THE

Telecommunication Journal OF AUSTRALIA

VOL. 13, No. 6 Registered at the General Post Office, Melbourne, for transmission by post as a periodical. FEBRUARY, 1963

THE TYPE 801 TELEPHONE

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INTRODUCTION

In January, 1963, a new type of coloured telephone having a pleasing appearance and advanced technical features was made available to the Australian public. It was the first type in the 800 series to be released and is known as the 801 type telephone. This telephone is designed for use in automatic exchange areas and incorporates automatic regulation of transmission performance. The general features of the design of the 801 telephone, together with its circuit and transmission performance, are discussed in this article. In future issues of this Journal, the various components of the telephone will be dealt with in greater detail.

Shortly after the candlestick telephone gave place to the moulded handset telephone, designers realised that plastics offered the opportunity to make durable telephones in colours other than black. Although coloured telephones were introduced into service in the Australian network during the 1930's, only the ivory instrument achieved any degree of popularity. Since World War II, a great many new plastic materials have become available commercially and many of these are very suitable for the manufacture of telephones in the full range of colours from strong reds, greens and blues to pastel shades.

Fig. 2.—Rear View with Handset Off.

The Australian Post Office has been well aware of the need for a range of coloured telephones which would harmonise with colours used in modern interior decorating schemes. Accordingly, after calling tenders throughout the world, it was decided in September, 1961, to develop a new Australian coloured telephone as a joint project of Australian manufacturers, that is, Standard Telephones and Cables Pty. Ltd. (S.T.C.), and Amalgamated Wireless (A/sia) Ltd. (A.W.A.), and Australian Post Office engineers. For the first time the Post Office had control over all design features. Information about telephone design had been accumulated for the past 15 years with a view to the eventual design of an instrument for the Australian network and it is clear that the 801 type telephone is at least as far advanced as any other available at present on the world market.

The new telephone instrument is a development from the "Assistant" telephone designed by the Bell Telephone Manufacturing Co., Antwerp, Belgium, with which S.T.C. is associated. However, the design details, both external and internal, have been modified considerably to produce the Australian instrument.

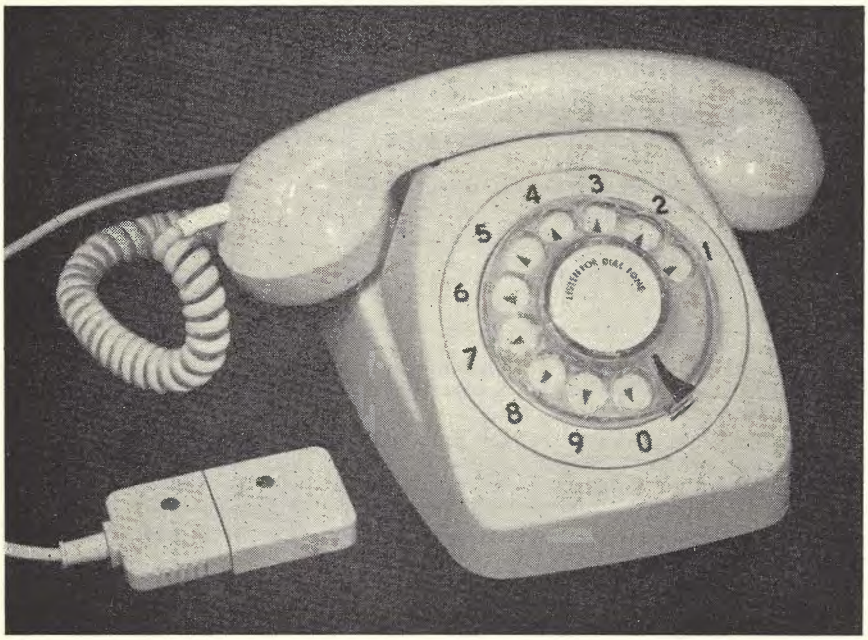


Fig. 1.—Face View of 801 Telephone.

GENERAL FEATURES

The objectives in the design of the new telephone were a high standard of performance throughout the service life, an aesthetically pleasing appearance, and economy in both installation and maintenance consistent with the requirements for economic manufacture. Particular attention was given to the design of components to ensure that they could be manufactured to the quality level required to give a high probability of a long trouble-free service life. The unit construction principle is employed to simplify manufacture and maintenance. Individual components are grouped and arranged in sub-assemblies which are the fundamental units from which the complete telephone instrument is built.

