at Sydney in 1962. At the end of 1956 both these exchanges, of the 120 line type described in the article by R. D. Kerr referred to earlier, were almost full and pre-occupation of engineering staff with the introduction of a teleprinter reperforator switching system on the public traffic system limited the rate of development of an automatic telex design. As a result a 500 line manual multiple switchboard, capable of expansion by division of the multiple to 1,000 lines was developed to cover the requirements of the large exchanges until 1962 if necessary, although it is expected that automatic exchange working will be introduced by 1961.

A.P.O. CORD TYPE TELEPRINTER MULTIPLE SWITCHBOARD

The switchboard is designed as a full multiple switchboard with nominal total capacity of 480 lines, including 120 trunks and home positions. This nominal capacity can be increased to well over 500 lines by using some trunks for inward calling only and some home positions for outward calling only, these lines appearing only in the answer section of the jack-field. The capacity of the switchboard can be doubled, that is increased to over 1,000 lines, by dividing the multiple into two parts. Each operator would then have access to only half the lines on the jack field directly in front of her, but could obtain access to the remaining lines by using the jack field on the next position. Full facilities for adapting the switchboard capacity in the above and further ways are provided in a cross-connecting cabinet which forms part of the switchboard suite (see Fig. 5).

Up to 80 lines, including trunks and home positions, can be allotted to each operator, that is each switchboard position has eighty jacks in the Answer group. The number of subscribers connected as Answer appearances to each operator's position is set by cross-connections at the cross-connecting cabinet, which also enables some of the Answer jacks to be used for special purposes.

The multiple is divided into two sections, the subscribers' multiple of 360 jacks and the trunk home position multiple of 120 jacks and associated free line signalling lamps. Testing for busy is carried out by testing the sleeve of the jack with the tip of the call cord, "busy" indication being given by operation of a single stroke bell and lighting of a busy lamp. In the trunks/home position multiple free line signalling lamps indicate the next free trunk or home position to use in each group; a group busy lamp is provided for each group to give a positive indication when all trunks in a group are in use.

Nineteen cord circuits are provided per switchboard position. Five cord positions may however be allotted for 10 outlet conference or broadcast working in association with a pair of jacks (designated respectively "conference", "broadcast") in the "Answer" jackfield; the technique of operation is to plug the "call" side of the normal cord pair used to connect the originating subscriber into the jack designated in accordance with the type of call desired, the ten special cords on the last five cord position then being used to connect up to ten other subscribers in "conference" or "broadcast" to the originating subscriber. Clock timing using B.P.O. Type 44B clocks is provided on the first nine cord circuits, the clocks being fed by six second pulses as in telephone working. Timing is carried out at the calling switchboard on trunk calls; local calls are untimed.

Answering and monitoring is carried out by an operator's machine (Creed Model 7) mounted in the switchboard carcase, copy being illuminated by a fluorescent lamp in the lower section of the key-shelf. The operator's circuit permits her to monitor as a third party on an established call, or to write to the "call" side or "answer" side separately with the other party held. She may monitor as a third party on either the "A" side, or on the "B" side of a duplex call, and can communicate with either the "call" side or the "answer" side by terminating that side on her machine. Ringing (A.C. ringing is employed to switchboard extensions) a called subscriber is carried out with the monitor key of the cord pair thrown by tapping a non-locking push-button "Ring Start" key provided at each position, the ring being tripped automatically by the subscriber answering. Ringing on the "Answer" side is provided by means of a "Ring Answer" push-button key permitting recall of a calling subscriber who has cleared temporarily, for example, because his call required a trunk connection not immediately available.

Circuit Operation—General

Apart from the physical appearance of the new switchboards the circuit design also is completely changed from that used in the 30 line switchboards described by R. D. Kerr.

Fig. 5.—Multiple Switchboard Positions.

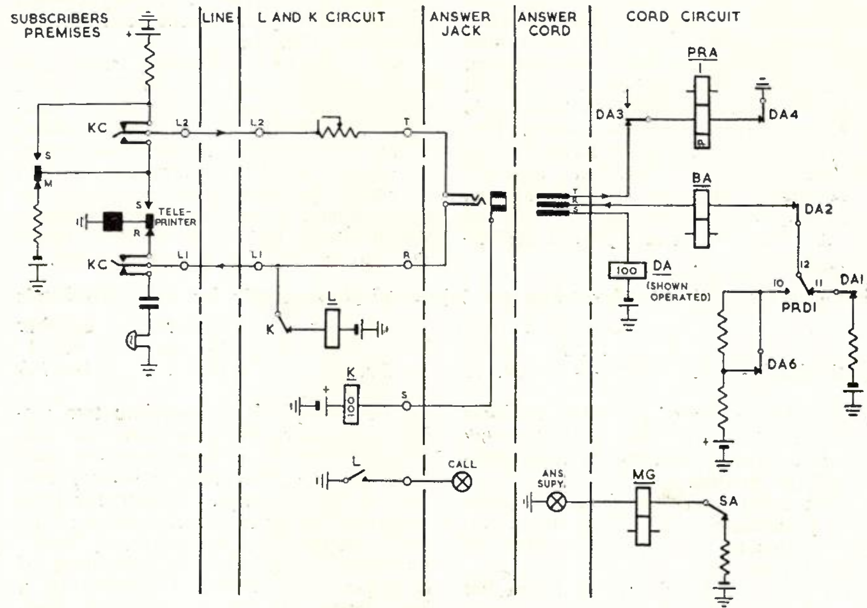

Fig. 7.—Double Current Schematic Circuit.

Whereas in the 30 line board the subscribers line circuits were relatively complex and the cord circuits simple, in the later design the line circuit is very simple, but the cord circuits are complex. This approach takes into consideration the growing number of subscribers being connected to the Telex network. With small boards, the inclusion of the polarised relays and other equipment in the line circuit with a simple cord circuit is the answer, but as the number of line circuits required increases to the point where multiple boards are required this is not so, and the simple line circuit with the complex cord circuit is most economical.

In the 30 line switchboard circuit, all switching, monitoring and supervision was performed on a double current basis. As the Telex network comprises both single current and double current subscribers, the conversion to double current was carried out in the line circuits. The two methods of transmission (single or double current) are necessary because of the two types of machine in use. The American Teletype equipment uses single current signalling, and the British Teleprinter is a double current machine.

In the multiple switchboard, it would clearly be impossible to provide separate cord circuits to suit each type of connection required, that is one cord circuit for double current to double current calls, one for double current to single current, etc., so the cord circuit was made to automatically adjust its signalling circuit to cater for any type.

Subscribers Line Circuits

(a) Single Current:

Fig. 6 is a simplified diagram of the subscribers' terminal equipment, L and K circuit, and a portion of a cord circuit.

The operation of KC on his terminal unit by a subscriber loops L1 - L2 by the Teletype machine. L is now able to operate to the negative battery behind K2 via KC operated, the Teletype machine, and K1 normal. L contacts light the call lamp in the answer jack field and sound the call in alarm if switched on.

The switchboard operator picks up an answer cord, throws the associated monitor key, and plugs into the jack. The operation of the monitor key will be covered when the cord circuit is discussed, but it connects the operator's machine, via the operator's circuit, to the answer cord. The cord circuit now has to determine whether the subscriber is Double or Single current. This is performed by the "discriminating answer" relay DA, on the sleeve, which has to operate to connect a Double Current subscriber. In this Single Current circuit, since K has a 4000 ohm coil, it operates, but DA having a 100 ohm coil does not. Thus the answer cord is set up to receive Single Current signals.

The Single Current signalling loop is provided from positive battery, R24, B coil, DA7 normal, Tip, L2, Teletype, L1, adjustable line resistance, Ring, B coil (connected to oppose the current in the other winding), DA1 normal, PRD11, PRD12, DA2 normal, PRA winding, DA3 normal, R2, to negative battery. A spacing bias is maintained on PRA via R14, PRA coil, BA1 normal, to earth at R12. The opening of the Teletype contacts at the subscribers premises removes the marking current fom PRA, and the spacing bias now is sufficient to move the contacts over to space.

So that incoming spacing signals, which open the loop at PRD, will not affect PRA, PRD going to space maintains an overriding marking bias on PRA. Upon the subscriber clearing, the return of KC to normal opens the loop, and PRA goes to space. Should the other subscriber also have cleared, PRD1 would tend to hold PRA to mark, preventing the clearing signal from going forward. Relay BA however operates to the resistance behind KC, and BA1 forces a heavy spacing current through PRA via MG winding, and lights the supervisory lamp. When a call cord is inserted in the jack, relay DC (the call cord equivalent of DA) remains unoperated for a single current subscriber. A description of the ringing circuits will be given when the cord circuit is discussed, but at this stage, supposing ringing has been initiated, ringing voltage occurs on the ring of the jack. Relay K is operated, so the ringing voltage goes out on L1 to the subscribers bell via KC normal. The operation of KC by the subscriber disconnects the bell, trips the ring, and completes the signalling loop.

(b) Double Current:

A simplified diagram showing the subscribers' terminal equipment, L and K

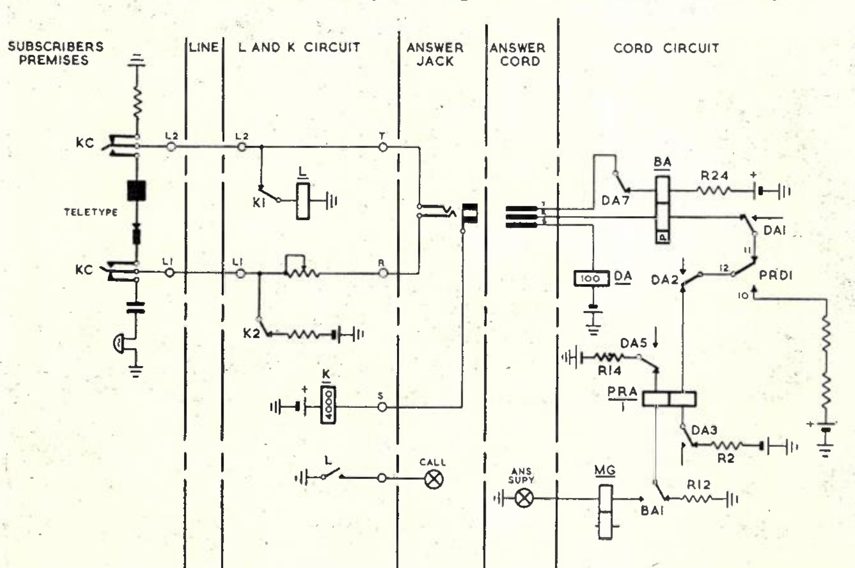

Fig. 6.—Single Current Schematic Circuit.

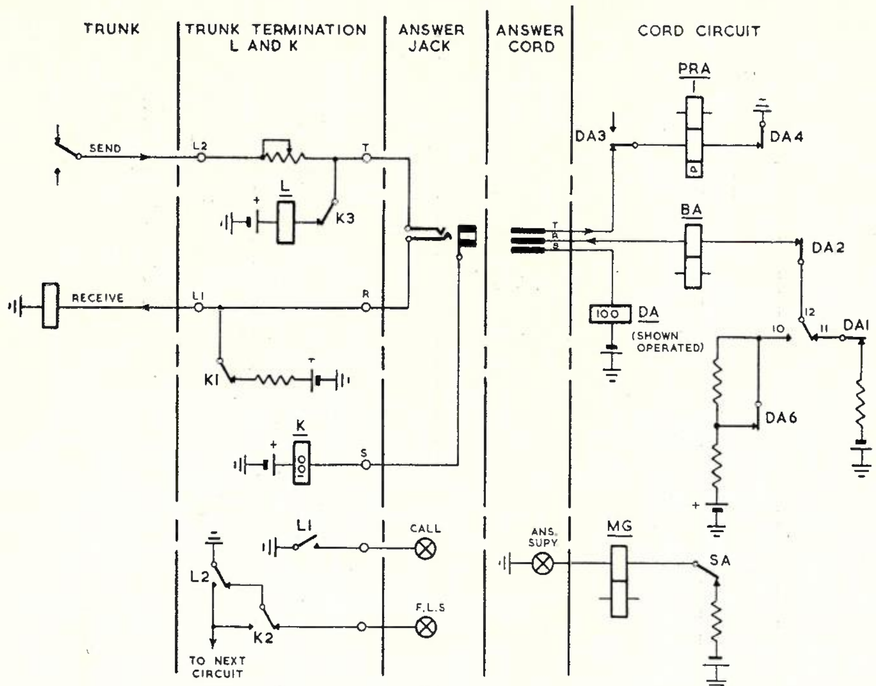

Fig. 8.—Trunk Switchboard Circuit.

circuit, and a portion of a cord circuit is shown at Fig. 7.

Upon the operation of KC by the subscriber, a path is provided for L to operate over L1 to earth behind the Teleprinter magnet. The machine motor starts, but because the magnet is held to mark the machine does not "run open". L1 lights the call lamp in the Switchboard answer field and sounds the call in alarm if it is switched in.

When the cord circuit answer plug is inserted, DA operates in series with K, as both relays have low resistance windings. The Teleprinter contacts are connected to PRA winding via L2, Line resistor, jack tip and DA3, to earth at DA4.

PRD contacts send via DA2, BA winding acting as a filter, ring, L1, to the subscribers' teleprinter.

If a call cord is inserted into the jack, DC operates in series with the low resistance K winding, and if ringing is initiated, ringing voltage goes to the subscribers' bell over L1 via the jack ring.

(c) Trunk Termination:

Fig. 8 shows a simplified diagram of a trunk termination, with portion of a cord circuit.

The trunk normally resting on space maintains positive battery on L2, and L remains unoperated. K1 maintains spacing battery on the trunk receive wire over L1. When a call is incoming, the trunk goes to mark, and L operates. L1 lights the call lamp in the answer field and L2 transfers the Free Line Signal to the next circuit.

The cord circuit operates as for a double current subscriber with DA operated in series with K.

If a call cord is plugged into the jack, K operates and K1 and K3 remove relay L and the spacing battery from the L1 and L2 wires respectively. K2 transfers the FLS lamp to the next circuit.

(d) Cord and Operators Circuit:

Although up to 19 cord circuits are connected to one operator's circuit, for explanatory purposes one cord and one operators circuit is shown on Fig. 9.

A cord circuit may be divided roughly into three sections, the answer section, the call section, and the link section which connects the call and answer sections together, and allows the operator's circuit to split the call and answer sections for monitoring, or monitor both. The call and answer sections are clearly divided on the figure, with the link section comprising relays PRB, PRD, and PRA, PRC contacts on its own. The call section is almost identical with the answer section except that ringing facilities are provided in the call section.

Suppose a Single Current subscriber initiates a call. The switchboard operator throws the monitor key associated with a free cord and picks up the answer plug. If no other monitor key is thrown, M in the cord circuit operates in series with the motor relay MO, and the operator's machine runs. The low resistance winding of M prevents further M relays from operating. M2 and M3 divert the tongues of PRA1 and PRC1 from PRB and PRD, and connect them to the operator's circuit. Negative battery from behind the number 44 clock on the right of the diagram flows via R6, R3, CS1 normal, M7 operated, MC3, DA1, DB1 normal, to operate MA in the operator's circuit. This current is insufficient to operate the clock, but MA switches the operator's circuit to the "monitor answer" position. In this position the operator's machine is connected to the answer cord only as the call cord is yet unconnected. Contacts on MA hold PRD in the operator's circuit and PRB in the cord circuit to mark at this stage. PRA1 in the cord circuit is connected to PRB in the operator's circuit, enabling the subscriber to "talk" to the operator. Similarly PRD in the cord circuit is connected to PRC1 contacts in the operator's circuit, enabling the operator to "talk" to the subscriber.

