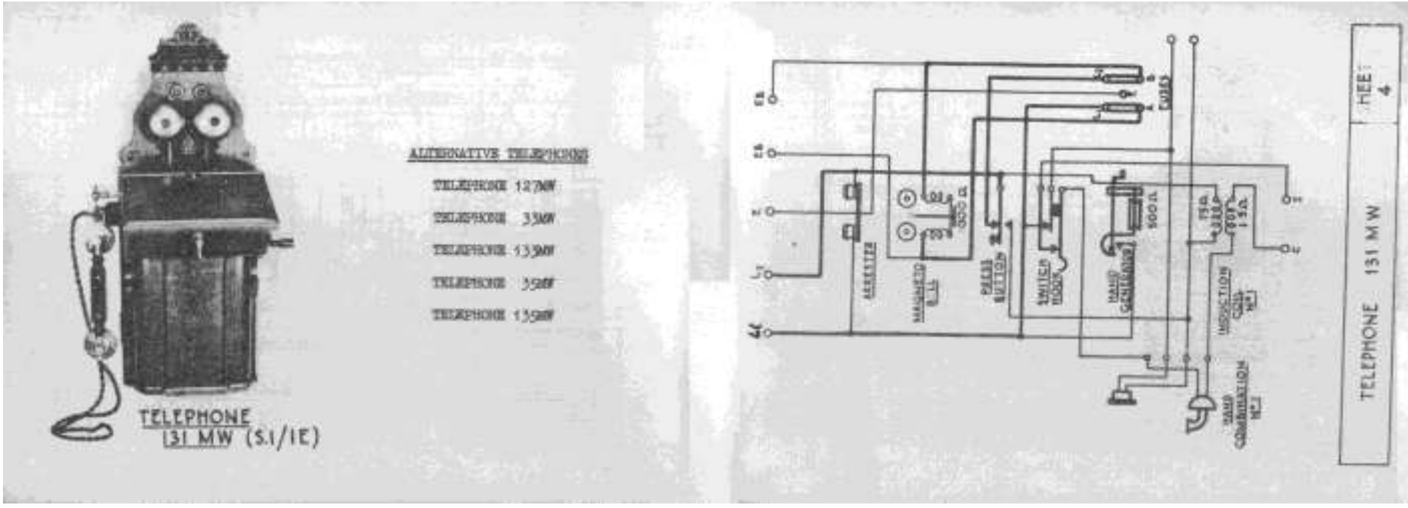
Telephones used in Australia 1910 to 1930's