The case and handset are moulded in a toughened polystyrene injection moulding material, acrylonitrile butadiene styrene (A.B.S.), which combines light weight with high impact strength. The surface has good resistance to scuffing, marking, abrasion and scratching, and is easily cleaned. In addition, A.B.S. resists aggressive chemicals such as acids, alkalis, and many solvents and is

* See page 502.

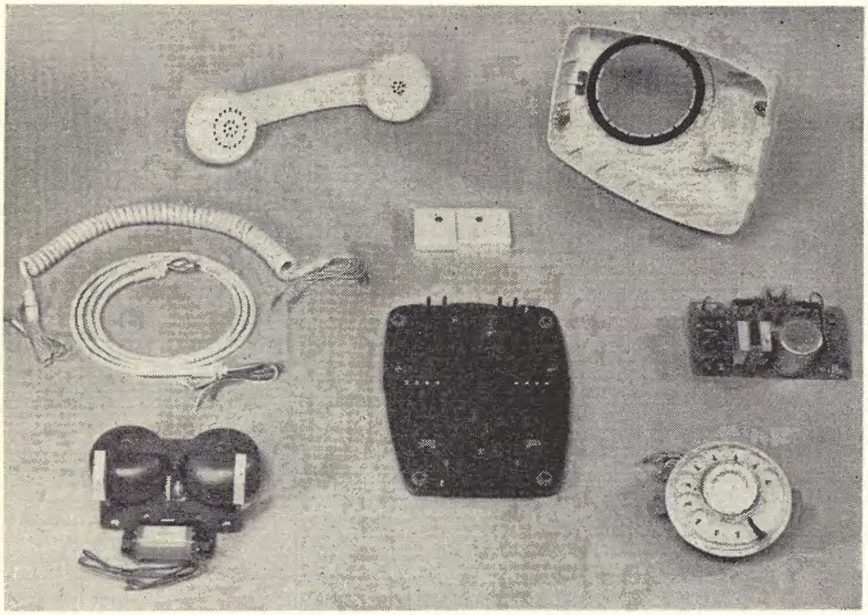


Fig. 3.—Component Assemblies.

not adversely affected by substances normally used for household cleaning.

The five colours chosen for the first order of the new telephone are light ivory, mist grey, fern green, topaz yellow, and lacquer red. These are shown in the photograph on the front cover of this issue of the Journal. Further details of the external appearance can be seen from Figs. 1 and 2.

The case functions primarily as a cover for the component assemblies and not as a mounting unit. It has therefore been possible to design it as a relatively thin, mechanically elastic shell with smooth contours. This case shape, together with the design of the gravity switch plungers (Fig. 2), almost eliminates the danger of accidental operation of the gravity switch by the cords. The handset, when replaced, is directed into its correct position on the gravity switch plungers by a self-aligning action. It is nearly impossible to accidentally balance the handset on the telephone case in any position near the plungers without operating them. A built-in carrying handle in the form of a recess in the case is provided (Fig. 2), which makes it easy to grasp the telephone and carry it in one hand.

The sub-assemblies and components which make up the telephone are shown in Fig. 3. With careful design of the layout, it has been possible to mount the induction coil, capacitors and gravity switch on a printed circuit card to form a compact printed circuit assembly as shown in Figs. 4 and 5. The "wiring" side of the printed circuit card (Fig. 5) is tropic-proofed after soldering, in order to prevent leakage currents between conductors due to "creepage" in moisture films on the card surface. The use of "quick connect" sleeves and studs allows easy and reliable connection of the component assemblies to cords and flexible links without the need for screw fastening or soldering. "Parking" studs for flexible links provide for possible variations of the basic circuit.

The handset is supplied in the same colour as the case. It is a shell moulding approximately half the weight of the previous standard handset. A convex transmitter cap without projections is provided, and the small mouthpiece horn on earlier handsets has been eliminated to improve the appearance without greatly affecting the efficiency of the instrument. The handset is slightly curved to bring the transmitter into the correct speaking position. Adaptor inserts in the handset cavities allow the use of alternative types of receiver and transmitter capsules. An acoustic shock absorber "click suppressor" is mounted on the back of the receiver to protect the user from noises loud enough to cause discomfort.