The operator is given the wanted subscriber's number and picks up the "call" cord. The tip of the call plug is touched against the sleeve of the wanted subscriber's jack, and if it is free no busy signal is given. The busy signal may be either a single stroke bell or a lamp indication, as determined by the operation of a switch on the board. The tip of the call cord is routed to relay BT in the operator's circuit via CS2 normal. If a jack multipled with the jack being tested is engaged say to a single current subscriber, the sleeve is predominantly negative due to the low resistance of DA as compared with K. BT therefore operates and sounds the busy bell or lights the lamp.

If a double current subscriber is already plugged up, the sleeve is at approximately earth potential, since it is at the centre point of the positive battery behind K and negative behind DA. BT again operates. A free jack presents positive battery to BT which does not operate.

We will assume that the wanted subscriber has a Double Current machine and the busy test finds the jack free.

DC operates and switches the call cord signalling circuit for Double Current operation. CS which operates for both Single and Double current subscribers, connects the tip to the signalling circuit, and prepares the circuit to the No. 44 clock. At this stage the called subscriber has not been rung, so the call supervisory is alight, MG is operated, and the clock circuit is still open at MG2. MG is operated from negative battery, R14, DC5 operated, RC1 and SC1 normal to earth via the call supervisory lamp. Before describing the ringing procedure we will briefly recapitulate.

The answer cord is in the calling subscriber's jack, and the operator has received the wanted party's number. Her monitor key is thrown, and she has tested the called jack for busy, found it free, and has plugged up the call cord ready to ring.

The ring key is depressed and released. Looking at the lower right hand side of the diagram, KRS is the key. An earth via R5 is applied to windings of RO and CR in series, but the current is just sufficient to operate RO, which operates RC in the cord circuit, and the holds in series with it on the other winding. Contact RC5 connects interrupted ring via MS3 operated, CR2 normal, from the contact A1 in the operator's circuit, to the ring of the jack, and ringing voltage is fed to the subscriber's bell.

RC6 connects the tip of relay BC, which having positive battery behind its winding, does not operate to the positive being returned from the subscriber.

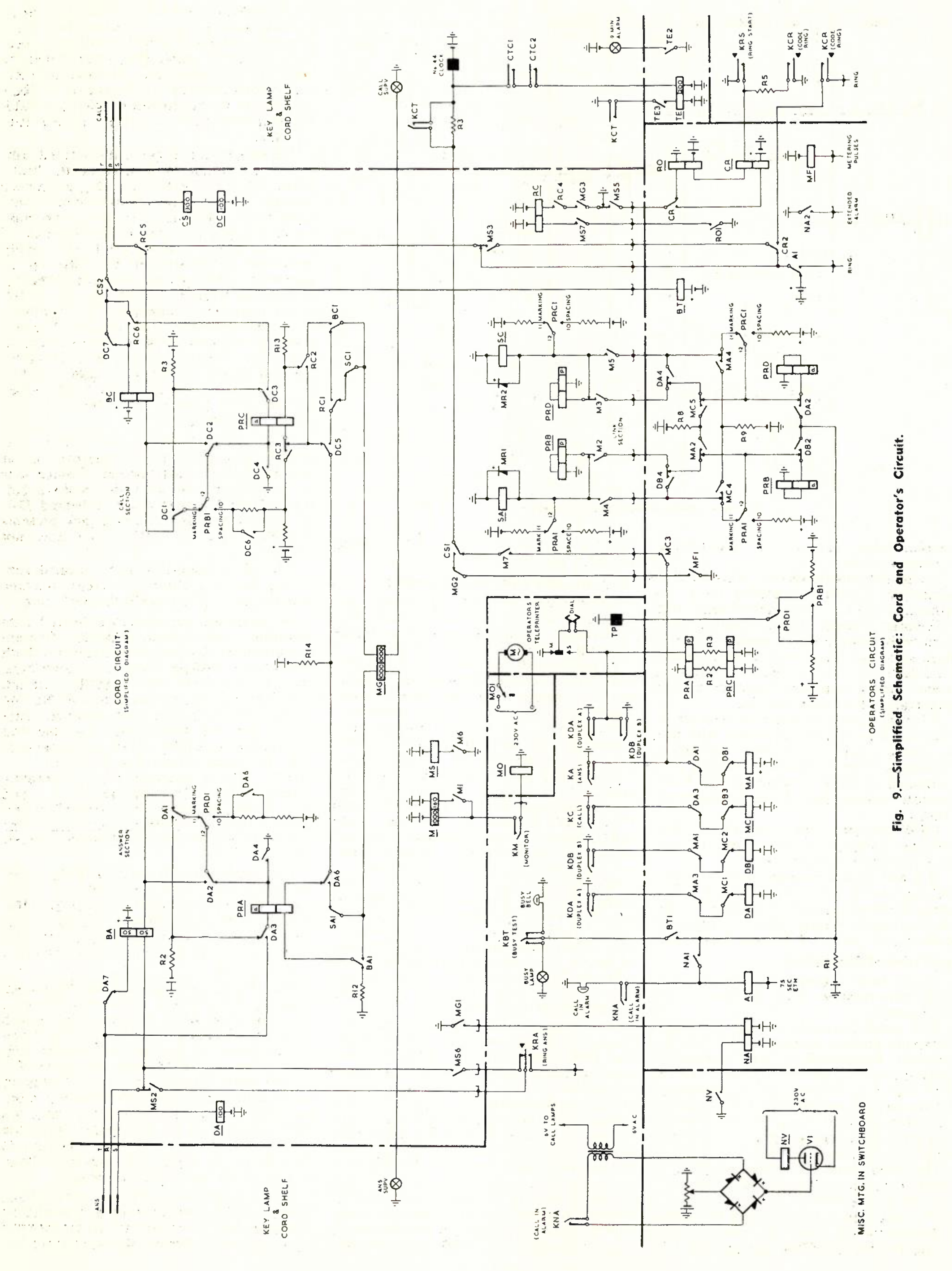

Fig. 9.—Simplified Schematic: Cord and Operator's Circuit.

RC1 transfers the supervisory circuit to hold via BC1 normal, looking for the operation of BC to trip the ring when the subscriber sends negative into the tip, after he has answered.

While the ring is going out, the operator sends "CLG" (calling the desired party) to the calling subscriber.

At this stage she may also return the monitor key to normal on that cord circuit, and attend to other calls. RO will be released, but RC in the cord circuit in use remains held via RC4 and MG3 operated, MS5 released, while the ring is still sent out via MS3 normal. KCR and relay CR were provided in the original design to cater for cases where a code ring, instead of the normal .75 sec. on, .75 sec. off ring provided. As this facility will not be required, the circuit operation will not be described.

To prevent the calling subscriber's machine from "running open" while ring is going out to the called party, positive battery via RC3 operated holds PRC to mark until the subscriber answers. When he does so, BC operates, releasing MG, which in turn releases RC. The signalling circuit is switched through to the tip and ring. BC again releases, but BC1 is isolated at RC1 normal. Contact SC1 is operated, since PRC is on mark. The purpose of this relay will be described under supervisory circuits a little later.

By reoperating the monitor key, the operator can monitor both parties, or by also operating the call answer key to "call" or "answer" she may monitor and speak to only the calling or called party. A similar facility is provided to monitor separate legs of Duplex services. Relays DA or DB are operated if the Duplex A or Duplex B keys are thrown, and contacts of these connect the operator's machine to the A or B leg, at the same time paralysing the normal monitoring circuit, and the operator's keyboard. This last precaution is necessary to prevent mutilation on these services.

The Duplex monitoring circuit will not be described here, but the normal monitoring circuit will be briefly covered.

Suppose a connection has been established, and the operator wishes to monitor both sides. Her monitor key for the particular cord circuit in use will be thrown, but the "call answer" key will be normal. Relays MA and MC are therefore normal, but relays M and MS in the cord circuit are operated.

PRA contacts, instead of keying PRB directly, are diverted through M4 operated, MC4 normal, PRA 1 in the operator's circuit to mark, to PRB also in the operator's circuit, and to PRB in the cord circuit via MA2, DB4 normal, M2 operated. Any signals sent from the answer cord will key the PRB relays in both circuits. PRB1 in the operator's circuit repeats the signals to the operator's machine, whilst PRB1 in the cord circuit repeats to the other party. Similarly PRC1 repeats to the two PRD relays in the other direction.

PRA and PRC in the operator's circuit are held to mark by current in their 4 - 6 windings via the dial and teleprinter contacts.

When the operator sends, PRA and PRC go to space because of the bias in their 1 - 3 windings, and PRA1 and PRC1 connect spacing battery to the two PRB and PRD relays connected to them. Thus the operator's signals are repeated to her own machine and to the two subscribers.

The operation of the "call answer" key to "answer" connects the output of PRA1 in the cord circuit to PRB in the operator's circuit, and allows PRA1 in the operator's circuit to key PRB in the cord circuit. MA4 operated holds the two PRD relays to mark, transferring the signalling path to the answer side of the circuit. Similarly the key thrown to "call" confines signalling to the operator and subscriber on the call cord.

Supervisory lamps are operated from the cord circuits, and when the connection is established, both supervisories are dark. MG has no current through its windings, and is unoperated, allowing metering pulses to be sent to the No. 44 clock from MF1 in the operator's circuit. In our example, we have a single current subscriber connected to a Double current subscriber. Relay BA supervises the single current circuit, remaining normal when the connection is through. For the Double current circuit, in this case on the call cord, BC is acting purely as a filter, with SC supervising the connection. This relay operates on marking, but releases on spacing voltage, due to the polarising rectifier MR2. This rectifier also allows the relay to hold over the normal spacing transitions in teleprinter signals, and so the relay will remain operated during signalling but will release on a long space.

When the transmission of the message has concluded, the parties clear by returning their call keys to normal.

Relay BA operates to the earth behind KC (See Fig. 6) and BA1 allows MG to operate in series with PRA and the supervisory lamp. As this current is 40 milliamps, it forces PRA to space even if PRD1 is spacing, tending to hold PRA to mark. This condition arises if the called party clears first, as PRD at space is deliberately made to hold PRA to mark to prevent mutilation of signals. However, under clearing conditions this marking current is overridden by the spacing current from BA1.

In the call cord circuit, a long space releases SC and the call supervisory lights via the other MG winding. Noting both supervisories glowing, the operator withdraws the plugs.

If the called party is a single current subscriber, the ring trip circuit functions a different way. RC is operated as before while ring is being sent, but BC is operated, until the subscriber answers, to the earth behind K C at the subscriber's premises. DC is unoperated, and during ringing the supervisory lights via DC5 normal, RC2 and BC1 operated. Upon the called party answering BC releases, releasing RC and darkening the supervisory. A spacing bias is maintained on PRC via DC5, RC3 normal to R13, and when the sub clears, this bias is increased by the added current drawn by the supervisory through the MG winding.

The situation may arise where a calling subscriber may clear down while the operator is setting up the call. In this case, when the called party is available, the operator can depress a "Ring answer" key without withdrawing the original answer cord. Ringing voltage is sent out on the ring to operate the subscriber's bell. On the left hand side of the diagram, the ring of the answer cord is diverted via MS2 operated to the ring answer key KRA, and thence back via MS6 operated to the signalling circuit. Depressing KRA connects ringing voltage to the answer cord ring.

A call in alarm is provided at every position, operated from the call lamp. When any lamp draws current it induces a voltage into a transformer (See Fig. 9), the voltage is rectified and applied to the grid of a valve. The valve conducts and operates relay NV, contacts of which sound the call in alarm, and operate a relay NA in the operator's circuit. This relay connects relay A to the .75 second earth to provide ringing and to sound an extended alarm if required.

The number 44 clock can only operate if both supervisory lamps are out, and will cease immediately one glows, indicating that one party is cleared, or that there is a line fault. Metering earth pulses operate MF in the operate circuit, and MF1 feeds these via MG2 normal, CS1, KCT operated, to the clock. KCT may be preoperated at any time during the setting up of a call, but the clock will only respond when a call is through because of the safeguard just mentioned.

If a call runs to 9 minutes, an alarm lamp flashes and that clock is stopped, to draw the operator's attention to the fact. Contacts CTC1 and CTC2 which are closed when the clock shows 9 mins., operate relay TE, and shunt the clock winding, stopping it from responding to further earth pulses.

(e) Printergram Circuits:

To enable Telex subscribers to lodge telegrams into the public network, printergram positions are provided at the C.T.O. Each position comprises a machine and a formholder, which besides holding various telegram forms as its name suggests, contains the keys and relays needed to make the position function. Although some positions are classified as incoming or outgoing only, others can work on a bothway basis, and as the equipment is exactly the same, a bothway position will be described.

Firstly consider an incoming message. The switchboard operator having ascertained that a printergram is to be lodged, plugs her call cord into a free jack in the printergram multiple denoted by the FLS lamp.

At the printergram position a call and a position lamp light, and the motor starts. The starting of the motor darkens the supervisory on the switchboard, and the connection may be established, and the printergram lodged.

To clear down the subscriber returns his "CALL" key to normal and the printergram operator presses a "CLEAR"

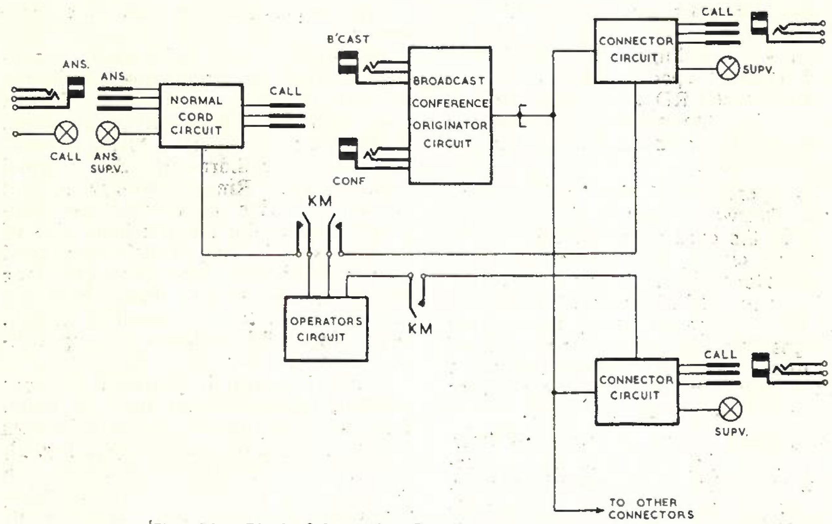

Fig. 10.—Block Schematic: Broadcast/Conference Facilities.

key, causing the supervisories to glow on the switchboard.

To call from a printergram position the "CALL" key on the unit is pressed. The position lamp lights and the motor starts, at the same time a call lamp on the switchboard glows. The switchboard operator ascertains the called party and the connection proceeds as for any other call. At the end of transmission clearing is carried out in the same manner as for an incoming call.