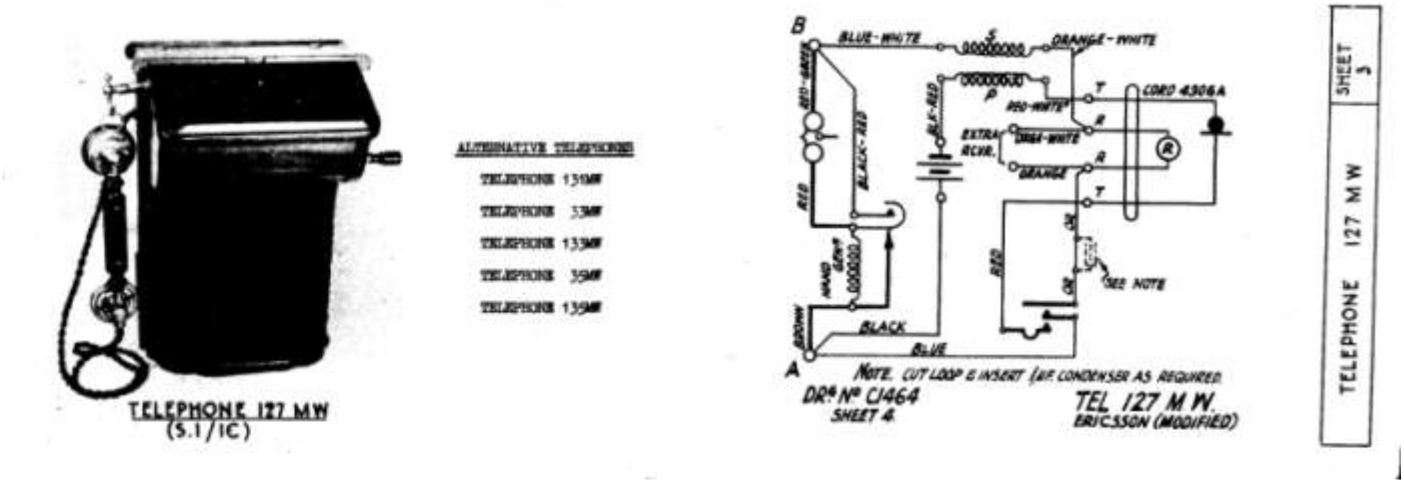
<u>Magneto</u>

The 131 MW (Magneto Wall) - Commonly referred to as the Commonwealth Ericsson, or Ericsson AB 535

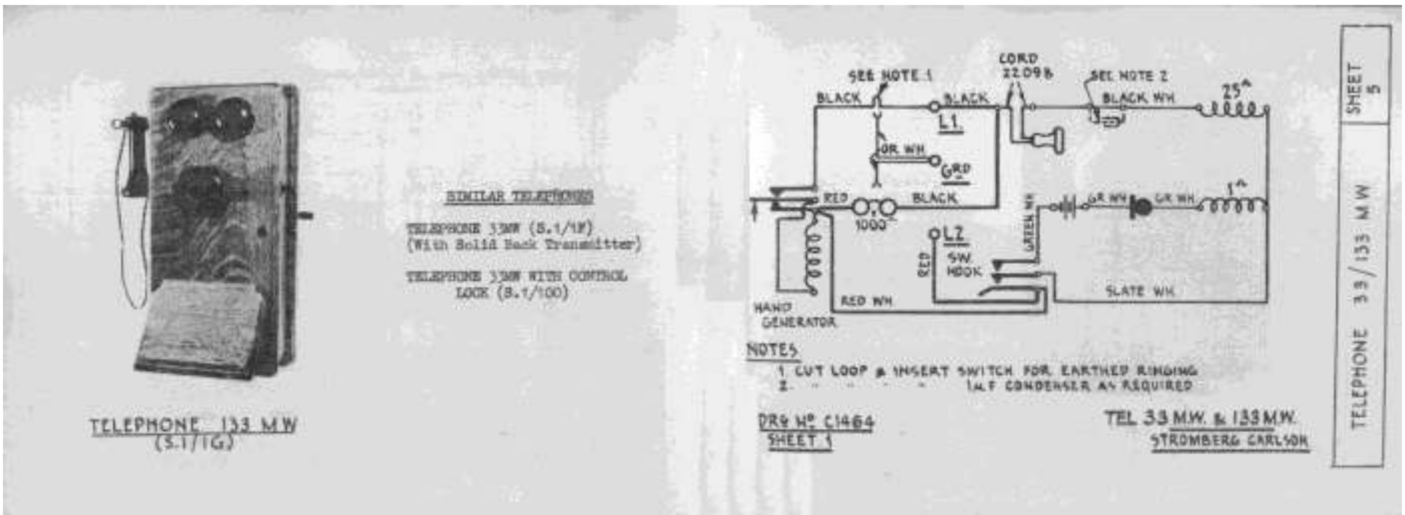


Aesthetically, ergonomically and technically, one of the best telephone instruments available from the 1890's. It was made using quality materials and timbers of oak or walnut with a fine finish to the timbers and good quality nickel plating to the brass components.

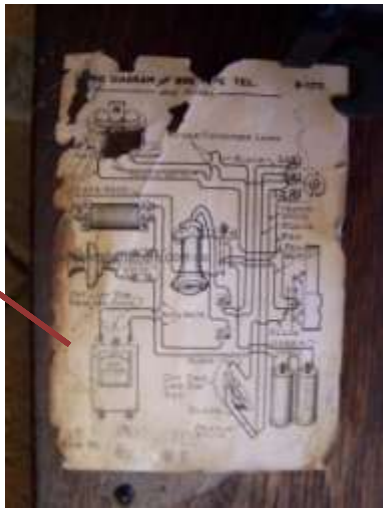
The 127 MW (Magneto Wall) - Commonly referred to as the Tucked Ericsson – a 1940’s PMG modification brought about by material shortages around the time of the Second World War. The example pictured below has the timber front to the battery box which was a feature of the original type 131MW ???????