The dial is adapted to the telephone case by use of a dial adaptor ring which also serves as an enlarged number ring. Placing the numbers away from the fingerplate reduces wear and obliteration of the numbers and makes identification more certain. By the substitution of alternative adaptor rings any modern dial can be accommodated. No letters or numerals are provided on the dial label and this allows adequate space for the subscriber's telephone number and the prefix of the national dialling code, when subscriber trunk dialling is introduced. Special numbering stamps are being developed so that the number can be printed on the label in a uniform manner by the installing technician. The dial mechanism and springsets are enclosed in a clear polystyrene dust cover. On the 811 telephone (the equivalent C.B. manual table telephone), a dummy dial is used to replace the dial and adaptor ring.

The bell has a single coil, polarised by a permanent magnet inside the coil, and will operate satisfactorily with ringing frequencies of $16\frac{2}{3}$ c/s to 50 c/s. A bell loudness control device, which can be operated by the subscriber to vary the loudness between a loud clear ring and a low level buzz, protrudes through the base plate of the telephone. To guard against the subscriber unintentionally placing himself out of call, the control does not silence the bell completely in the minimum position. The telephone base plate provides ventilation by pressed-out louvres and is equipped with four rubber feet which have been designed to give the telephone a firm grip on the table surface.

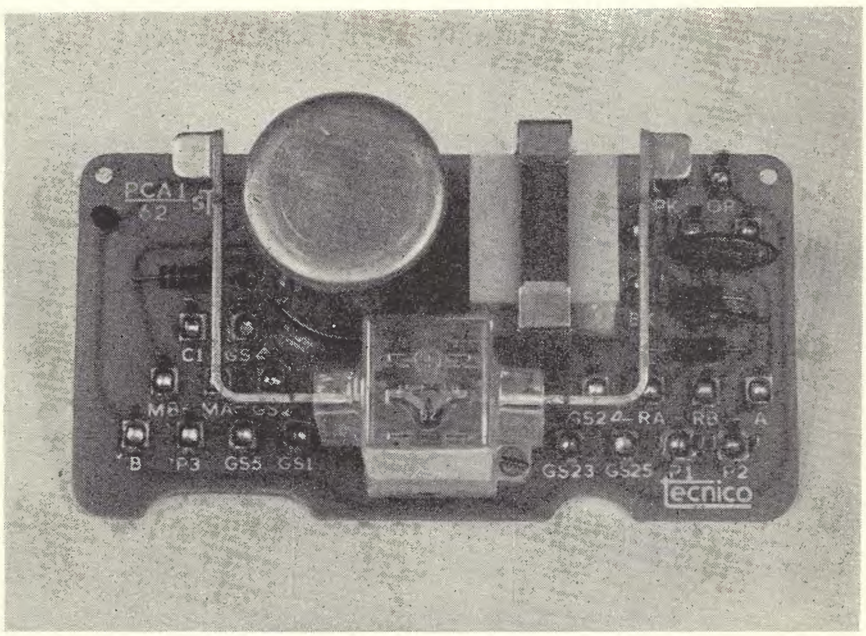


Fig. 4.—Printed Circuit Assembly.

The handset cord is retractable, coiled, covered with P.V.C., and coloured to match the case mouldings. The cord was designed to have a retractile force much lower than the force required to make the telephone slip on all normal surfaces. The small pull created by the cord together with the light weight handset makes the telephone very comfortable to use. The cords are fitted with "quick connect" sleeves which plug on to the studs on the printed circuit assembly, the instrument plug, and the transmitter inset. The cord pull is taken by grommets which are securely welded to the sheath instead of by strain cords. The conductors are also welded to the sheath at the ends to stop them being drawn in when a strong pull tends to stretch the sheath. The instrument and handset cords, which enter the telephone through separate openings at the rear, can be interchanged without disconnection of the terminations, to cater for those instances where a telephone instrument is used mainly on the right-hand side of the table.

The connection between the instrument cord and the fixed wiring is made through a flat plug and socket unit which has been designed for minimum protrusion from the surface on which the socket is mounted (Fig. 1). Provision is made for the plug to be made captive by changing one of the wood screws used to mount the socket. This is done by using a longer screw which passes through a tongue on the plug as well as through the base of the socket. Both long and short screws will be provided with each socket supplied. Plug pins and socket points provide for a maximum of six conductors from the telephone. Normally a three conductor cord is used. Provision is made for the connection of an extension bell by removing a strap in the socket. No alteration to telephone instrument, cord or plug is required. Contacts on socket springs 3 and 4 "make" when the plug is removed. This facilitates the standardisation of cable connections to instruments in plan number working.