Printergram positions may be busied out to incoming calls by the operation of an "unstaffed" key located at a supervisor's desk.

(f) Broadcast-Conference Circuits:

A requirement of the Telex service is that a subscriber can be connected to a number of other subscribers at the one time, with the facility of being able to transmit a message to all of them simultaneously, without being able to receive from them. This facility is known as "Broadcast" operation, and a second requirement allows the subscriber to send to or receive from a group of other subscribers, who can also send and receive to each other. This second facility is known as "Conference" working.

The facility has been provided on the 30 line manual switchboards, with a pair of jacks labelled "Broadcast" or "Conference" appearing on the jackfield. In the place of 5 of the cord circuits are located 5 Broadcast/Conference cords. In the new multiple switchboard 10 Broadcast/Conference cords may be provided in place of 5 normal cord positions.

The description to follow is confined to the new multiple board, but the principles of operation are almost identical with that for the 30 line switchboard.

See Fig. 10. A subscriber calls and is answered in the normal way by the switchboard operator. Upon "Broadcast" or "Conference" being requested, the call cord of the cord circuit is plugged into the appropriate jack. The call cords of the connector relay sets are plugged into the jacks of the called subscribers, after the normal "busy" test. Ringing is initiated as for a normal call by operating the monitor key and depressing the ring key for each cord in turn, with the supervisories of the connector call cords indicating when the called parties have answered.

Two basic circuits have been included in Fig. 11 to show the difference between Broadcast and Conference working. If the call cord of the cord circuit is plugged into the Broadcast originator jack, BC operates to the sleeve, setting the cord circuit up for Double Current operation. BC1 operates all BA relays in the connector circuits, removing the earth from PRD contacts. Signals from the originating subscriber key PRA, which, on going to space, earths the common to all the PRA relays in the connector circuits, moving them to space. Spacing excursions by PRD in the connector circuits cannot affect PRB in the originator's circuit, as the earth is removed at BA1 in each unit.

In the case of the conference circuit, BC is not operated when the cord circuit call cord is inserted in the originator's jack. Spacing excursions by PRD in the connector circuit apply an earth to the signalling "hub", and PRA in the other connectors, and PRB in the originator's circuit respond. Hence any party on the

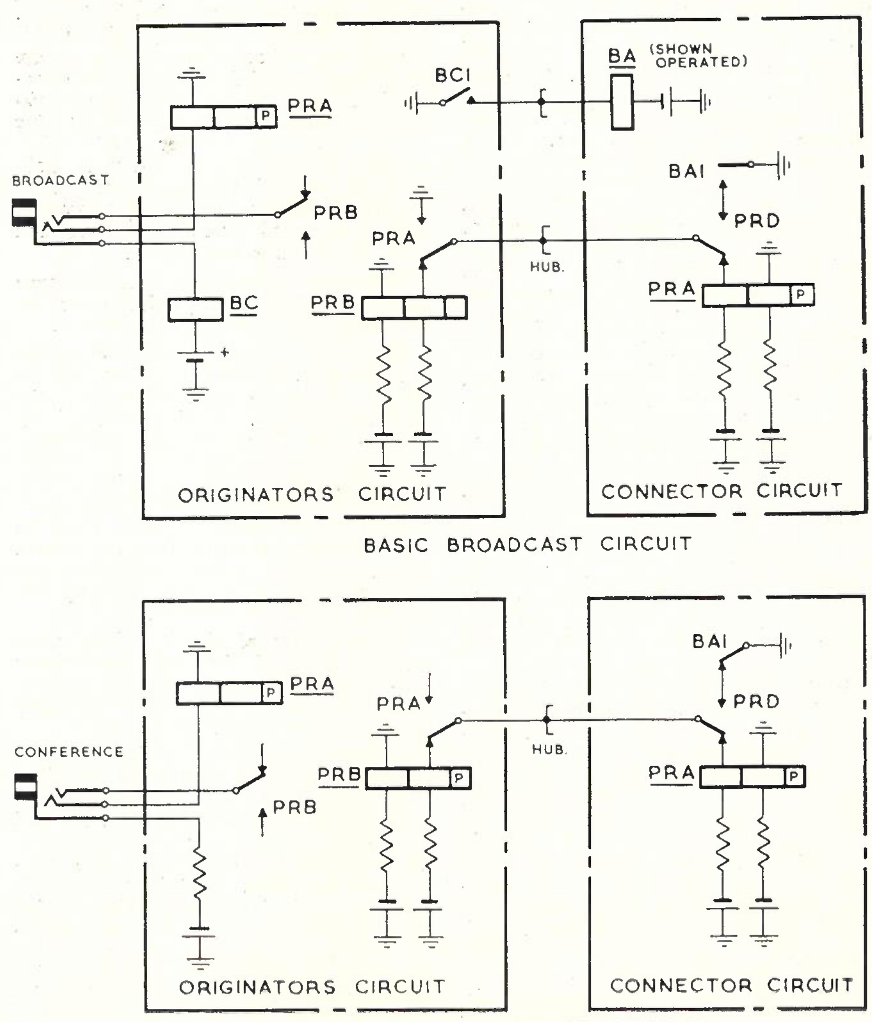

Fig. 11.—Basic Schematic: Broadcast and Conference Circuits.

conference connection is able to "talk" to all of the other parts.

A detailed description of the operation of the circuit will not be given here, but in effect the connector circuit is the "call" end of a cord circuit and a link section connected to the operator's circuit through a monitor key. The originator's circuit merely repeats the originator's signals to a number of connector circuits, which in turn repeat the signals to the connected subscribers.

(g) Rack Equipment:

This is shown in Fig. 12. 2000 Type equipment has been used throughout, which is quite a departure from earlier telegraph practice.

Subscribers L and K relays are mounted in the long flanges at the bottom of the rack, 16 circuits, including the line adjusting resistors, to a flange. Above these are the terminal blocks upon which subscribers' lines appear. They are front mounted to allow the test trolley to have easy access to them for tests to subscribers' equipment. Above these again are the cord, operators, and conference/broadcast circuits. Up to three operators' circuits may be mounted on one rack, with the proportion of cord or conference broadcast units depending upon local requirements. These again may be distributed over more than one rack. The mounting on the upper right hand side of the rack contains alarm circuits, etc., while lower down are mountings containing jacks trunked back to the board, and sockets supplying battery, test signals and the like for use by the testing technician operating the test trolley.

Fig. 12.—Switchboard Rack Equipment.

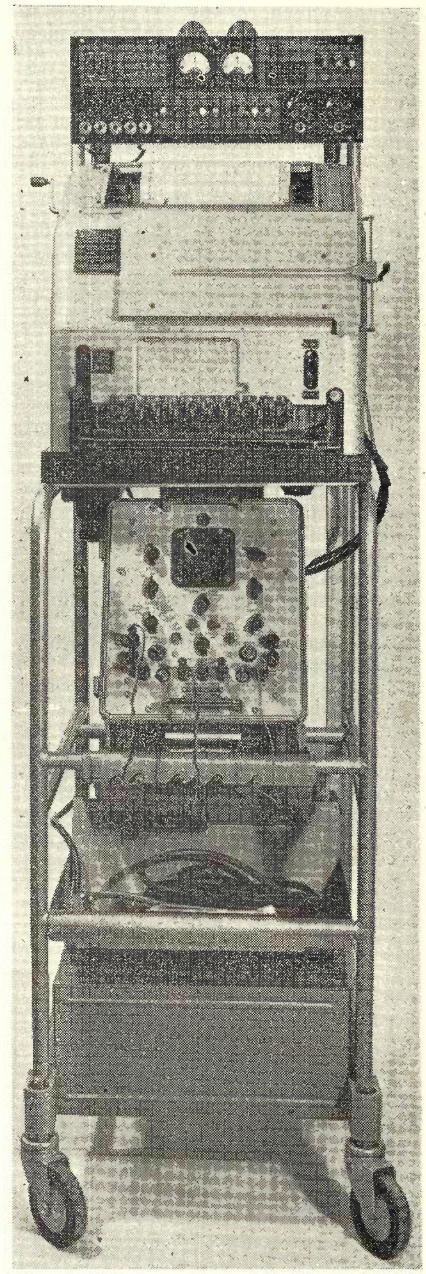

Fig. 13.—Test Trolley.

(h) Test Trolley:

To enable complete checks of all the equipment associated with the switchboard, a test trolley was designed expressly for the switchboard circuits. To give it manoeuvrability, the trolley occupies no more floor space than the teletype machine mounted on it. (See Fig. 13.) Of tubular steel construction, finished in grey hammertone, the trolley combines usefulness with appearance.

From the photograph the main items of equipment can be seen. At the top is the control panel, below it the teletype, and below that again the cathode ray distortion test set, inclined back to allow an operator standing at the keyboard to view the screen. A tray is provided to hold the various cords which connect the trolley to the rack equipment. All cords are detachable so that the trolley can be wheeled about unimpeded by dangling wires, and so that they can be easily repaired. The cabinet at the base holds transformers, motor relays, bells and various other items of equipment. The relays comprising the main test circuitry are mounted in relay bases not shown in the photograph, but located behind the cord tray.

To give an idea of the usefulness of the trolley, the following facilities are listed briefly:

(i) By plugging up call and answer cords of any cord circuit into test jacks on the switchboard, a complete test can be carried out on the cord circuit from the equipment.

(ii) By connecting a plug to the front mounted terminal blocks on the racks, current, ringing and distortion tests can be made to the subscriber's equipment.

(iii) Checks on call and supervisory lamps mounted in the switchboard can be made remotely from the equipment room without disturbing the operator.

(iv) Polarised relays can be tested and adjusted on the unit.

(v) A special "talk trunk" enables the trolley operator to "talk" using his machine, to the switchboard operator.

(vi) Warning lamps are provided to prevent the trolley being moved while cords are plugged up.

(vii) The trolley automatically becomes an extension on the standard A.P.O. Telegraph Transmission Test Set No. 6, whenever it is plugged in. This enables it to transmit test messages containing controlled amounts of distortion with a record appearing on the trolley teletype.

3. TELEX LINE CONCENTRATOR UNITS

The Semi-Automatic 18 Line Concentrator.

This unit has been designed to enable Telex subscribers, not normally catered for by a switchboard, to be given service. For instance, a number of firms may be potential subscribers in a country town, yet not in sufficient numbers to justify a switchboard, or to have a line each back to the nearest existing board. This unit, automatic in operation, enables these subscribers to be given service over a limited number of lines to the nearest switchboard. Fig. 14 shows a block schematic of a typical installation.

The concentrator, mounted on a 8′ 6½″ by 20¼″ rack, is capable of connecting up to 18 subscribers to a parent board over up to 8 lines.

The subscriber simply throws his call key in the normal manner to make a call. The equipment searches for his line and connects him through to a free trunk back to the parent board, where a call lamp appears, and the call is answered by the operator. If all trunks to the parent board are busy at the time of calling, a distinctive busy signal is given to the caller. At the parent board, a call to a subscriber on the concentrator is made by plugging up a free trunk to it, and dialling the wanted subscriber's number. The concentrator equipment steps to the wanted party and indicates the fact to the switchboard so that ringing can be initiated. From there on it proceeds as for a normal call.

Being normally unattended, safeguards are included to prevent fault conditions interrupting service. For instance, if the equipment connects a subscriber to a trunk to the parent board which is faulty, that trunk is automatically locked out until the fault is cleared. A test panel on the rack enables routine tests to be made locally by technical staff when necessary.

A check of the operation of the concentrator can also be made from the switchboard. By plugging up each trunk in turn, and dialling a test number, the return or non-return of a test signal automatically indicates if the unit or the trunk is faulty.

If required, PBX facilities can be provided on a group or groups of lines.

Local alarms to protect the rack equipment are provided, and if mounted near other exchange equipment they can be tied in with alarms on that equipment. If mounted away from other equipment however, the concentrator provides its own alarm indicators, and generates its own service signals.

The 4 Line Concentrator

Up to four subscribers may be connected to a parent board over one pair

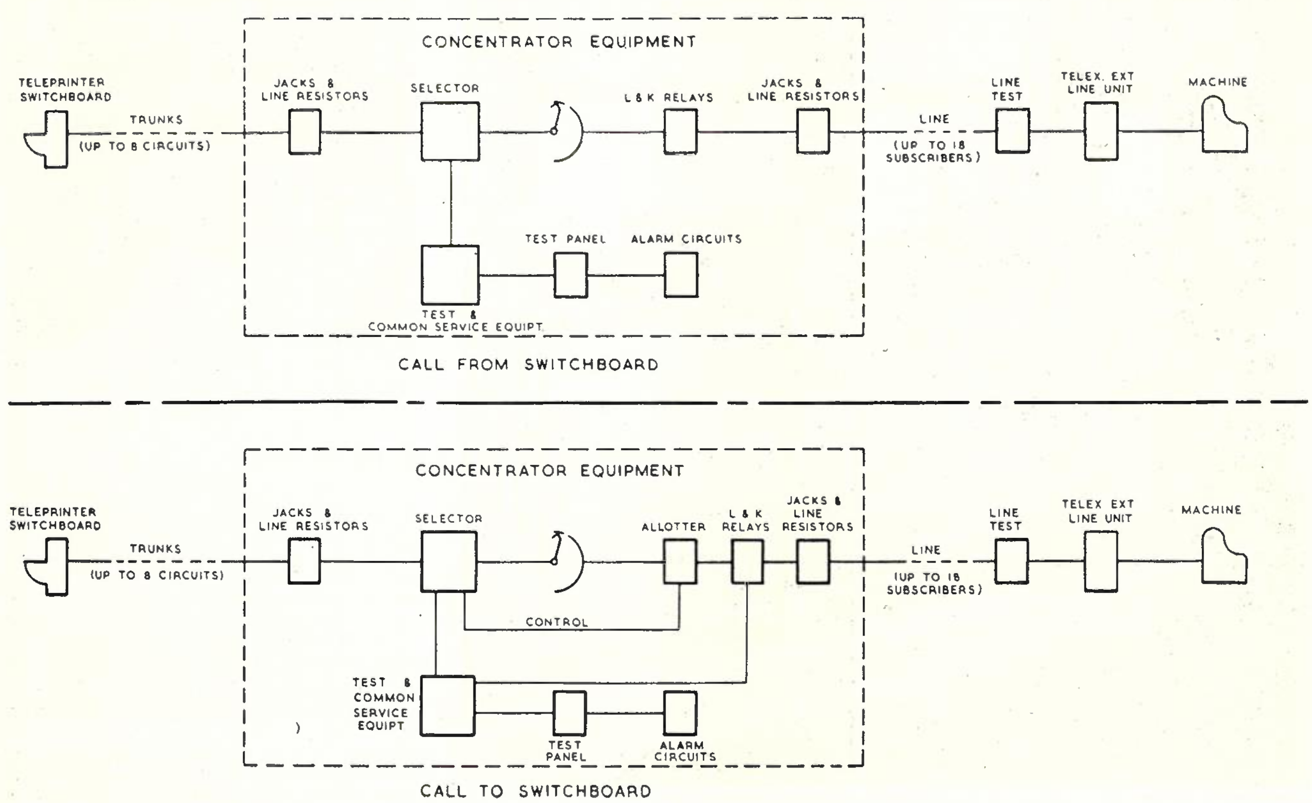

Fig. 14.—Block Schematic: Automatic Line Concentrator.

using this equipment. The concentrator is made up of 3 relay set bases which may be accommodated on a standard telegraph rack.