The 133 MW (Magneto Wall) – Manufactured by Stromberg Carlson in the US. Note the earlier type 33MW had the Solid Back Transmitter, whereas this type 133 used an Inset Transmitter.

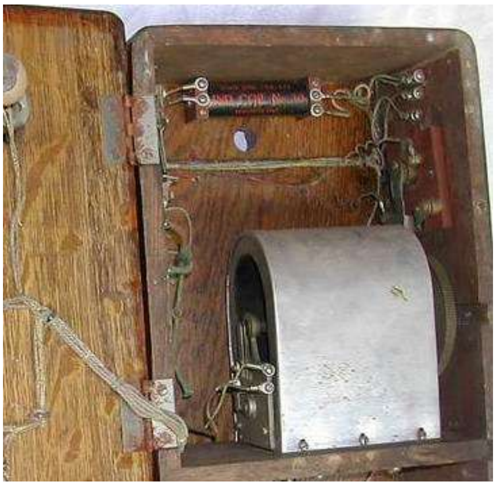


Other than the *most prevalent British Ericsson* (type35/135), the Stromberg Carlson magneto wall telephone is the only other manufacturer that I have found to be identified in Australian technical manuals. That said though, telephones from a number of other manufacturers were widely used in Australia. From a 1939 Telecommunications Journal article, the recoveries of magneto wall telephones occurred at a rate of 1000 per month throughout Australia. Of these about 60% was British Ericsson, leaving the rest to made up of a mixture of other manufacturers – only the British Ericsson was refurbished to a handset type, becoming the 233 MW.



This Stromberg Carlson is quite clearly marked as a PMG telephone with the letters stamped into the front panel.

Pictured at the left is the lightning arrestor embossed with the message " "TURN TO CLEAN AFTER THUNDER STORM"



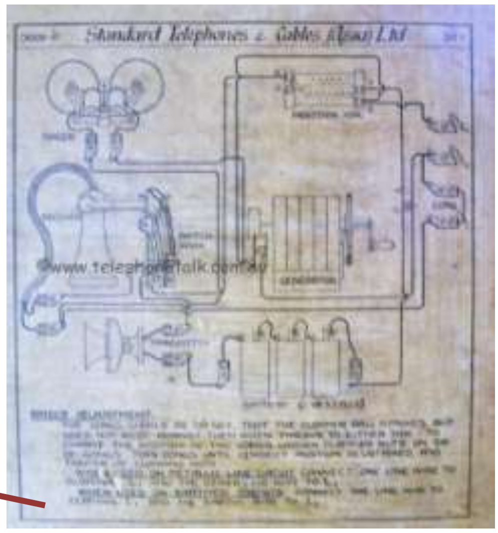
These two pictures show the alterations that are made (to a Stromberg Carlson) to accommodate the Control Lock and key.

The key/lock was located where the lightning arrestor had been initially.

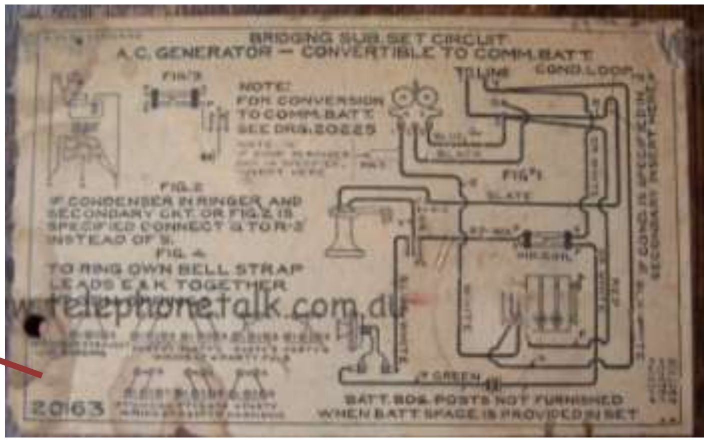
This was an early attempt to prevent unauthorised us of the telephone.

The following pictures of other telephones that have obtained in Australia, have been included in this "Type33/133" group on the presumption that they may have all been included in this the same model number.