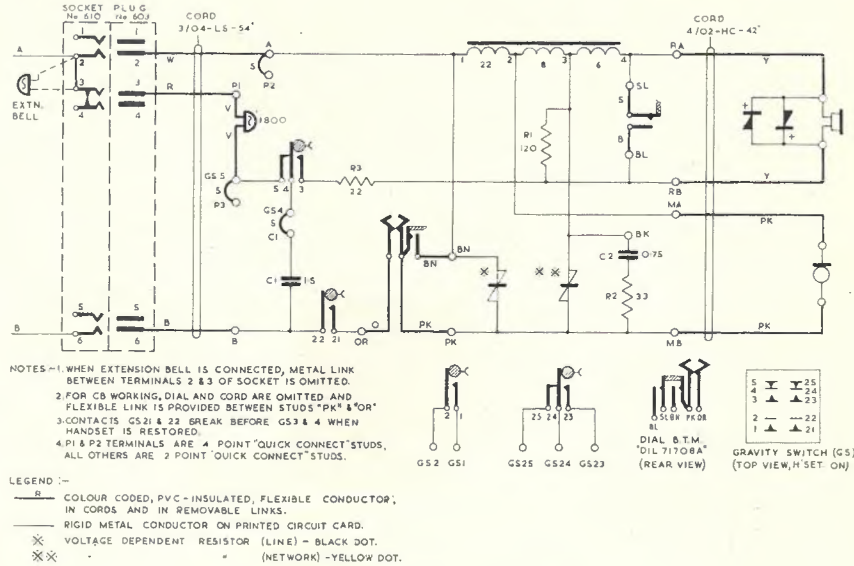


Fig. 6.—Circuit of 801 Telephone.

The electrical circuit provides the following improvements compared with circuits used previously:

(i) Transmitting, receiving, and side tone levels are automatically regulated within standard limits by using two voltage dependent resistors, more commonly known by the trade name "Varistors", as control devices.

(ii) The provision of a "click suppressor" across the receiver has made possible the sequencing of the gravity switch contacts to spark quench the contacts in the line circuit. In earlier circuits the gravity switch contacts had to be sequenced to short out the shock pulse which occurred when the gravity switch was operated; this contact sequence did not provide a spark quench.

(iii) The bell is disconnected from the line by the gravity switch while the handset is lifted.

Provision is made for the addition of push buttons at the front corners of the angled surface of the case. These will be bought with the telephones or added in the workshops or in depots as required. Push buttons are secured to the base plate connected to the circuit assembly by flexible conductors fitted with "quick-connect" sleeves and remain in position when the case is removed.

Ventilation of the interior of the instrument is provided by a ventilator grille at the rear of the case in the carrying recess. This, in conjunction with the fixed louvres in the base plate and the slots between the case and base plate, provides an adequate flow of air over the components to avoid condensation under humid conditions. It also allows sound-waves caused by the bell operation easy egress from the case.

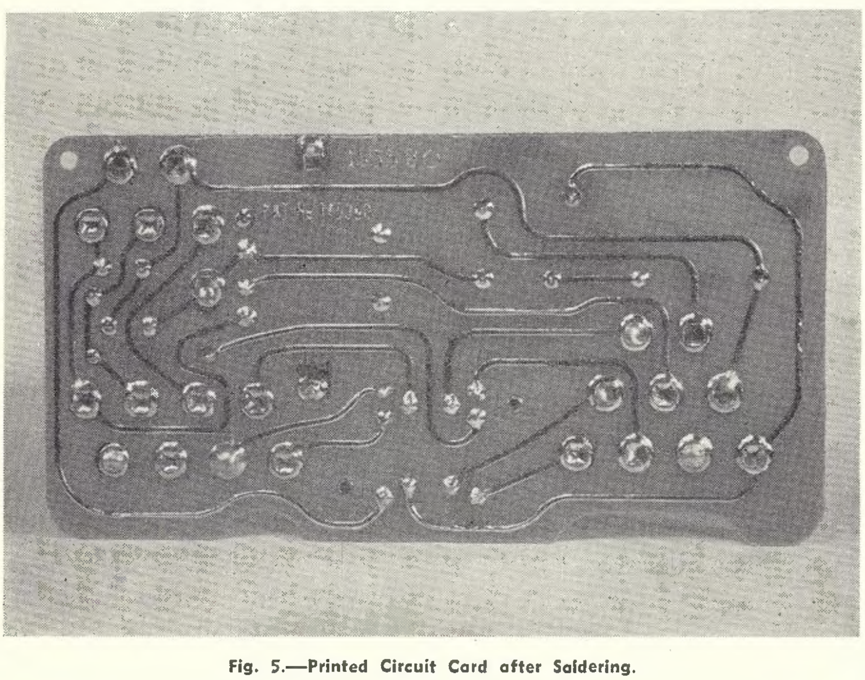
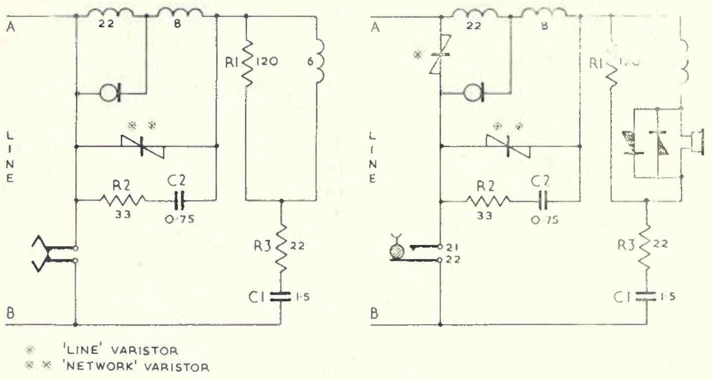