It is semi-automatic in operation, generating its own service signals, and adjusting its signalling circuit to suit the method of working of the subscriber connected to it.

FUTURE DEVELOPMENTS IN THE TELEX SERVICE

Although the new manual boards are able to provide adequate room for development, the design of a fully automatic Telex system has begun. This system uses keyboard selection, on a nation-wide numbering scheme. Unattended operation of machines is provided for, necessitating the use of answer back. Except for an operator to handle special services and conference/broadcast calls, the setting up and supervision of calls will be on a fully automatic basis.

The numbering scheme means that "register translator" equipment will be used, at main switching centres, to control the setting of motor uniselector switches in local and distant centres, over telegraph channels, to establish the routing of a call.

To minimise false clear downs by fleeting trunk faults, clearing over trunks is by a special clearing code only, generated automatically when a genuine clearing condition is encountered.

However the design of this equipment is still at an early stage, so the description of it will be left to a later issue of the Journal.

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PRESERVATIVE TREATMENT OF WOODEN POLES

*W. G. KEATING, A.R.M.T.C.**

INTRODUCTION

Wooden telegraph poles are subject to biological attack from several wood-destroying agencies, of which the main ones are the decay fungi, termites and wood borers. Mechanical deterioration, such as weathering, may also seriously affect the pole and in some areas using certain species, this form of breakdown may be the main cause of pole failure. Certain timbers possess a natural high durability that enables them to resist these forms of attack for a considerable period and consequently they are much sought after. Until recently Australia has been fortunate in possessing a good supply of durable timbers suitable for poles but over the last few years it has become increasingly apparent that this position has deteriorated with a corresponding need to use the less durable but more plentiful species. The nature of deterioration of timber has been dealt with in the article by F. A. Samuelson in the October, 1957, issue.

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EXPERIMENTAL RESULTS

The high cost of replacing condemned poles and maintaining existing ones has led the Department to investigate the possibility of using some form of preservative treatment that would ensure a pole life of approximately thirty or forty years. The first step in this direction was the establishment, in co-operation with the Division of Forest Products, C.S.I.R.O. and others, of tests aimed at determining the best type of preservative and method of treatment necessary to give adequate protection to poles cut from non-durable timbers. These tests have now been in progress for twenty-one years and are situated in five sites, two in New South Wales, at Wyong and Clarencetown, and three in Victoria, at Belgrave, Ballarat and Benalla. Fig. 1 shows the test plot at Ballarat (Victoria) established in 1936. The sites have been chosen in areas where there is a high decay or termite hazard. Although results from similar tests and service records from overseas are known these Australian tests are regarded as being very important because the information now becoming available applies to local conditions. Briefly, these tests have shown that of the preservatives under test, creosote provides the best protection against all types of deterioration and that the full length treatment of the pole, either by the pressure process or the hot and cold open tank, is the best method of application. Poles

Fig 1.—Pole Test Site at Ballarat, Victoria.

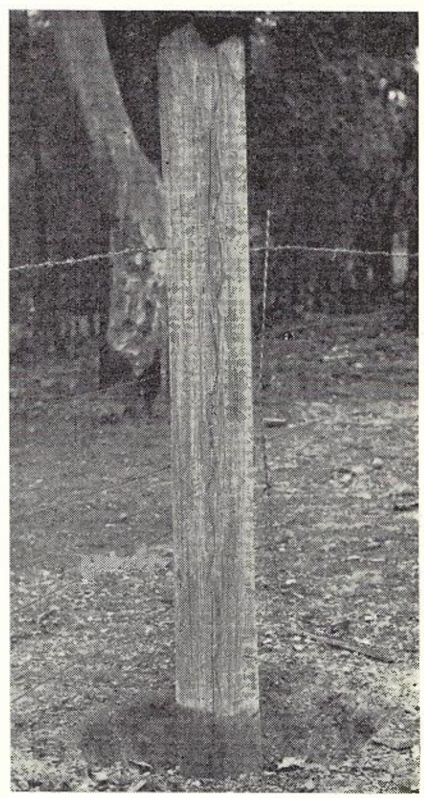

Fig. 2.—A Full-length Pressure Treated Pole at Benalla, Victoria, after Twenty Years' Service. Note Clean Appearance of the Pole after Weathering.

treated with creosote by either of these processes are still in excellent condition after an average of 21 years' service (see Figs. 2 and 3), and should have a life of 40 years. The information made available by these tests was one of the main reasons for the Department deciding to adopt the full length pressure treatment of poles.

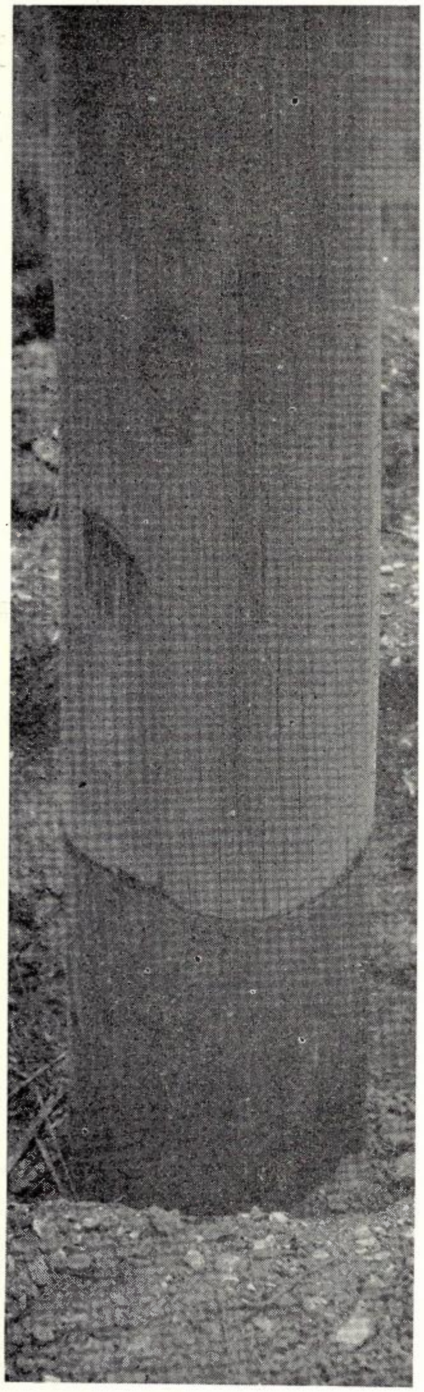

Fig. 3.—Creosote Oil, Open Tank Butt Treated Pole at Benalla, Victoria, in Sound Condition. Borer Holes, Developed During Seasoning Period before Treatment.

PRESERVATIVES

Creosote has been regarded as the standard wood preservative for well over a hundred years, in fact, dating from 1838, the year that John Bethell patented the use of "dead oil of tar" for wood treatment. Coal tar creosote is defined by the American Wood Preservers Association as ". . . a distillate of coal tar produced by high temperature carbonization of bituminous coal; it consists principally of liquid and solid aromatic hydrocarbons and contains appreciable quantities of tar acids and tar bases, it is heavier than water and has a continuous boiling range of at least 125 degrees C, begining at about 200 degrees C." Australian creosote varies from this definition in that its specific gravity is lower than overseas creosotes making it lighter than water. The following table shows the analyses for a range of 6 Australian vertical retort creosotes compared with typical American and European oils.

The initial toxicity of Australian creosotes has been proved but as yet the field tests described earlier have not been operating for a sufficiently long period to establish the permanency of local oils;

Property	6 Australian Creosotes	Typical American	Typical European
Specific gravity	0.948-0.991	1.089	1.039
Tar acids (%)	16.9-25.9	6.0	6.3
Tar bases (%)	3.8-4.8	6.1	6.2
Unsaturated hydrocarbons (%)	4.0-11.0	11.0	9.0
Aromatic hydrocarbons (%)	29.3-38.9	76.9	78.5
Paraffins and naphthenes (%)	28.8-40.0	nil	nil

however indications are such that it is probable that they will be comparable to overseas products. An Australian standard specification, K55-1936, has been issued setting out the requirements for creosote for use as a timber preservative and the methods of analysing it.

Creosote is only one of a large number of wood preservatives in common use throughout the world. For convenience they are usually classified under three headings—

1. Preservative oils—(i.e. creosote oil).
2. Organic Solvent type preservatives (e.g. pentachlorophenol in kerosene, diesel oil, etc.).
3. Water borne type preservatives (e.g. copper-chrome-arsenates).

Of these pentachlorophenol dissolved in a heavy petroleum solvent has in recent years been challenging creosote for use on telephone poles, but at this stage service records can only give indications as to its usefulness. These records show that a high degree of protection will probably be obtained. Latest developments in the field of water-borne preservatives have shown that the salts can be fixed in the timber to resist leaching, so making this type of preservative also suitable for exterior use. However, despite this competition from other preservatives creosote is still the most widely used as indicated by the following U.S.A. statistics for the year 1955.

Preservative Used	No. of poles
Creosote and creosote-coal tar	5,066,246
Petroleum-pentachlorophenol	1,428,470
Creosote-petroleum	98,868
All other	14,427
TOTAL	6,608,011

Creosote has been used extensively by the Department for treating both new poles and maintaining existing ones. A small percentage of new poles has been treated by the hot and cold open tank method. This treatment if carried out correctly has probably effected considerable savings even though the butts only have been immersed. Maintenance treatments at present consist of opening up the soil around the pole to a depth of about 18 inches, cleaning away all decayed wood then either spraying or brushing creosote onto the pole for 18 inches below and for the same distance above ground line. The back filled soil is then puddled with approximately half a gallon of creosote. The efficiency of this method depends on a complete removal of decayed wood (both sapwood and heartwood), injection of the creosote into all pockets in the pole and a dry pole. Also it is essential that retreatments should be carried out on the average every three years.

It is of interest to note that the maintenance technique as practised by the State Electricity Commission of Victoria

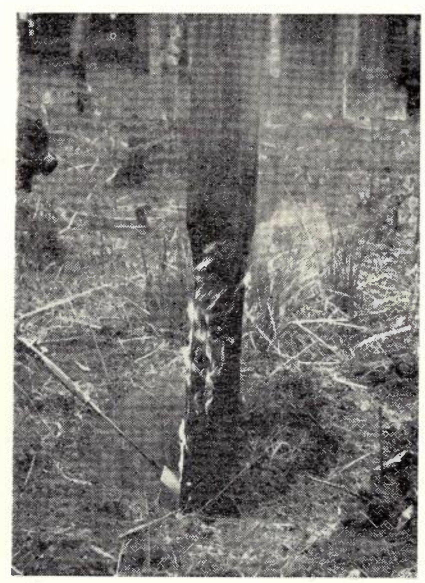

Fig. 4.—Oxyacetylene Charring Process, Charring with Special "T" Jet.

has in field trials shown to be superior to that practised by the Department. This method consists of opening up the soil around the pole as before, scouring out any decay pockets with an oxy-acetylene torch followed by charring of the pole for 18 inches above and below ground line as shown in Fig. 4. Then while the pole is still hot, creosote is sprayed on the treated area. Advantages to be gained by using this form of maintenance are (i) decayed wood is thoroughly removed, (ii) remaining timber is sterilized, (iii) heating ensures that pole is dry and that creosote absorption is uniform, (iv) spraying gives satisfactory penetration into checks and pockets, (v) retreatments are required every five years as against three for the brush and puddle method. Disadvantages are that skilled staff must be employed and that costs of equipment and individual treatments are high.

COMMITTEE'S RECOMMENDATIONS

With this background of a possible shortage of durable timbers, and the rapidly increasing costs of pole replacement and maintenance treatments, the Department appointed a committee consisting of Messrs. I. M. Gunn and F. A. Samuelson to investigate all aspects of pole and crossarm usage with the object of effecting savings on current methods. This committee carried out an extensive investigation which covered relevent practices by other authorities in Australia and overseas and a detailed examination of Departmental procedure. Their report included a number of recommendations where considerable savings could be made, the most important of these, and in fact the one on which most of the others are based, was that poles should be full length pressure treated with creosote. Consequently this recommendation has been adopted although the treatment will be carried out by private contractors rather than by the Department.

In January, 1957 the first commercial pressure preservation plant was opened at Grafton, New South Wales. Other plants are at Wauchope (New South Wales), Trentham and Brooklyn (Victoria), and Longford (Tasmania). These plants will be supplying 134,840 treated poles to the Department over an initial two year period. This number includes the total estimated requirements for Victoria and Tasmania, 60% of New South Wales needs and a small proportion of poles for Queensland. The bulk handling of poles at central depots will show considerable savings over previous practices even with additional freight charges to and from the depots. This is only one of the changes necessitated by the adoption of pressure treatment, the others will be described in the following paragraphs.

PRESSURE TREATMENT

Pressure treatment, as its name implies, involves impregnating the timber with preservative at pressures above atmospheric. The most successful and widely used of the pressure processes are those in which the treatment is carried out in closed cylinders. In general, such processes have a number of definite advantages over the non-pressure methods. Outstanding is the fact that, in most cases, a deeper and more uniform penetration and a higher absorption of preservative can be secured thus providing more effective protection to the timber. Furthermore, the treating conditions may usually be so controlled that retention and penetration can be varied to meet the requirements of service. Also these pressure processes are adapted to the large scale production of treated material. The main disadvantage is the high cost of the equipment required and the cost of the labour involved.

The plant necessary for pressure impregnation of poles consists of a treating cylinder approximately 6 feet in diameter and 70 feet in length capable of withstanding working pressures up to 250 pounds per square inch, storage tanks, vacuum and pressure pumps, storage and metering tanks, heating units, air compressor, condensers and various other auxiliary equipment, see Fig. 5. Timber is usually loaded onto steel trolleys or bogies which run on rails into the cylinder. In addition instruments are required for recording pressures and temperatures. Besides the actual treating equipment, it is necessary to have machines for shaping and boring the timber and provision made for mechanical handling. Also sufficient storage space must be provided for large seasoning stacks.

At the present time there are three main pressure processes in use, all of which employ the same principle but differ in the details of application. These are the full-cell process, the Lowry process and the Rueping process. The latter two are often referred to as "empty-cell" treatments because at the conclusion of the treatment cycle the wood cells are lined with preservative and not filled with it. It will be one of these two empty-cell processes which will be used with Departmental poles.