Standard Telephones and Cables (STC, UK)



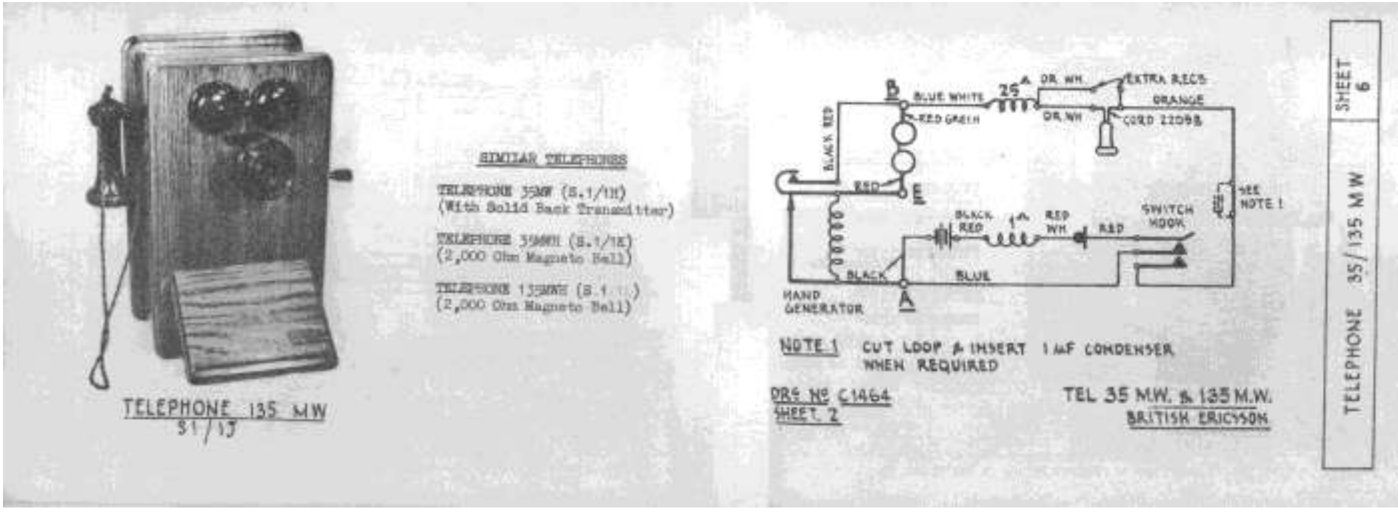
Kellogg USA



Western Electric (USA)

Canadian Independent

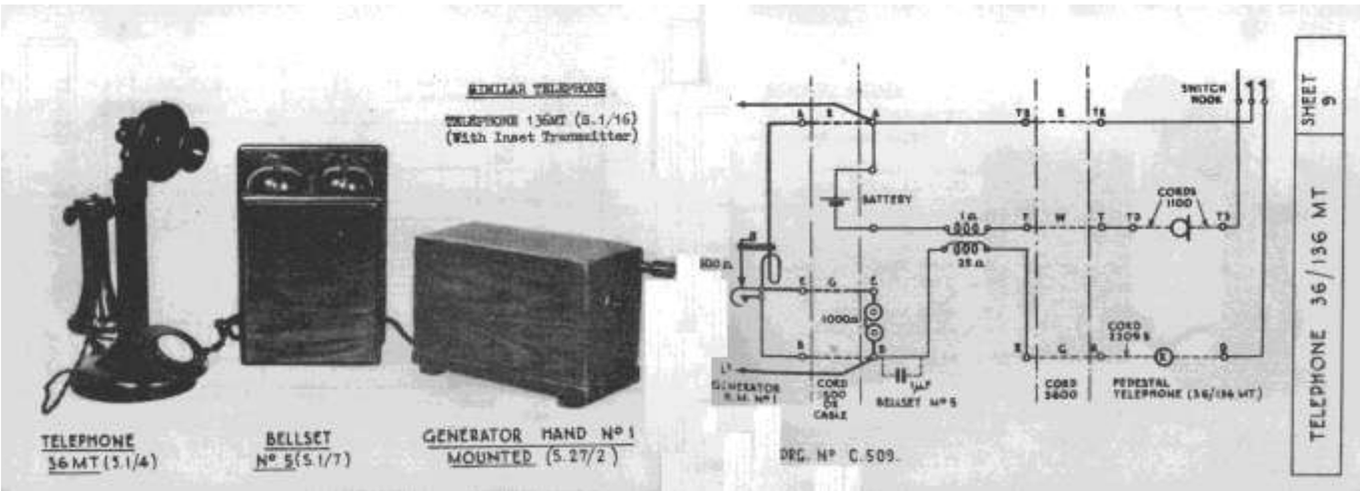
The 135 MW (Magneto Wall) – Manufactured by British Ericsson in the UK. Note the earlier type 35MW had the Solid Back Transmitter, whereas this type 135 used an Inset Transmitter.