Fig. 5.—Printed Circuit Card after Soldering.

CIRCUIT.

The complete circuit of the telephone is shown in Fig. 6.

The gravity switch contacts of the earlier 400 type circuit, which normally "made" when the handset was lifted to connect the bell circuit capacitor as a spark quench across the dial contacts, have been replaced by a changeover springset GS3, 4 and 5, so that the bell circuit is opened when the handset is lifted. This eliminates the high impedance shunt to speech current of a bell connected across the line. The "break" side of either of the two changeover contacts provided on the



(a) Dial Impulse Springs. (b) Gravity Switch Contacts.

Fig. 7.—Spark-Quench Arrangements.

gravity switch, may be used to disconnect external capacitors connected in parallel with C1 for ringing purposes. The capacity across the impulse springs can thus be controlled in these instances and the impulse distortion that occurs with excessive capacity avoided.

The gravity switch contacts previously in series with the "A" line, have been moved so that they are in series with the "B" line. This has two advantages:

(i) The "B" line potential is isolated on one side of the 1.5 microfarad capacitor and GS.22 contact when the handset is cradled. This enables maximum separation of conductors of opposite polarity in the design of the printed circuit card layout.

(ii) On "hanging up" the gravity switch contacts GS.21 and 22 open the D.C. loop and this causes a high transient voltage across the contacts in a similar manner to that caused across the dial impulse contacts when dialling. In the 400 type telephone these contacts were only partly quenched by the bell coil and series capacitor. In the 801 telephone, however, the new circuit uses the elements of the dial spark quench circuit, slightly re-arranged, for a second function as a spark quench on the gravity switch contacts.

Fig. 7(a) shows the spark quench circuit applied to the dial impulse springs and Fig. 7(b) shows the spark quench circuit applied to the gravity switch contacts GS.21 and 22. In order to achieve this quenching it has been necessary to sequence the contacts GS.3 and 4 to break after contacts GS.21 and 22 as the handset is restored. The sequencing of the gravity switch contacts in this telephone is therefore opposite to that provided in the 400 type telephone. This is possible due to the provision of the shock absorbing rectifiers across the receiver which make sequencing for click suppression in the receiver unnecessary.

The dial spark quench circuit has been adjusted to an optimum value by insertion of R3 (22 ohm) between the gravity switch spring GS.3, and the RB terminal; the influence of R3 on the receiving transmission efficiency is negligible because of the relatively high impedance of the receiver.

The series connection of straps and links has been reduced to decrease fault liability at connecting points, but the inherent potential for circuit modifications has not been impaired.

TRANSMISSION PERFORMANCE.

The circuit of the 801 telephone is based on the transmission circuit used in all modern instruments and first used in the Western Electric 500 telephone some 20 years ago.

The transducers used in the 801 telephone are the present standard transmitter No. 13 and receiver 4T. The dimensions of the handset which determine the position of the transmitter cap relative to the receiver cap and have a big effect on the transmission performance, are in accordance with standards widely used in Europe.