In making treatments with the so called full-cell process a preliminary vacuum is first applied to withdraw as much air as possible from the wood cells. The preservative is then admitted into the treating cylinder without admitting air. After the cylinder is filled with

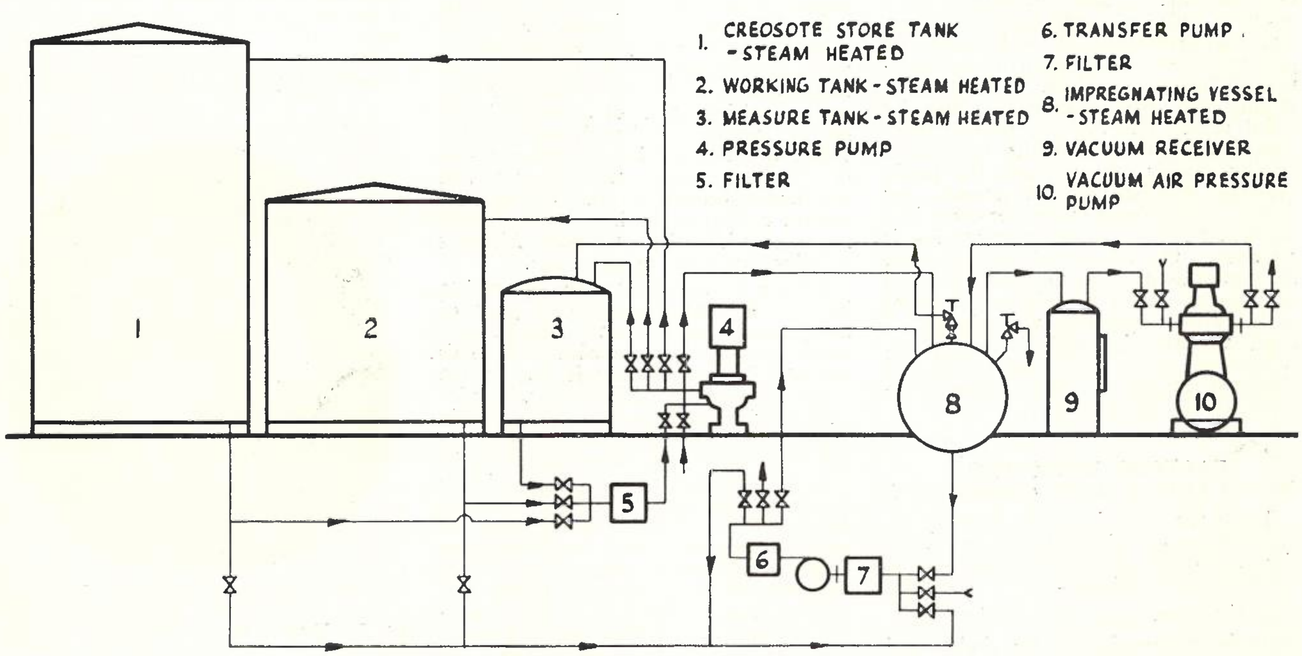

Fig. 5.—Arrangement of a Pressure Creosoting Plant.

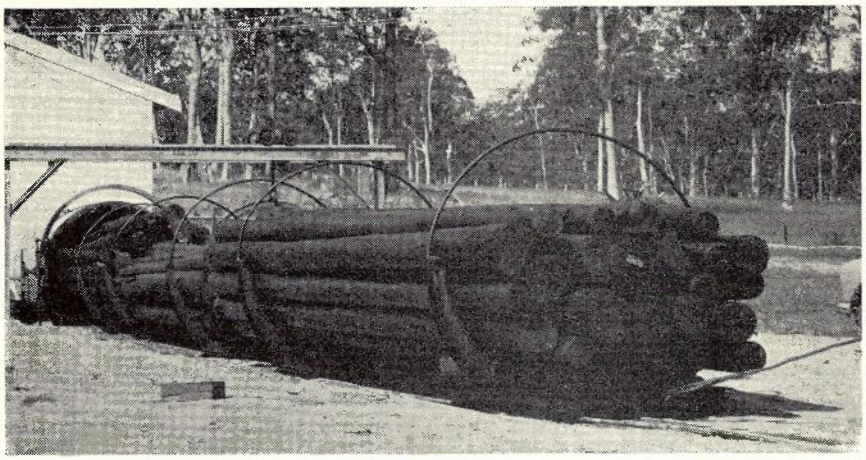

Fig. 6.—Withdrawing Charge from the Cylinder.

preservative, pressure is applied until the required absorption is obtained. A final vacuum is commonly applied immediately after the cylinder has been emptied to free the charge of dripping preservative.

The empty-cell processes aim at the deepest possible penetration using only a limited final retention of preservative. In the Lowry process patented in 1906 by C. B. Lowry the cylinder is filled with hot preservative (180°F) at atmospheric pressure. Following this, a pressure of 200 pounds per square inch is applied and held until the required gross absorption is obtained (usually when the charge will not accept further preservative). The air that is naturally present in the wood cells is compressed during the preservative pressure period and serves to expel part of the injected oil when the pressure is released and the final vacuum drawn. The Rueping process, patented by Max Rueping of Germany in 1902, has as its chief characteristic the application of preliminary air pressure to the wood, prior to the injection of the preservative. The purpose of this is to force additional air into the wood cells. The cylinder is then filled with hot preservative while still maintaining the air pressure, and the liquid pressure is raised to 200 pounds per square inch to force the preservative into the wood till the required absorption is obtained. On release of the pressure, the compressed air in the wood expands and forces out a considerable amount of the preservative that was injected. A final vacuum is applied as before, recovering more preservative. Fig. 6 shows a charge of poles being withdrawn from the cylinder.

FACTORS AFFECTING PENETRATION AND ABSORPTION

There are several factors affecting the penetration and absorption of preservatives and these are for convenience listed under three headings—

(a) the anatomy of the wood

(b) the preparation of the timber and

(c) the treating procedure.

(a) Anatomy of the Wood

Variations in the structure of different species of timber and also variations within any one species affect the penetration of preservatives. These variations are too numerous to discuss in detail but as this article is mainly concerned with the treatment of poles, that is natural round timber, only those points appropriate to treatment of this nature will be mentioned.

In eucalypts, the difference in permeability between sapwood and heartwood is most marked. Sapwood may be penetrated with preservative at pressures in the order of 200 pounds per square inch whereas the heartwood requires a pressure of 1000 pounds per square inch. Fig. 7 shows a section of an ironbark fence post treated at 200 pounds per square inch with creosote. The reason for this significant difference in treating pressures is due to the changes that take place as the inner layers of sapwood change to heartwood during the growth of the tree. In a very young tree all the wood is sapwood, but as the trunk and larger branches increase in diameter with the annual increment of sapwood layers on the outside of the already existing wood, the extreme inner portion ceases to function, except mechanically, and also undergoes certain other changes. As growth continues the heartwood volume increases while the sapwood thickness remains the same or decreases.

During the transition from sapwood to heartwood changes occur in the pores of hardwoods which make them highly resistant to the passage of liquids. This decrease in permeability is due to the gradual accumulation of gums, tannins and other extraneous materials which in most species give the definite colour to the heartwood as well as increasing its natural resistance to fungal and insect attack as compared to the sapwood. This explains why the specification for poles to be treated calls for a minimum thickness of sapwood whereas previously a maximum was specified. Other anatomical factors such as void space available for the preservative, rate of growth, etc., may also affect penetration and retention.

(b) Preparation of Timber

Satisfactory treatment requires that the material to be treated is adequately prepared to receive the preservative. Timbers to be used in the round, such as poles, must have all the bark removed including the inner bark which at certain times of the year is rather tenacious and difficult to dislodge. Bark, besides being rather impermeable to liquids would, if it is dislodged during treatment be liable to foul the filters and pipe lines of the treatment plant.

Pressure treatment in closed cylinders necessitates some form of seasoning of the timber. Green wood contains water, commonly called sap which is held in two ways, namely (i) "free water" which is present in the cell cavities and (ii) "hygroscopic moisture" which is intimately associated with the cell walls themselves. As the drying of green wood progresses the amount of free water in the cells gradually diminishes and soon those cells near the surface lose all their free water. At the stage when there is no free water but the cell walls themselves are still saturated the wood is said to be at "fibre saturation point". This point is usually between 25 and 30 per cent moisture content.

With most treating methods the presence of any considerable amount of free water in the cell cavities may retard or even prevent the entrance of the preservative liquid. Thus the application of a superficial oil treatment as by brushing or spraying, which is the form of maintenance treatment at present carried out in the Department, to green or wet wood is ineffective; even with the pressure process it is impossible to treat green timber satisfactorily. It is not necessary that the timber be seasoned to a uniform moisture content throughout but the part that is to be penetrated by the preservative, in this case the sapwood, must have enough water removed to make room for the preservative to enter. It is also important that the timbers be seasoned sufficiently so that any checking that is liable to occur will

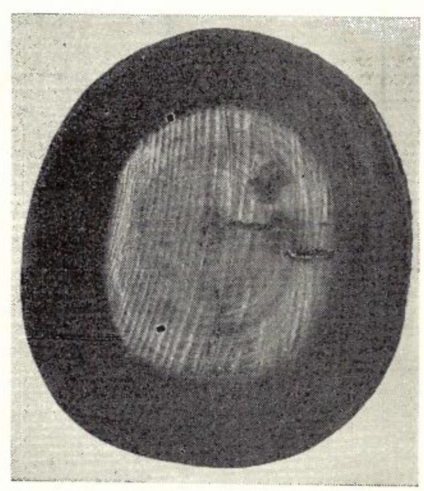

Fig. 7.—Photograph of Treated Ironbark Fence Post Section. Note Sharp Line of Demarcation Between Treated Zone (i.e. Sapwood) and Heartwood.

take place before treatment and the preservative will penetrate into the cracks.

The most common form of seasoning employed, especially for poles, is air seasoning. This involves racking poles on stacks built on substantial foundations with sufficient space between each layer and underneath the stack to ensure adequate air circulation. Since wood dries more rapidly from the end than from the side grain, it is essential that some form of end coating be applied to the poles to prevent end checking. Periodic measurements are made with electrical moisture meters to determine when the poles have reached a moisture content low enough to enable them to be treated satisfactorily. The length of the seasoning period required for poles is usually in the order of six months.

It is possible that the situation may arise where due to unfavourable climatic conditions or other reasons it may be necessary to treat poles before they have had time to air season sufficiently. In these cases it is usual to condition the wood by a special heat treatment. This treatment generally removes a substantial amount of moisture from the timber and also heats the wood to a more favourable treating temperature.

Two methods are in common use overseas to accomplish this artificial seasoning. One is the steaming—and—vacuum method where the timber is steamed for a considerable period following which a vacuum is drawn, thus lowering the boiling point of the water in the timber so that part of it is evaporated. The other method is called the Boulton or boiling-under-vacuum process. In this process the charge is placed in the cylinder and sufficient hot creosote (about 140°F) run in to first cover the timber. While maintaining the temperature a vacuum is created so reducing the boiling point as before. The water in the wood is evaporated rapidly at a relatively low temperature thereby avoiding the hazards of injury that might arise from heating the timber to the normal boiling point of 212°F.

All cutting, framing and boring of holes should be done before treatment to ensure satisfactory protection of cut surfaces. For this reason treatment plants have machinery for preforming all these operations. This is another avenue where considerable savings will be effected, for obviously it is much more economical to carry out these operations by machine than by hand. In this regard it has been found necessary to discontinue the practice of slotting poles for the purpose of accommodating crossarms. In future, poles will be scarfed over the full crossarm area and except for some special cases crossarms will be fixed by means of arm braces instead of combiners. There were two reasons for introducing this new method of fitting. One is that owing to variations in arm dimensions due to seasoning it is not practical to decide on a common width of slot that would satisfactorily take all arms. The other reason is that slotting would cut into the heartwood where there would be only slight preservative penetration and consequently little protection at a point where the likelihood of decay becoming established due to the lodgment of water is high. A satisfactory technique has been devised for fitting arms to a scarfed pole that eliminates any danger of turning under a man's weight.

Treated timber should be handled with sufficient care to avoid breaking through the treated zone. This necessitates taking adequate precautions during loading and unloading and erection. Although cutting after treating is highly undesirable, it cannot always be avoided. When

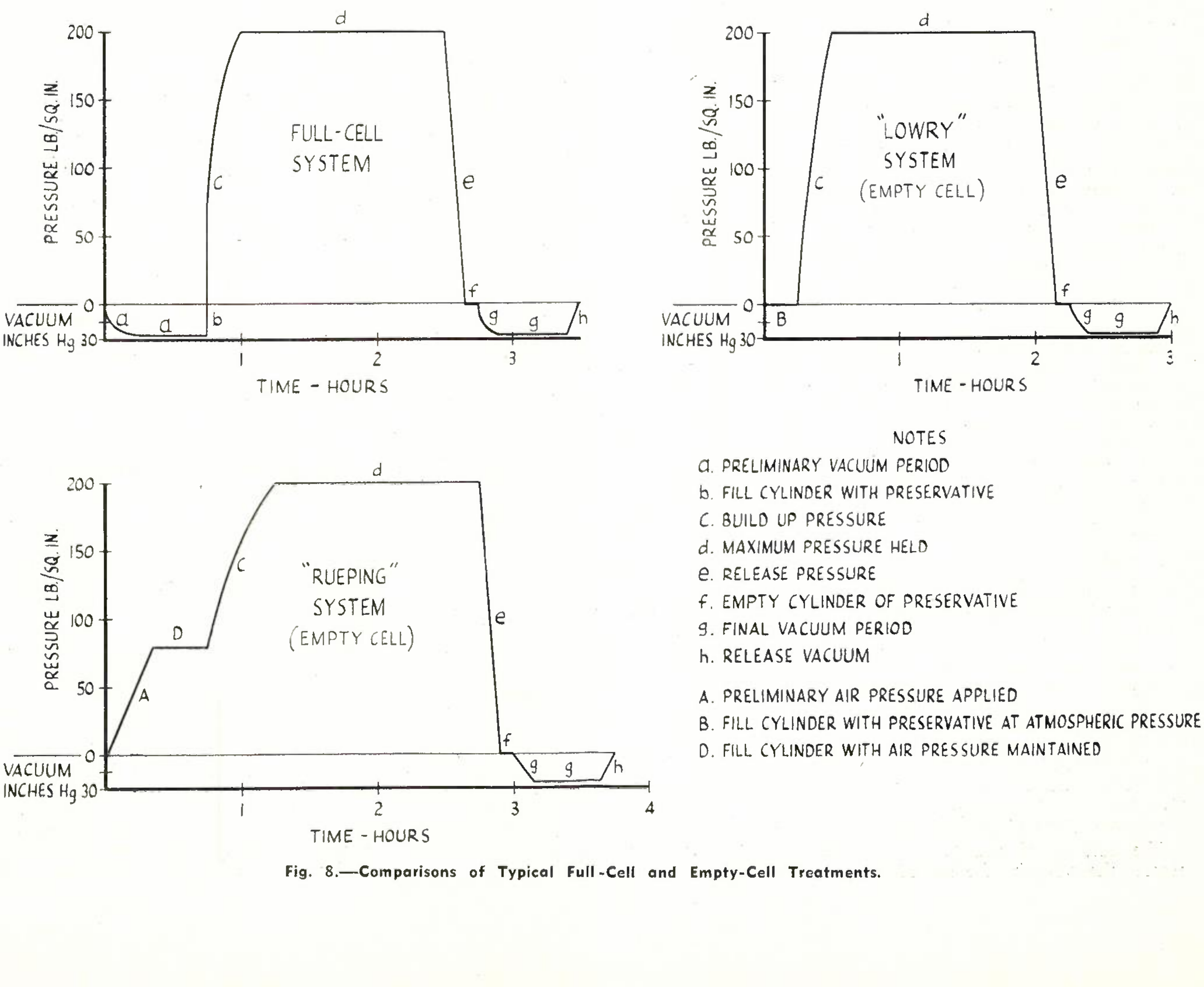

Fig. 8.—Comparisons of Typical Full-Cell and Empty-Cell Treatments.

cutting is necessary the danger may be partly overcome by thoroughly brushing the cut surface with creosote. This raises the point of protection in bolt holes that are drilled before treatment. Fortunately penetration of preservative is greater on end grain that side grain. In the bolt holes a large proportion of end grain is exposed and even at the comparatively low treatment pressure of 200 pounds per square inch, sufficient penetration is obtained in the heartwood portion to ensure adequate protection.