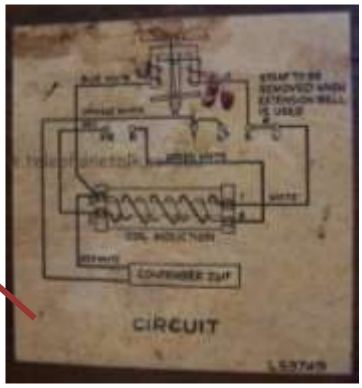


Although this is the version with the Solid Back Transmitter, it also has the wiring option to allow a field conversion to an Automatic wall instrument.
The circuit diagram describes the process for conversion from Magneto to either Automatic, or CB (Common Battery). In both instances, there is minor strapping change and also replacement of the induction coil, the receiver and transmitter capsules.

Because of the technological improvements to telephones during the lifetime of the magneto telephone exchange, it is unlikely that many conversions were actually carried out – I don't think I have ever actually seen one.

The 36 MT (Magneto Table) – Note this earlier type 36MT had the Solid Back Transmitter, whereas the later type 136 used an Inset Transmitter.

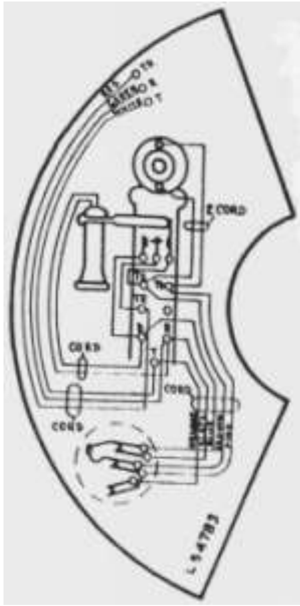




A magneto table combination of a Candlestick/Pedestal telephone made by British Ericsson and marked Commonwealth of Australia PMG, No2 with a similarly badged bell-set and generator box.

The microphone is the narrow brass cylindrical version with a small insert transmitter capsule designated c1865/38 M3A.

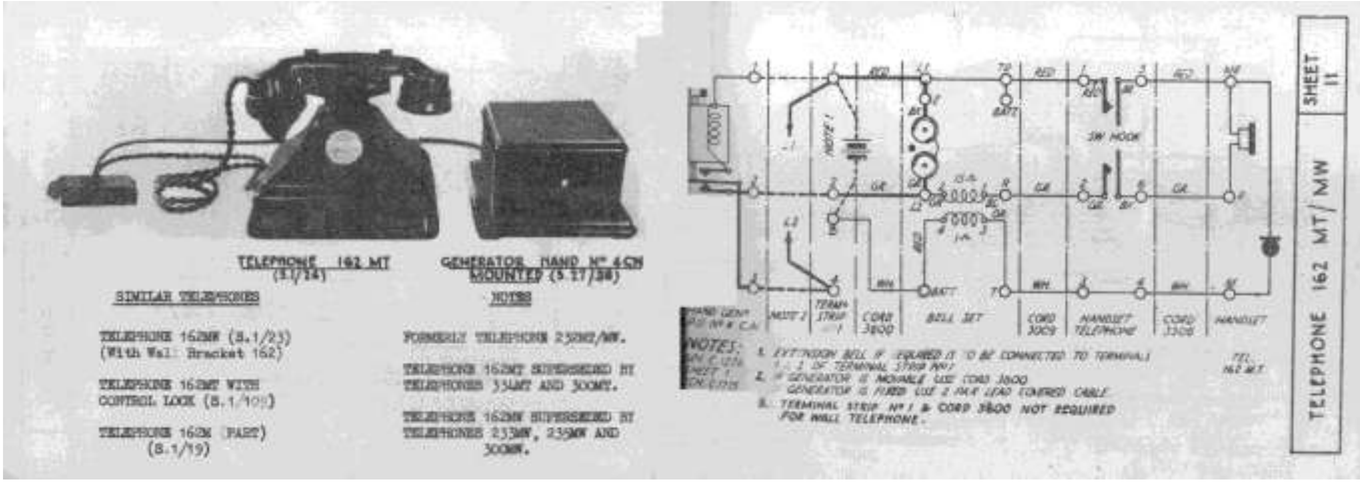
The foregoing designations seem to refer to the telephones' UK origin, with the telephone only known as the type 36 in Australia