The induction coil design minimises iron and copper losses and the magnetic reluctance of the air gap is chosen for maximum transmission efficiency under the "long loop" condition, consistent with adequate control of saturation by "zero-loop" feed current.

When receiving from the line, the signal divides between the transmitter and receiver and the ratio:

$$\frac{\text{Audio signal power into transmitter}}{\text{Audio signal power into receiver}} = y$$

is known as the "y" ratio. When transmitting, the audio signal output of the transmitter is divided between "Line" and "Balance Network" and the ratio:

$$\frac{\text{Audio signal power to Line}}{\text{Audio signal power to Balance Network}}$$

is also equal to y. The value of y is determined by the ratio of coil windings, together with related line and balance network impedances.

Theoretically, maximum overall efficiency is obtained when y is unity but, to be compatible with an existing network in which receivers of low sensitivity such as type 1L are used, a telephone using a receiver with high sensitivity such as type 4T has to bias the "y" ratio to favour the transmitter. The departure from the 1 : 1 ratio introduces additional copper and iron losses in the induction coil, and the value of y chosen is a compromise which best fits the present transmission levels required in the Australian network. The winding ratios of the induction coil (ICO-1) used in the 801 telephone are identical with those of British Post Office Coil No. 31 and almost the same as those of the British Post Office Coil No. 30 which was used in the 400 type telephone. The relevant winding turns of these coils are shown in Table 1.

TABLE 1. COIL TURNS

Coil	Line	Network	Receiver
ICO-1; B.P.O. No. 31	900	540	315
B.P.O. No. 30	1220	666	420

As a result of the gain in transmission by the use of more efficient transducers, modern telephones when connected by short lines have uncomfortably high "receive" volume and sidetone. On P.B.X. working an extension telephone may be connected to the local feeding bridge by a very short loop in the case of an internal call, but on a call over the exchange line the loop distance from the feeding bridge may be several miles. Automatic regulation of transmission levels on "send" and

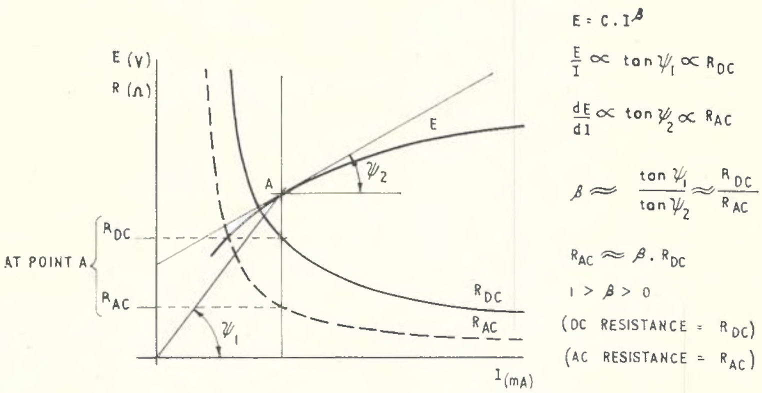


Fig. 8.—Characteristics of a Voltage Dependent Resistor (Varistor).

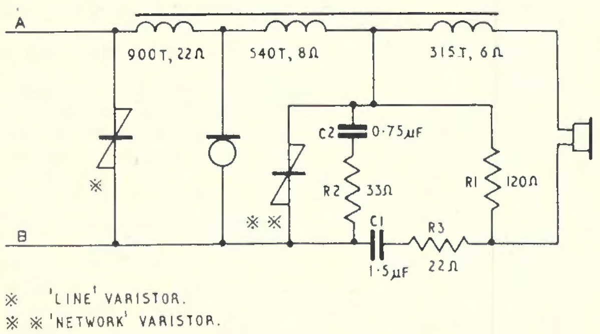


Fig. 9.—Schematic of Transmission Circuit.

"receive" and improved sidetone suppression on short loops is therefore desirable.

The values of components in the balance network were chosen so that high values of sidetone attenuation could be obtained under medium and long loop conditions when the influence of the varistors is small. The automatic regulation in the 801 telephone is controlled by two varistors. They consist of a multitude of silicon-carbide crystals, bonded with a ceramic binder into a disc. The contact resistances between the various crystals form a complicated network of series and parallel paths giving the voltage dependent characteristics of the unit.