(c) **Treating Procedure**

The type of process used and the individual treating variables are important in determining a satisfactory treatment. Of the three processes mentioned previously either one of the two empty-cell processes has been found to be suitable for poles. The full-cell treatment is not favoured due to the likelihood of the exudation of creosote at some future date. It is probable that treatment of poles in this country will be carried out by the Lowry process. This process gives good penetration with limited retention.

Naturally the type and quality of the preservative will have a considerable influence on treatment. Initially, in Australia, poles will be treated with straight creosote which must conform with the Australian Standard Specification K55-1936, "Creosote Oil for the Preservation of Timber". This specification stipulates that the creosote must conform to set standards of specific gravity, fluidity, water content, distillation range, residue, tar acids and matter insoluble in benzole.

Treatment temperature has a big influence on penetration and retention of preservative due to its effect on the preservative itself, and also the timber. The viscosity of creosote, since it is an oil, alters appreciably with even small changes in temperatures and as might be expected significant improvement is achieved in penetration and absorption with increased treating temperatures. There is ample evidence to show that the higher temperatures also condition the timber itself so as to make it more receptive to the preservative. At the same time there is a maximum to which the temperature may be raised and still avoid serious degradation of the timber. This maximum probably varies from charge to charge but indications are that temperatures in the order of 180°F to 200°F would be suitable for eucalypt pole timbers.

The length of the treatment cycle and the intensity of vacuum and pressure are shown in Fig. 8. These diagrams are for typical conditions and may be varied for each individual charge. The pressure period should be long enough to obtain the maximum benefit of the pressure employed and to allow sufficient heating of the wood to produce favourable conditions for treatment. Better penetration is usually obtained with moderate treating pressures and moderately long pressure periods.

The amount of preservative that has entered the wood by the end of the pressure period is known as the gross absorption, and the amount remaining at the completion of the final vacuum is termed the net retention. Obviously the particular treatment process employed and the condition of the timber determines what percentage of the gross absorption the net retention shall be. Most specifications lay down requirements for depth of penetration and net retention. For telegraph poles, a compromise must be reached between that loading of preservative that will give adequate protection and that which will produce a clean pole. The net retention is usually calculated from gauge readings taken before and after treatment. This volume of preservative is converted to a weight measurement and the retention stated as so many pounds per cubic foot of timber. Overseas where the timber for treatment are mainly softwoods with a wide uniform sapwood band retentions are stated in pounds per cubic foot of total pole volume. For example, current British Post Office requirements are for 7 to 8 pounds of creosote per cubic foot of wood. The eucalypts which are the main pole timbers in this country have a comparatively narrow, irregular sapwood band, and consequently it is more appropriate to state the retention in so many pounds of preservative per cubic foot of sapwood. This method has the disadvantage in that the sapwood volume must be measured for each individual pole, whereas when retentions are stated on a total volume basis, the volume of the charge may be measured by displacement when the cylinder is first filled with preservative. Initially, the loading specified for Departmental poles is between 12 to 18 pounds of creosote per cubic foot of sapwood. These figures are based on the results of the field tests described earlier.

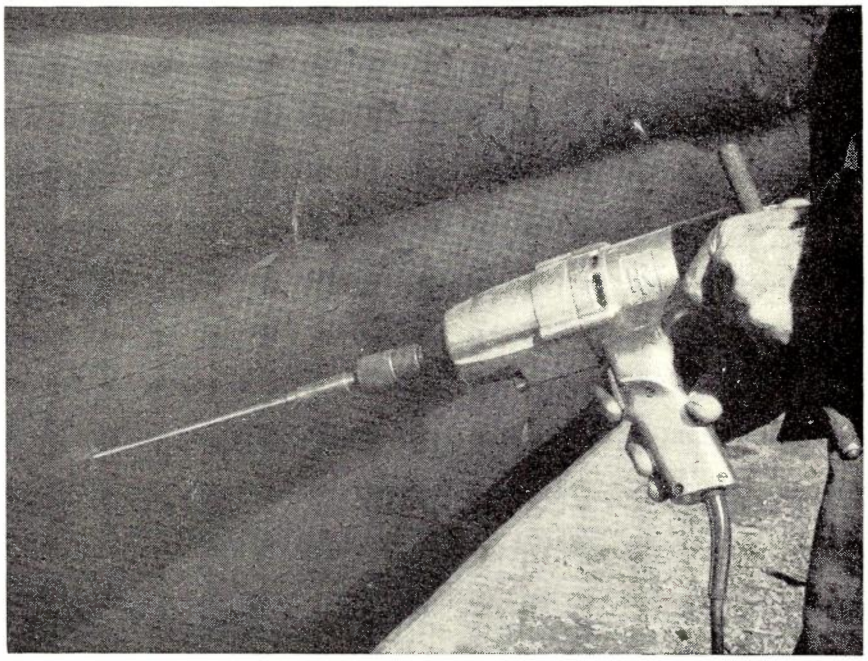

Fig. 9.—Testing for Depth of Penetration of Creosote.

The depth of penetration of the preservative has an important bearing on the service life of treated timber. Eucalypt poles should be treated to the full depth of sapwood or to at least one inch if the sapwood is wider than this. The method of checking the penetration is by taking increment borings. Small cores about ⅛ inch in diameter are taken out of the poles and from these it is immediately apparent to what depth the preservative has penetrated. Fig. 9 shows the method of boring. It has been found that it is more convenient and quicker to use an increment borer attached to an impact wrench, rather than hand methods when testing for penetration of preservative. Overseas, where nearly all pole timbers are softwoods, it is an easy task to make borings by hand, but with dense hardwoods, such as the eucalypts, it becomes a rather time consuming and tedious operation.

PROPERTIES OF CREOSOTE-TREATED POLES

The prime object of preservative treatment is to extend the life of the pole, but fears are sometimes expressed that treatment will adversely affect certain other properties. These are discussed below.

Experiments indicate that creosote itself has no significant effect on the strength of the pole, but that any loss in strength that may occur is due to excess temperatures and pressures that might be used during the artificial seasoning or treatment period. For this reason it is advisable to air-season poles whenever possible as the temperatures that must necessarily be used during the artificial seasoning processes described earlier, especially the steaming and vacuum process, are likely to weaken the pole. As indicated previously, during treatment it is advisable to heat the preservative to a suitable temperature to ensure adequate penetration and retention. This temperature should be the maximum possible that can be used without weakening the pole. This requires some knowledge of the individual characteristics of the species used and their ability to withstand high temperatures. Until recently there had been no work carried out on Australian pole timbers to investigate this aspect, but the C.S.I.R.O. Division of Forest Products is examining the effect of temperature and pressure on strength in its current pole testing programme. Indications are that moderate treatment cycles applied to air seasoned poles will not weaken them.

Creosote treated poles sometimes cause trouble because of the exudation of the oil on the surface of the pole. This phenomenon is sometimes termed "bleeding". Greatest inconvenience naturally occurs where poles are erected in built up areas. The exact causes of bleeding are not known, but the intensity of exposure to sunlight has a marked influence. This is indicated by the fact that any exudation usually takes place on that side of the pole facing the sun. The air and preservative in the heated outer layer of the wood expand, causing the oil to flow towards the surface. Other factors such as the character of the creosote, the process used, the concentration of the preservative in the outermost layers and the nature of the timber itself may all affect the degree of bleeding that might occur. If trouble does occur, lowering the retention of creosote while still keeping to a safe minimum coupled with a final steaming after treatment will probably eliminate most of the inconvenience.

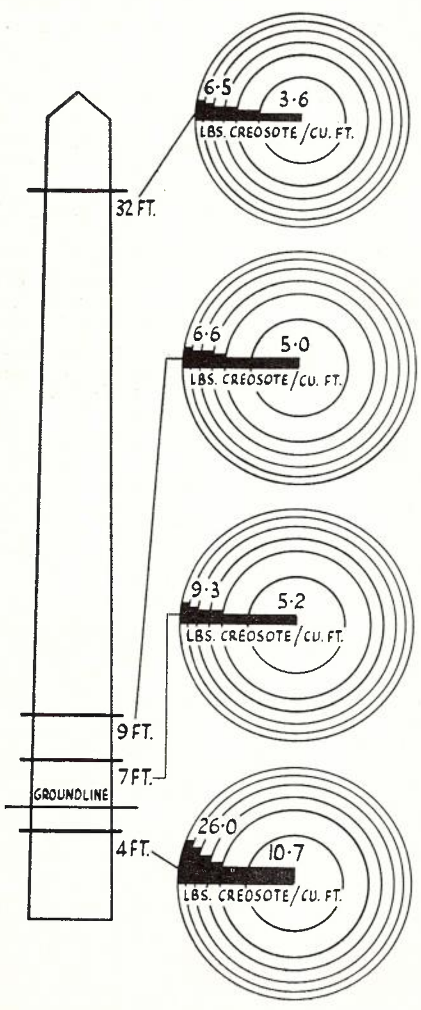

Fig. 10.—Distribution of Creosote after 23 Years' Service. Black Bars Show Average Concentration of Creosote at Various Depths in Each of Four Cross-sections.

The point is sometimes raised that creosoted poles would be a fire hazard. Admittedly within the first six months after treatment the fire risk may be slightly higher than with sound untreated poles, but after this period the more volatile fractions have evaporated and there are indications that the risk then is lower than with untreated poles. It might be pointed out that poles with decayed sapwood form a much greater fire hazard than even freshly treated poles.

Little work has been carried out to investigate the distribution and composition of creosote in a pole that has been in service for a number of years, but the results of one such test are of interest. As this test involved only one pole, caution must be exercised in drawing a general conclusion. This pole, still in a serviceable condition after 23 years was removed from a line in Pennsylvania, U.S.A., and the distribution and composition of the extracted creosote was determined. The average retention of the charge, which included this particular pole, was 8.6 pounds of creosote per cubic foot. The accompanying diagram, Fig. 10, shows the resulting distribution of the creosote. It is interesting to note that the highest concentration is at the ground line which fortunately is the point where the greatest hazard occurs. The composition of the creosote above groundline has altered appreciably, but it still retained sufficient toxic properties to provide adequate protection in that area. Below groundline the creosote composition was virtually the same as when it was injected into the pole.

Contrary to a popular conception, sound sapwood is as strong as heartwood and as it is the sapwood that will be treated it can be assumed that this treated portion will remain with the pole for its full life. Consequently the sapwood strength can be justifiably included in the strength of the pole, whereas formerly, due to the fact that sapwood deteriorated within 4 or 5 years, this was not possible. Accordingly poles to be pressure treated are smaller than previously by the amount allowed for sapwood. Over a large number of poles the monetary saving due to this reduction in size is considerable.

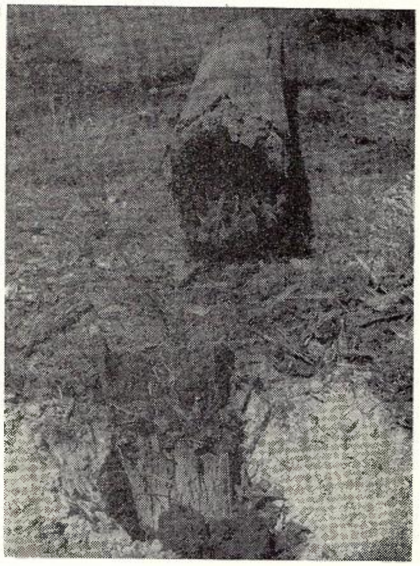

Fig. 11.—Untreated Test Pole Completely Destroyed by Decay and Termite Attack.

What life can confidently be expected from a pole pressure treated with creosote? It is erroneous to compare overseas results and apply them directly to Australian conditions, but at the same time an indication can be obtained of the expected life of poles treated by the same process. The British Post Office has authentic evidence of 8,000 Scots pine poles which, untreated, would last only for 4 or 5 years, being still in service and in excellent condition after 64 years. Latest service records of poles in service in the U.S.A. show that an estimated average life of 40 years is now accepted for full length creosoted poles. Service and test records in Australia are not sufficiently old for determination of service life with a high degree of accuracy. In fact, no failures have occurred in some 179 creosoted test poles in the five test sites which have been operating for an average period of 21 years. The latest inspection results show that some 15% of the poles are showing slight attack in the sapwood and some 2% are moderately attacked. Statistical analysis indicates that the average life of these poles can be estimated as being in the vicinity of 40 years. This is compared with an average life of 15 years for the untreated controls. Fig. 11 shows an untreated control specimen completely destroyed by decay and termite attack.

ECONOMICS OF PRESERVATIVE TREATMENT

Having established that a life of 40 years can be expected from a treated pole the next step is to make an economic study to determine if treatment is economically justified. The following table lists the capital costs, renewal costs and annual charges for untreated and treated wood, in the case of a 24 foot light pole in the Tamworth district, New South Wales.

Economic Comparison of Various Types of Poles

24′ Light Pole in Tamworth District, New South Wales (fitted with 3 arms)

Type of Pole	Untreated Wood	Treated Wood	Remarks
1. Estimated Life	20 years	40 years	
2. Capital Cost	£ s. d.	£ s. d.	
Cost of Pole	4 2 0	7 2 6	Cost delivered peg marks for untreated pole
Freight	—	1 18 9	Freight to Tamworth
Distribution	—	13 7	Distribution from Tamworth
Treatment	5 5	—	
Erection	8 9 6	6 17 6	
3. Total Capital Cost	12 16 11	16 11 10	
4. Re-arranging and Dic-mantling cost	10 0 0	10 0 0	Covers re-arranging wires to new pole and dismantling old pole
5. Total Renewal Cost	22 16 11	26 11 10	Items 3 plus item 4
6. Present Value of Annual Charges			
Pole Inspections	3 15 0	3 15 0	
Re-treatment	4 10 0	—	14/- each 3 years untreated wood
Sapping	6 0	—	At 10 years cost 9/-
Sinking Fund	13 12 0	4 4 0	Note 1
7. Total P.V. of all charges	34 19 11	24 10 10	Item 3 plus item 6

NOTE 1: Sinking fund is calculated as the sum invested annually at compound interest which will return the renewal cost at the end of the life of the pole, and converted at present values on a perpetuity basis.

This table shows that there is an appreciable margin in overall costs, reduced to present values, in favour of the treated wood pole as compared with the untreated pole. In those areas where the present practice is to use untreated timber poles the average saving incurred when using treated timber may be taken as approximately £10 over the life of the treated pole. One factor that tends to lower the cost of the treated pole is that there is no maintenance treatment required.

CROSSARMS

It is desirable that treated poles should be fitted with crossarms that have a service life equal to or slightly in excess of the poles. Accordingly arrangements are in hand to introduce pressure treated crossarms. Here the conditions of service, particular requirements, and causes of failure are so markedly different than for poles that a different treatment process and type of preservative will probably be used.