The Australian pedestal on the left (above) has no provision in the baseplate for a dial, but both instruments have the same circuit diagram pasted on the heavy cast baseplate. Both telephones have the same badge, Commonwealth of Australia PMG but notice that one has holes in the earpiece perch. The base also has a lower rise to the centre, resulting in the pedestal being approximately 25mm shorter.

There is no sign of a manufacturer name, but there is sufficient difference to indicate that they were different manufacturers, but similar enough that they were probably made to a specification.

The 162 MT (Magneto Table) – Initially made by Siemens in the UK, and subsequently (type 232) in Australia by STC, AWA and TMC.

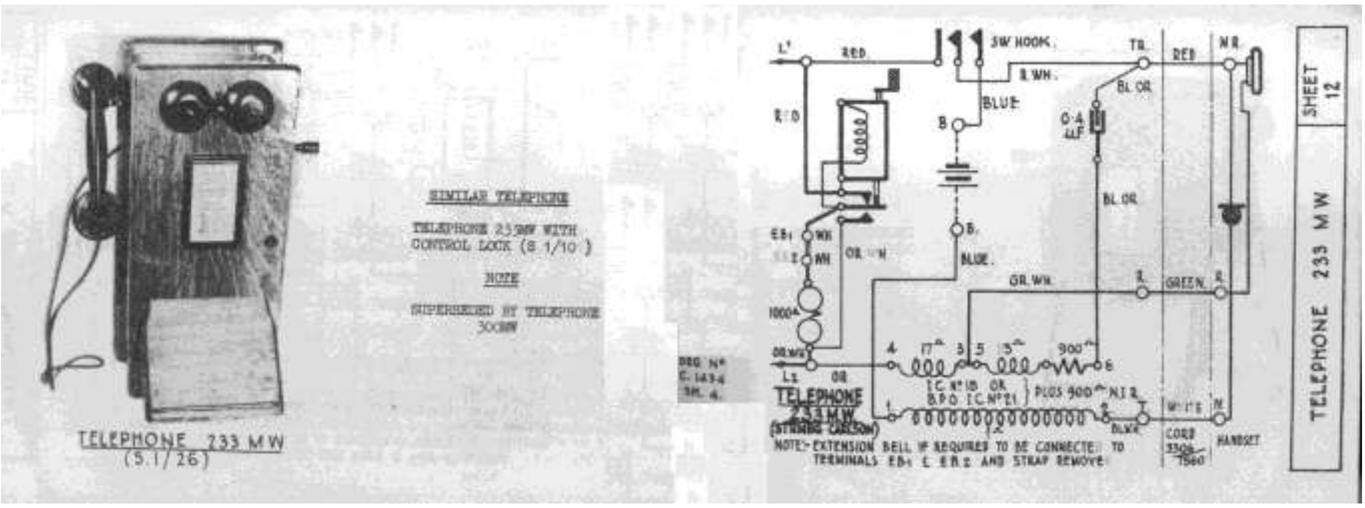


Two slightly different arrangements to convert the 162 magneto telephone for wall mounting.