The characteristics of a voltage dependent resistor are shown in Fig. 8 with voltage and resistance plotted against D.C. current on a linear scale. At the operating point A the apparent D.C. resistance of the unit is a function of the angle ψ_1, while the incremental A.C. resistance is a function of the angle ψ_2. For direct current, the voltage-current relationship of the unit is of logarithmic nature. When plotting on a logarithmic scale it approaches a straight line, thus demonstrating that β is almost constant over the range of operation.

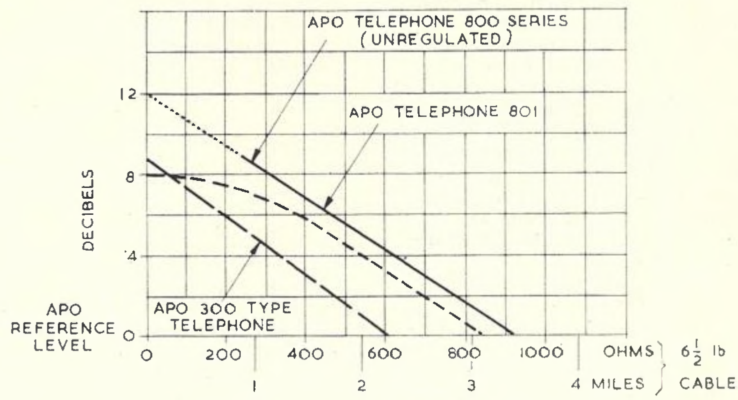
Two varistors are used as shown in Fig. 9. The "line varistor" acts as a shunt across the line and the "network varistor" as a shunt across the balance network.

The main effect of the line varistor is to produce the desired regulation of "send" and "receive" efficiency by shunting audio frequencies under the control of the D.C. voltage across the line terminals. A comparison of transmission ratings between "regulated" and "unregulated" Australian Post Office telephone circuits is shown in Fig. 10. These ratings are based upon transmitter characteristics typical of a No. 13 transmitter midway through its useful life.

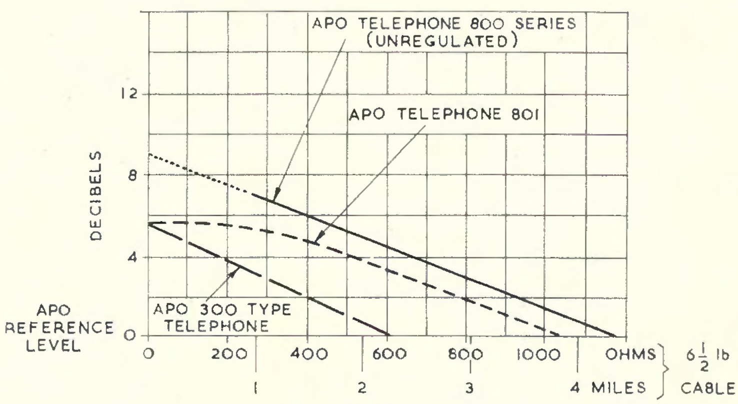
The main effect of the network varistor is to produce an improved sidetone suppression, shunting the network so that a balance with the combined impedance of the line and line varistor is achieved. This gives the desired improvement in sidetone attenuation on short loops. Sidetone attenuation of the 801 telephone has been determined as the average ratio of "Receiver Voltage" to "Transmitter E.M.F." at the frequencies of 0.5, 1, 2 and 3 Kc/s. At zero loop the sidetone suppression is 7 db better than that of the unregulated circuit. This is of particular value when a telephone is used in a noisy location.

The use of the varistors also provides an additional benefit as their combined D.C. shunting effect reduces the transmitter current by approximately 20% on a zero loop, as shown in Fig. 11. This reduces "frying" and increases the service life of the transmitter.

In determining the subscribers' local line transmission limits for the 801 telephone, cognisance was taken of the progressive deterioration of transmission efficiency of carbon transmitters, because of reduced depth of modulation and an increased "speaking resistance" (dynamic resistance) during their service life. As varistors regulate by shunt control, the transmission loss on long loops, which is due to the presence of regulators, also increases with higher "speaking resistance". The limit loop conditions make allowance for this fact.



(a) Efficiency Rating "Send".



(b) Efficiency Rating "Receive".

Fig. 10.—Relative Ratings of A.P.O. Telephones.

TABLE 2. LOCAL LINE TRANSMISSION LIMITS, 801 TELEPHONE.