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GATING: AN APPROACH TO CALL-QUEUEING

*E. G. WORMALD, A.M.I.E. Aust.

INTRODUCTION

It is well known that subscribers often judge a telephone service by delay experienced in obtaining an answer from a manual switchboard operator, and complain if the delay appears excessive. In small non-multiple exchanges and on subscribers' "A" positions in even large manual exchanges, an operator is seldom presented with more than a few calling signals at any one time. It is then not difficult to remember their order of occurrence, and they are usually answered in that order. In these circumstances, complaints of undue delay may be related to traffic load and operating efficiency but to little else.

Another factor affects any operating situation where a large number of calling signals may be seen simultaneously by an operator. An example is incoming trunk or junction groups with multiple answering appearances where a large number of calls are shared by a group of operators. In such a case the large average number of simultaneous signals and their rapidly changing pattern blur the operator's memory of events, so that the order of service departs appreciably from that of occurrence. A nearly random order of service may be found to exist.

In some circumstances, such as when calls from an automatic network are directed to semi-automatic manual positions for trunk demand, enquiries, complaints, etc., the operator has no control over the answering order, which is determined by the automatic equipment. Special elements are therefore needed to provide a "memory" of the order of occurrence, so that calls may be answered in their order of origination.

The randomness in order of answering which may be introduced carries a penalty, for a proportion of calls become "unfortunate", that is, delayed unduly in consequence of being answered after their turn. Under pure chance conditions, waiting times experienced will probably be distributed in the following way:—

Less than average for all calls	57%
Between average and twice average	29.5%
Between twice and three times average	8.5%
Between three and four times average	3.1%
Between four and five times average	1.2%
Longer than five times average	0.7%

It is important that the proportions tabled above are unaffected by variations in the average delay, except possibly as a secondary effect if conditions are improved to such an extent that the operator's memory can again become effective.

It will be noted that, although the proportion of calls delayed appreciably longer than average falls away rapidly, it is not negligible for comparatively long delays. For example, during a year about 10,000 calls should have to wait more than one minute for an answer in a situation where 6,000 calls per day are being handled with an average delay of twelve seconds. If only one per cent of such unfortunate callers complain, the resulting complaint rate of 100 per annum could be misinterpreted as indicative of a poor grade of operating effort.

An entirely different picture is seen if some means is provided for the automatic prevention of unfortunate calls. Naturally this complicates the equipment associated with circuits incoming to the switchboards, and increases the costs of provision and maintenance, but there is little doubt that the service improvement which follows makes the additional expense well worth while.

QUEUEING

One method of eliminating unfortunate calls which has been widely used is that of call-queueing, to serve calls automatically in the exact order of origination. The necessary equipment takes many different forms and uses any one of a number of principles of operation, but usually entails the provision of a uniselector for each calling circuit, to "remember" the order of origination. Two or more extra relays per calling circuit are required to control the uniselector, together with a group of relays

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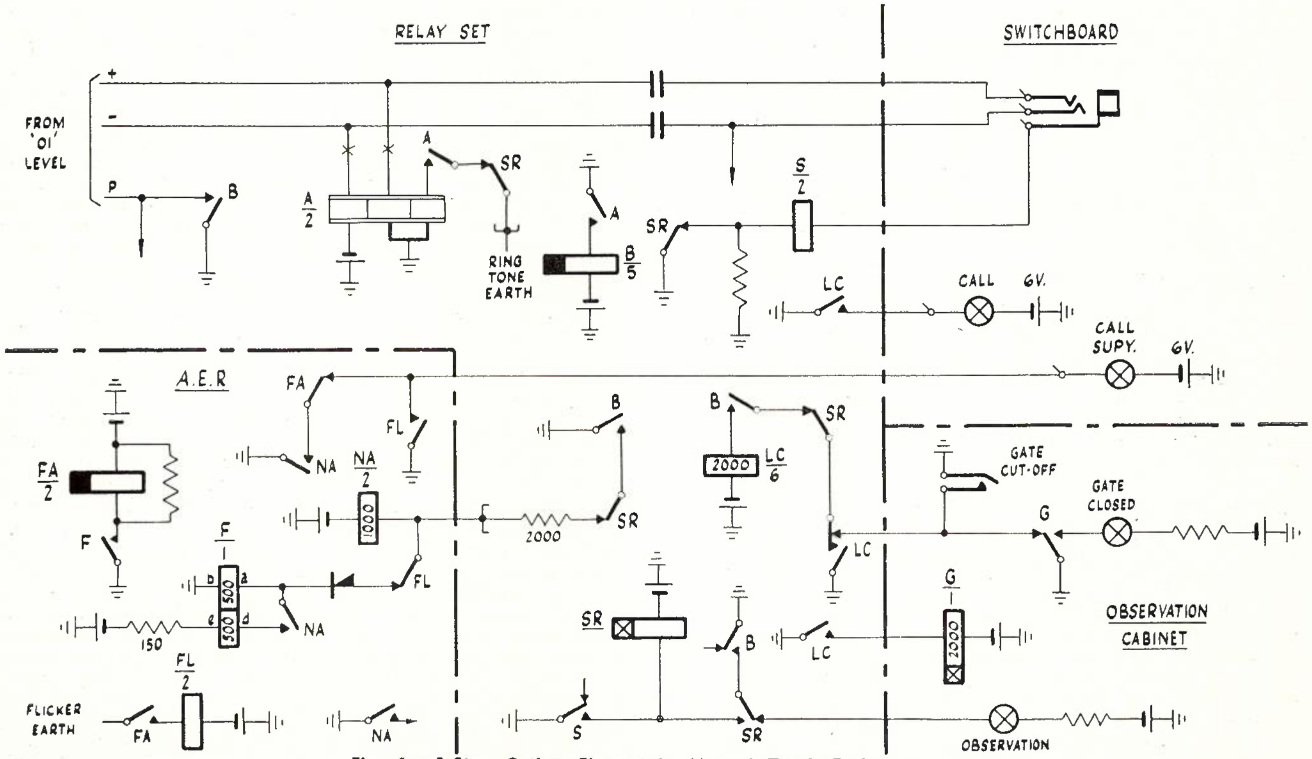

Fig. 1.—2-Step Gating Element in Manual Trunk Exchange.

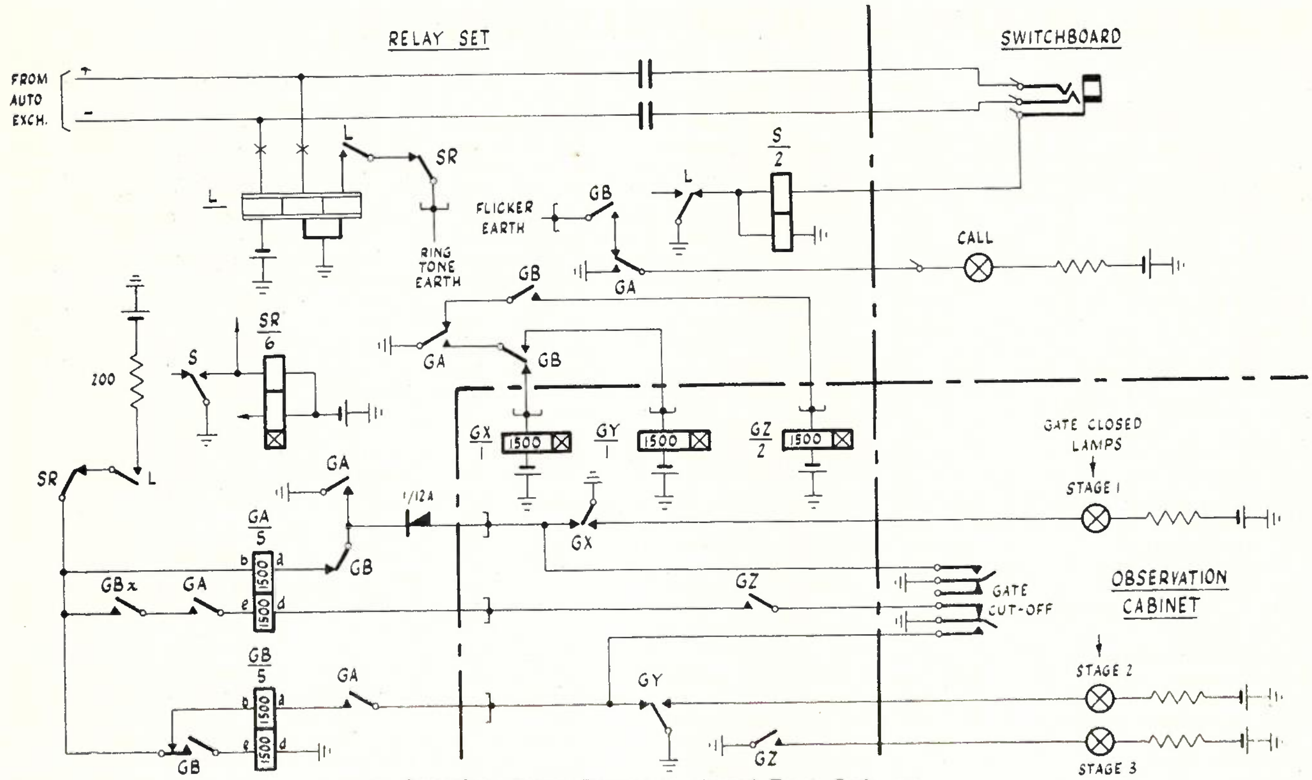

Fig. 2.—4-Step Gating Element in Manual Trunk Exchange.

and usually one or more uniselectors common to a queue for overall control.

These items are usually apart from, although intimately connected with, switches ("distributors" or "finders") required to connect each call to an operator when it has become the oldest waiting. It is possible to combine queueing and operator-hunting in one switch if a large bank capacity is provided (for example by the use of a motor uniselector), but the resultant system is not always necessarily cheaper than one using separate switches for queueing and connecting.

Apart from the elimination of unfortunate calls, call-queueing has a distinctive effect on the nature of the traffic flow. Serving calls in exactly the same order as they originate smooths out variations in the waiting time experienced by successive calls, to a pronounced degree. The waiting time for any call comes closer to the instantaneous average value, which varies relatively slowly in accordance with the ebb and flow of traffic. Whilst of great interest in traffic theory, this phenomenon has little effect on the complaint-of-delay rate once unfortunate calls are prevented.

"TWO-STEP GATING"

Attention has been paid recently to the circuit principle known as "gating". Although a common arrangement in American telephone systems, but apparently seldom used elsewhere, it offers the possibility of preventing unfortunate calls at a much lower cost than the cheapest possible true queueing system.

Its simplest form, the "two-step gate", usually involves the provision of an extra relay for each incoming circuit, together with one common control relay for the group of circuits. Fig. 1 indicates a typical circuit arrangement, as employed on channels from the local automatic exchange to the demand trunk positions at Lithgow, N.S.W. The extra relays are LC and G (for "Lamp Control" and "Gate").

It functions by dividing waiting calls into two batches distinguished by the state of their LC relays. One batch is composed of the more recently originated calls, each with their LC relay unoperated to prevent their being answered yet. Older calls form the other batch, having LC operated, and are taken by the usual processes involved in connecting an incoming call to the telephonist (including the operation of relays S and SR in Fig. 1). Except in special circumstances, the order of connection within a batch is purely random, the telephonist having no idea of the relative age of the various calls.

The critical point is that all calls in the batch being answered must be taken (unless abandoned) before any call in the following batch can be answered. Until then, each fresh call merely swells the number in the "forming" batch waiting with unoperated LC relays. When the last call in that batch is taken, the consequent release of its LC relay allows G (held until now) to release. This provides an earth for the operation of LC relays for all calls then waiting, that is for the whole of the batch which has been forming. Relay G is energised when the fastest LC relay in the batch operates, but its slug provides sufficient operating delay to cover any possible spread in operating lag of the various LC relays.

Incidentally, at Lithgow a useful extra facility is that the "call supervisory" lamp provided on each switchboard position capable of answering 01 calls, which is lit whenever a call is waiting, changes from a steady glow to a flicker whenever the total number of waiting calls (in both batches) exceeds 3. This warning is given by a relay (F in Fig. 1) which is differentially connected to the Night Alarm lead so as to achieve a rather more stable mode of operation than is possible with the more usual series connected "pilot" relay. In effect the N.A. lead is used as one arm of a bridge circuit which passes beyond the balance point and operates F when the resistance in the lead becomes sufficiently low, that is when more than 3 waiting circuits have connected their 2000 ohm earths to the N.A. lead.

The observation cabinet, under the exchange supervisor's control, has lamps to indicate whether the gate is closed and whether any call is waiting; with a key to cut off the gate, and so revert to random answering, in the event of any trouble affecting the gate circuit.

Gating equipment of the foregoing type has given very satisfactory service at Lithgow since the installation of the automatic exchange in 1954. However, when the installation of a temporary 30-position sleeve control trunk switchboard in Dalley exchange building, Sydney, was undertaken in November, 1955, it was thought that the more complex gating arrangement was justified by the large number of calls expected on the 96 junction circuits incoming from the local automatic network.

"FOUR-STEP GATING"

It was found that, for roughly twice the cost of the simpler gating system, namely two additional relays per incoming junction instead of one, the smoothing of waiting times achieved by a true queueing system could be much more closely approached. The reason for this may be stated simply. One gating relay has two possible states (that is not operated or operated) and functions by forming incoming calls into a virtual queue of two steps having a variable sized, randomly served group of calls on each step. Waiting times commonly range from near zero, when a call enters a group just before the gate acts and is fortunate enough to be answered immediately afterwards, to about twice the average, when the oldest call of a group is the last answered.

On the other hand, a pair of gating relays has 4 possible states (counting all unoperated/operated combinations) and may be used to form incoming calls into a virtual queue of four steps. The order of service within the groups is still random, but for the same total number of calls there are roughly one third the number using each step of the queue. Since calls cannot enter or be answered from the two intermediate steps of the queue, except by the gating procedure which steps all groups along the queue, waiting times less than two-thirds of average or longer than four-thirds of average are improbable.

The Dalley sleeve control switchboard was installed with incoming junctions incorporating a gating circuit element similar to that shown in Fig. 2. During busy periods relays GX, GY and GZ will usually be found operated due to each "step" of the "queue" being occupied. (For the purpose of explanation calls will be classified as belonging to step I, II, III or IV depending on their age.) Each call on step IV has its GA relay unoperated with GB operated, causing its call lamp to flicker as a signal to the operators that it should be answered. As long as any unanswered calls remains on step IV, relay GZ is operated to block the advance of calls from step III, which have both GA and GB operated.

When the last call from a particular group on step IV is served, operating its relays S and SR, and so releasing its GB and extinguishing its call lamp, the common relay GZ releases. This opens the holding earth for relay GA of all calls waiting on step III. The consequent release of their GA relays moves these calls from step III to step IV, where they are ready to be answered. GZ re-operates after a delay sufficient to ensure that its contacts open long enough to allow even the slowest GA relay to release.

When step III has been cleared in this way, GY releases. Calls which have been waiting on step II, with GA but not GB operated, thus have one winding of their GB relay energised. In operating, GB changes over to a holding circuit on its second winding so as to become independent of the later re-operation of GY, which is brought about (after a guard delay) because of the resultant advance of calls from step II to III. It also makes GA dependent on GZ, opening the a-b winding to which it has been held until now.