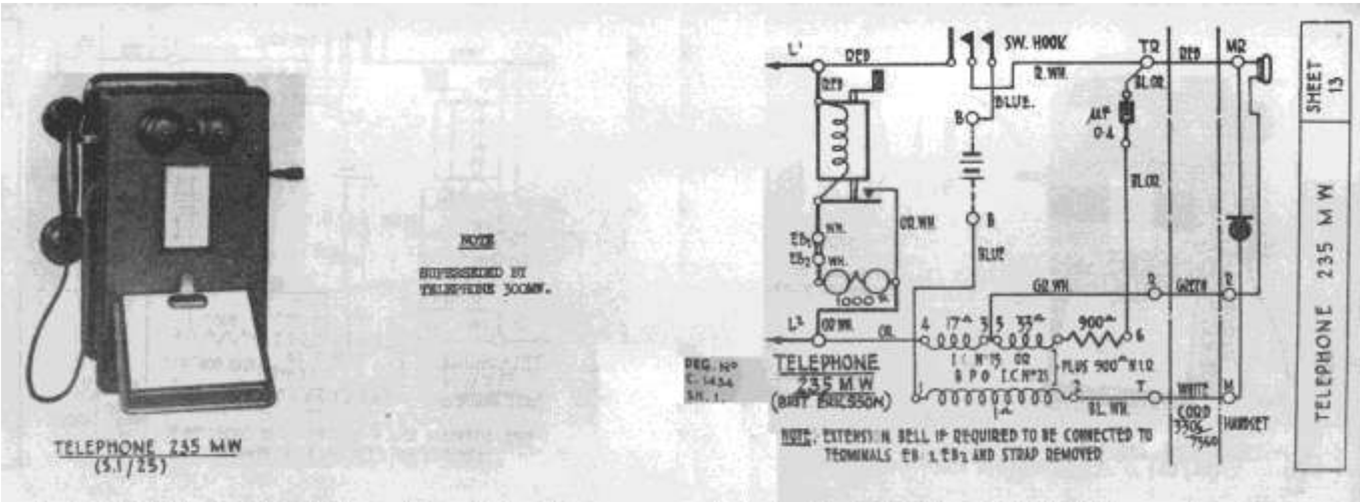
Different wall bracket styles.

Both are using the earlier No1 version of the hand generator.

The 233 MW (Magneto Wall) – A later version with moulded handset, manufactured by Stromberg Carlson in the US. No pictures available



The 235 MW (Magneto Wall) – A later version with moulded handset, manufactured by British Ericsson in the UK. No pictures available