	4 lb. Cable	6½ lb. Cable	10 lb. Cable	20 lb. Cable	40 lb. CC Open-Wire	70 lb. CC Open-Wire	100 lb. HDC Open-Wire
Ohms	1150	920	770	610	1320	1155	1078
Miles	2.62	3.41	4.37	7.0	25.4	38.5	61.3

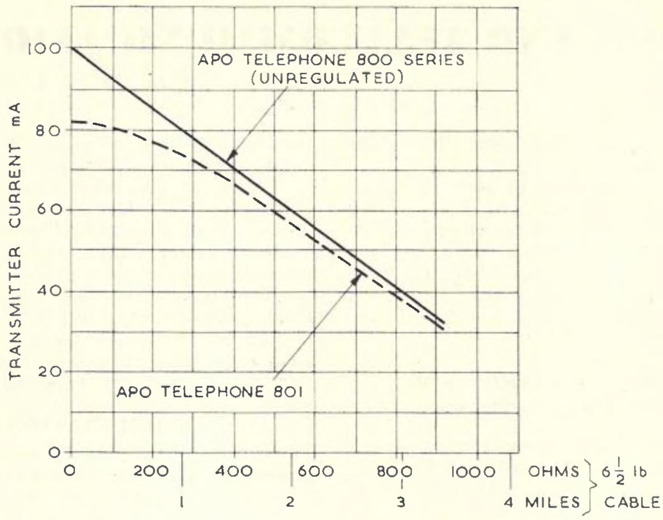


Fig. 11.—Control of Transmitter Feed Current by Voristors.

TABLE 3. CONVERSION FACTORS.

	4 lb. Cable	6½ lb. Cable	10 lb Cable	20 lb. Cable	40 lb CC Open-Wire	70 lb. CC Open-Wire	100 lb. HDC Open-Wire
Conversion factor — Ohms	.67	.84	1	1.26	.58	.66	.70
Conversion factor — Miles	1.7	1.3	1	.62	.17	.11	.07

The transmission limits are shown in Table 2.

The conversion factors for use when composite loops with conductors of different weight are provided are shown in Table 3.

CONCLUSION.

The introduction of the 801 telephone has brought automatic subscribers instruments in Australia up-to-date by world standards, and plant in this field will now match the new types being introduced in the switching equipment and other fields. It is expected that this modern instrument will appeal widely to the general public as well as giving improved transmission performance and maintenance facilities.

ACKNOWLEDGEMENTS.

The author is indebted for the help given by his colleagues in the Telephone Equipment and other Sections of the Engineering Division at Headquarters, and in particular those in the Research Laboratories. A number of valuable contributions to the design features of the new instrument were made by S.T.C. and A.W.A., and significant contributions were made to the design of components by other Australian manufacturers, particularly Transmission Products Pty. Ltd., makers of the 6-pin plug and socket, Blys Industries Pty. Ltd., makers of the cords and grommets, J. J. Hoelle Pty. Ltd., makers of the "quick-connect" terminations, and Rola Co. (Aust.) Pty. Ltd., makers of the sintered ceramic permanent magnets. The assistance given by the Training Section in the preparation of this article is also acknowledged.

TECHNICAL NEWS ITEM

NEW INTERNATIONAL TELEPRINTER EXCHANGE

The new exchange for the international teleprinter (TELEX) service opened at the Overseas Telecommunications Terminal, Paddington, Sydney, on December 31st, 1962. This service is provided by the Overseas Telecommunications Commission (Australia). The initial international telex exchange was established at O.T.C. House, Sydney, in October, 1958 to give service to four countries; today, it is open to 50 countries and the volume of traffic exceeds the volume of the international telephone traffic. To meet the demands of the future, it has been necessary to transfer the exchange to the Paddington terminal and to increase its capacity. Direct connection is available on demand to many countries of the world, and the majority of other countries are accessible by indirect connection.

Telex transmission channels at present are almost exclusively provided by high frequency radio circuits. Complex automatic error detecting and correcting terminal equipment is provided on these channels so that the quality of telegraph communication is of a high standard. On completion of the Commonwealth Pacific Cable (COMPAC) project in late 1963, a large increase in the number of telex circuits available to Canada, United States of America, Britain and Europe will be possible. This is expected to give rise to an added impetus to the rapidly expanding volume of telex traffic already offering.

To meet this further development a semi-automatic international telex exchange will be installed at Paddington in 1964. This new exchange will enable the telex operators in distant countries to select telex subscribers automatically. On present planning, it is probable that direct subscriber to subscriber switching (without the intervention of operators) may be provided for inter-continental telex calls to and from Australia by 1966.