This clearing of calls from step II allows GX to release. Calls which have been waiting on step I, with neither GA nor GB operated, thus have the a-b winding of their GA relays energised. In operating, GA locks to its own make contact so as to become independent of the later re-operation of GX, which is brought about (after a guard delay) as a result of the advance of calls from step I to step II. A 1/12A rectifier is associated with each GA relay to prevent its lock-circuit contacts from wrongly earthing the common gate control lead, which must depend on GX alone.

Once the calls on step I have been advanced to step II and GX re-operated, a new batch of step I calls is assembled. Any fresh call operates its L relay to provide a battery supply for GA and GB, but neither can operate, due to lack of an earth, until GX releases during the next gating action.

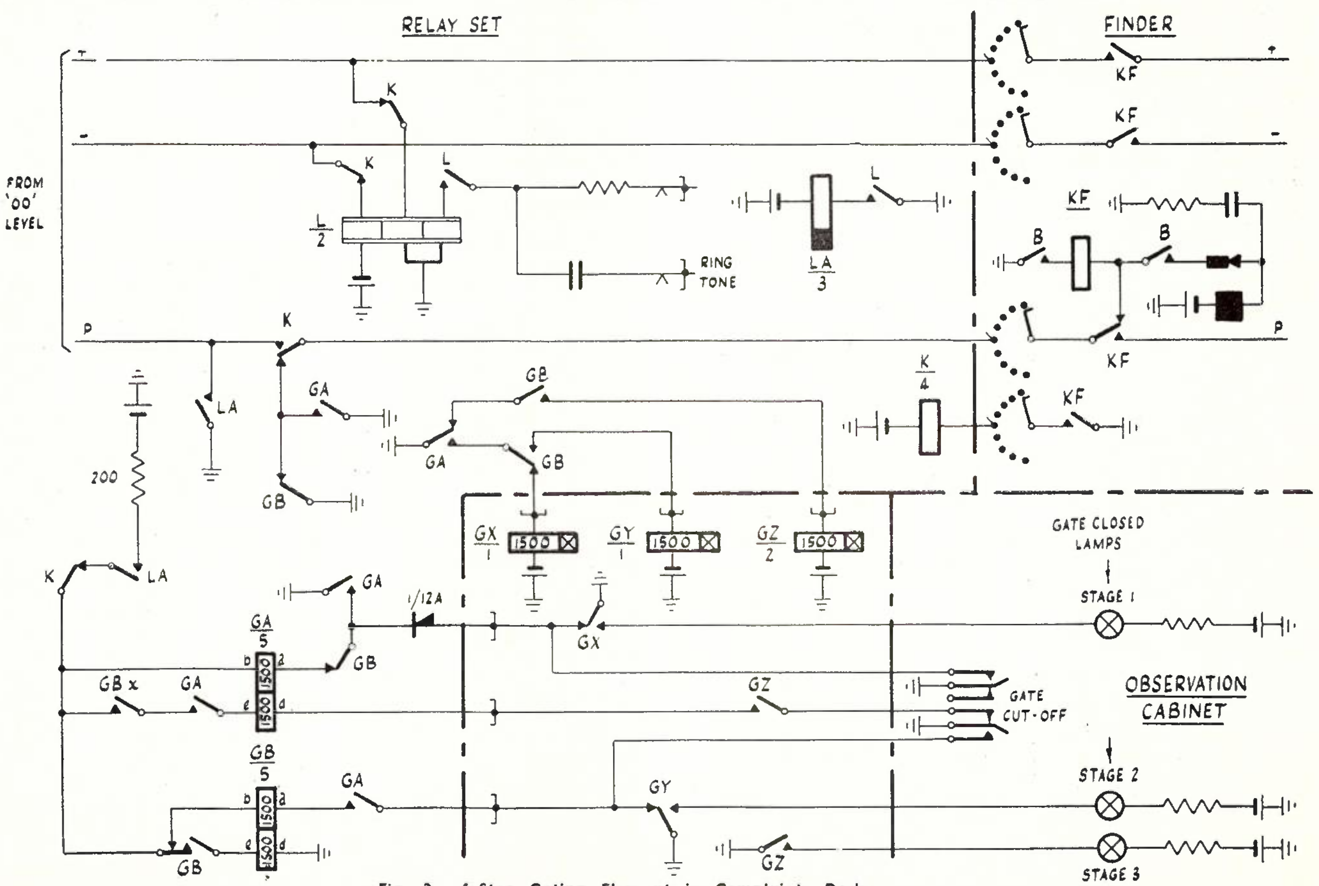

Fig. 3.—4-Step Gating Element in Complaints Desk.

In service, an unexpected psychological trouble was experienced. At cutover the relay sets were wired a little differently to Fig. 2, so that only calls waiting in step IV had their calling lamps lit. It became evident that the operators felt an innate reluctance to take the last call of each batch, apparently tending to wait for more lamps to light in an effort to avoid giving any impression that the switchboard might be overstaffed. With no indication of the number of calls waiting on other steps, the operating tempo became noticeably slower for the last one or two calls in each displayed batch.

This effect was overcome by using the arrangements shown in Fig. 2, whereby waiting calls on steps I, II or III light their lamps steadily, but calls on step IV flicker their lamps. With the telephonists instructed to answer flickering lamps first, the order of service was not changed but the switchboard operations became noticeably smoother because the total number of waiting calls could be seen. There was a further advantage in that if the gating equipment became "stuck" due to a junction failing to flicker its lamps when on step IV, the telephonists went straight on to answer other incoming calls (in random order) whereas previously there was a delay until the supervisor became aware of the hold-up and threw the gate cut-off key. The revised arrangements worked well until the end of 1957 when the switchboard suite was taken out of service with the initial cutover of the Dalley semi-automatic trunk exchange.

The four-step gating circuit element has been used in complaints desks in the Sydney metropolitan network. As shown in Fig. 3, the circuit principles are very similar to those of Fig. 2 except that instead of controlling a calling lamp, contacts of gating relays GA and GB are used to remove an earth from the appropriate finder bank contact when step IV is reached. Until then the gate circuit makes an incoming call inaccessible to any operator. Installations using this circuit element have shown it to be reliable and to possess the desired traffic characteristics.

CONCLUSION

The field of use of this type of equipment remains to be determined. Gating equipment is comparatively so inexpensive, both to provide and maintain, that the possibility of its use must be considered in situations where the elimination of unfortunate calls is desirable but conventional queueing equipment would be too expensive. It may even be that the traffic characteristics of the four-step gate are sufficiently close to those of a true queue as to make it a preferred alternative in all situations.

A line of demarcation between the use of two- and four-step gating equipment remains to be determined. As a compromise between traffic characteristics and economics, it may be possible to arrive at some figure for the busy hour average number of waiting calls (perhaps of the order of 3 or 4) below which the elimination of unfortunate calls is almost the only noticeable improvement, allowing the two-step arrangement to be used; and above which the delay-smoothing effect becomes important, indicating the use of four-step equipment. On the other hand standardisation on one type may be the best arrangement.

In the following list references 4, 6 and 9 give examples of gate-type circuit design (all from American Bell Telephone System sources) while the others deal chiefly with mathematical aspects of gate type service. Of these, reference 10 makes a very readable introduction to and summary of the subject. All references are concerned with gates of the two-step type: the four-step arrangement is a local development.

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Letters to the Journal

A letter to the Secretary, Postal Electrical Society of Victoria, has been received from Mr. R. G. Kitchenn and is published below. The subject matter is contentious and replies from the "experts" would be welcome. Informal letters on other subjects will also be published if they are of general interest to the readers.

15 Gloucester St.,
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Victoria

The Secretary,
Postal Electrical Society of Victoria,
G.P.O. Box 4050,
Melbourne.

A DISTORTED VIEW

Dear Sir,—A formal article prepared for the Journal is frequently restrictive upon an author in that its views are apt to be taken as official Departmental pronouncements.

In an informal letter, on the other hand, it seems to the writer that—within reason—one may rush into fields normally denied to the angelic tread of article- authors, without fear of staining the official escutcheon. Here is scope for the not-too-cautious to vent his views, to stimulate discussion and to jeopardise his professional reputation in fields where opinions outnumber facts.

To start the ball rolling, then, let us look at the question of signal distortion on a telephone line. It's not important where the two telephones are connected only by a pair of wires, but when some distorting electronic devices are interposed, we have to place some limit on the amount of distortion produced by the devices. Forgetting about multichannel telephone systems and their special requirements affecting crosstalk between channels, let's ask the fundamental question: "What is the maximum tolerable distortion between the 2-wire terminals of a circuit used as a trunk line connexion between two telephone exchanges?"

We might be on the right track if we try to relate distortion to a certain minimum percentage articulation or intelligibility. But this raises a crop of new questions which, to the knowledge of the writer, have not been answered by the authorities.

What **do** the authorities say? The C.C.I.F. (C.C.I.T.T. nowadays, of course), who might be expected to know about this matter, have specified many characteristics of trunk telephone circuits—but distortion (of the kind we are at present discussing) is not among them. The subject is being studied by the Committee at present.

The C.C.I.F. has made some recommendations about the distortion in 4-wire audio repeaters and in broadcast programme lines, however, which are of interest to us. For a 4-wire audio repeater there is a provisional recommendation that the total harmonic distortion at the output should not exceed 5% at an 800 c/s output power of 50mW (17dbm), assuming that normal (test tone) level does not exceed 10 dbm. In effect, this recommends that a test tone 8db above line-up level should not produce more than 5% distortion in one repeater. A typical circuit may contain (say) four repeaters; assuming r.m.s. addition of distortions, the overall circuit would have a distortion of 10% at 7db above test tone.

For a broadcast programme line, about 600 miles long, there is a provisional recommendation for the performance of the complete circuit rather than that of one of its elements; however, it is defined in terms of "harmonic margin" and is measured by means of a wave analyser. At a test tone of 9db above normal line-up tone, the harmonic margin should be not less than 20 db. This is interpreted to mean that any distortion component should be not less than 20 db below the level of the fundamental. Now 20db as a voltage measurement is 10%. To arrive at an overall value for the line expressed as a total percentage distortion as before, we shall assume that when the second harmonic is 10%, the third is 6% and the fourth 3%, the approximate total distortion for the whole line then being of the order of 12%.

The present Departmental limit of total non-linear distortion between two trunk switchboards appears to be 5% for a test tone 5db above normal, while that for a broadcast programme line appears to be 4% for a test tone 10db above normal.

Let us leave the question of line distortion for the present, and examine the distortion present in terminal equipment.

A carbon transmitter as universally used on telephones is a device of high output and prodigious distortion of all kinds. Improvements in recent years have aimed at the reduction of the various distortions, but it remains an unpleasant fact that the very desirable efficiency of the device is dependent on a process which produces considerable non-linear distortion. Until the carbon transmitter is replaced by a transmitter working on a different principle (perhaps using transistors to increase the level of a low-distortion, low-output device), then our telephone transmissions are inevitably severely distorted before they leave the subscriber's premises.

By how much? This is where your specialist readers may be able to help with up-to-date information. In 1935[1] measurements on Transmitter Insets No. 10 indicated that at all sound pressures normally experienced, the second harmonic distortion between 1000 and 2000 c/s was about 14%. Other distortion components were also present (including subharmonics). Although the present standard telephone transmitter is somewhat improved, the distortion must surely be of the same order?

The telephone receiver isn't entirely innocent of distortion, either. Ignoring the peaks in its frequency response, and considering only non-linear distortion, we find that this device too, is fundamentally non-linear in operation. Here, again, we could benefit from the advice of the specialist, but the writer believes that it would be reasonable to assume a total distortion factor in the region of 10%.

We now connect our two telephone instruments with a linear (from a distortion point of view!) pair of wires, and assess the total non-linear distortion between speaker and listener as the r.m.s. sum of the transmitter and receiver non-linear distortions—in the region of 17%.

The terminal equipment distortion on a broadcast programme line is unlikely to be greater than 1% for the microphone and its amplifier, and up to 2% for a receive amplifier and loudspeaker.

It now seems appropriate to summarise our knowledge—and assumptions—about non-linear distortion on transmission systems; the table below does this.

The outstanding feature of this comparison is that in the telephone channel terminal equipment distortion is overwhelmingly greater than transmission medium distortion, while with a broadcast line it is much less than the transmission medium distortion. Is this reasonable? A doubling of the existing Departmental limit of non-linear circuit distortion would surely have an imperceptible effect on the overall transmission quality.

Service	C.C.I.F. Limit	Dept'l Limit	Assumed Terminal equipment distortion %	
			Trans.	Rec.
Telephone	None yet stated	5% at 5db above normal t.t.	14%	10%
Broadcast	12% at 9db above normal. (Possibly to be reduced)	4% at 10db above normal t.t.	1%	2%

What would be gained by such a relaxation?

Small economies in normal trunk line equipment could be obtained, for present equipment design provides for a substantial margin to account for the difference between average and peak speech power; a relaxation of the distortion criterion would reduce this margin and the necessary power-handling capability of the equipment.

Greatest benefit would be obtained in single-channel (and perhaps other) radio trunk circuits. Signal-noise ratio in existing designs of such circuits can be improved by increasing the effective transmitter power and/or by increasing the modulation "depth" of the system. The first course is expensive; to gain a 3db improvement by this means requires the power of the transmitter to be doubled, or demands a more complex aerial system. The second method merely involves the twisting of a knob—but the price paid for this convenience is an increase of non-linear distortion. If the permissible distortion limit is relaxed then substantial savings in capital cost and annual charges could be made. In recent tests on a typical single-channel radio system, it was found that an increase of 12db in the modulation level resulted in a decrease of articulation from 97.5% (normal modulation level) to 96.5%. The corresponding non-linear distortion of test tone at this increased level was about 12%. Thus up to 12db improvement could probably be achieved in the signal/noise ratio of such a radio system by this means—or alternatively, the advantage could be used to provide longer circuits or smaller transmitter powers than presently required. But the advantage is entirely dependent on whether a greater amount of telephone circuit distortion may be allowed than at present. Would such a relaxation be justified?—Yours,

R. G. KITCHENN

Reference:

[1] McMillan, D., P.O.E.E.J. Vol. 28, p. 167.

CORRECTIONS

The following corrections are necessary to articles appearing in two recent issues of the Journal:—

Vol. 11, No. 1, The Type N1 Cable Carrier Telephone System, by P. W. Seymour.

Page 26, Column 3—

Equation 6 should read—

$$\sqrt{V_1} = \sqrt{\mu_1 \mu_2 \frac{K_1}{K_2}} \, . V_1$$

and Equation 7 should read—

$$\sqrt{V_2} = \sqrt{\mu_1 \frac{K_1}{K_2}} \, . V_1$$

Vol. 11, No. 2, Nomograms for Equaliser Design, by K. F. Dwyer

Page 51, Fig. 1, Last two lines should read—

$$\text{Insertion loss in db} = 20 \log_{10} \left| \frac{R_0 + Z_1}{R_0} \right|$$

$$= 20 \log_{10} \left| \frac{R_0 + Z_2}{Z_2} \right|$$

Page 52, Column 3, Second line of last paragraph—

Type III(a) should read Type II(a)

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