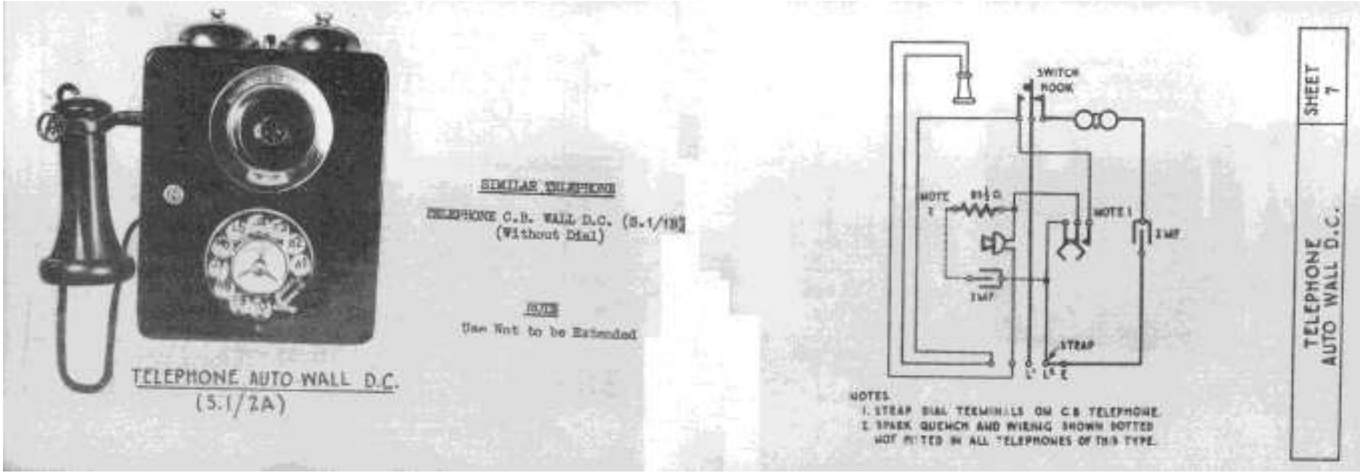


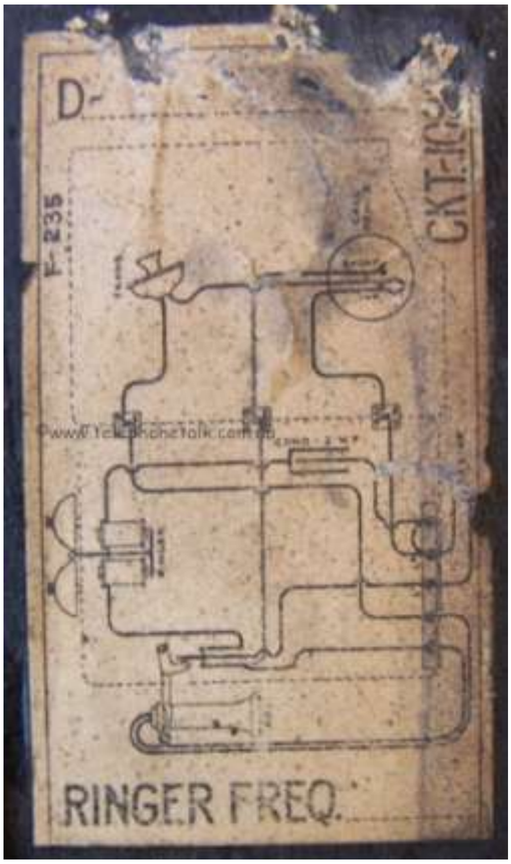
Common Battery / Automatic

Because the Telephone Dial can be such an important part of the identification of the telephone, Attachment 1 is a scanned copy of a Telecommunication Journal of Australia, dated October 1947.

Attachment 2 has other pictures that show slight variations to the dials shown in the TJA article in Attachment 1.

The 35AW (Automatic Wall) – Very popular with collectors, this one is made by Automatic Electric in the US and also known in Australia as the "Geelong" telephone.



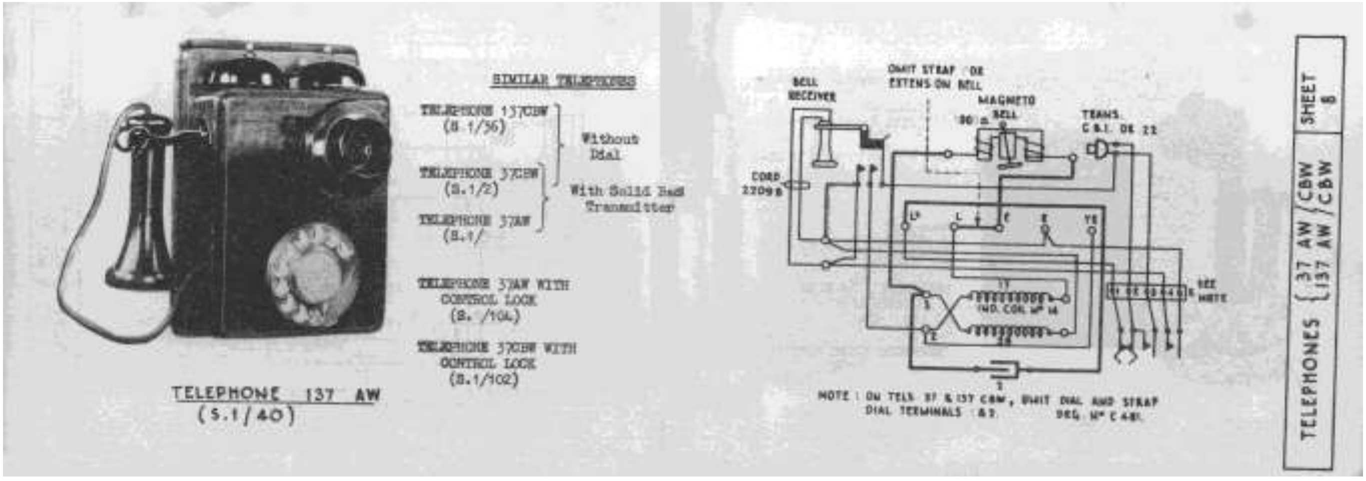


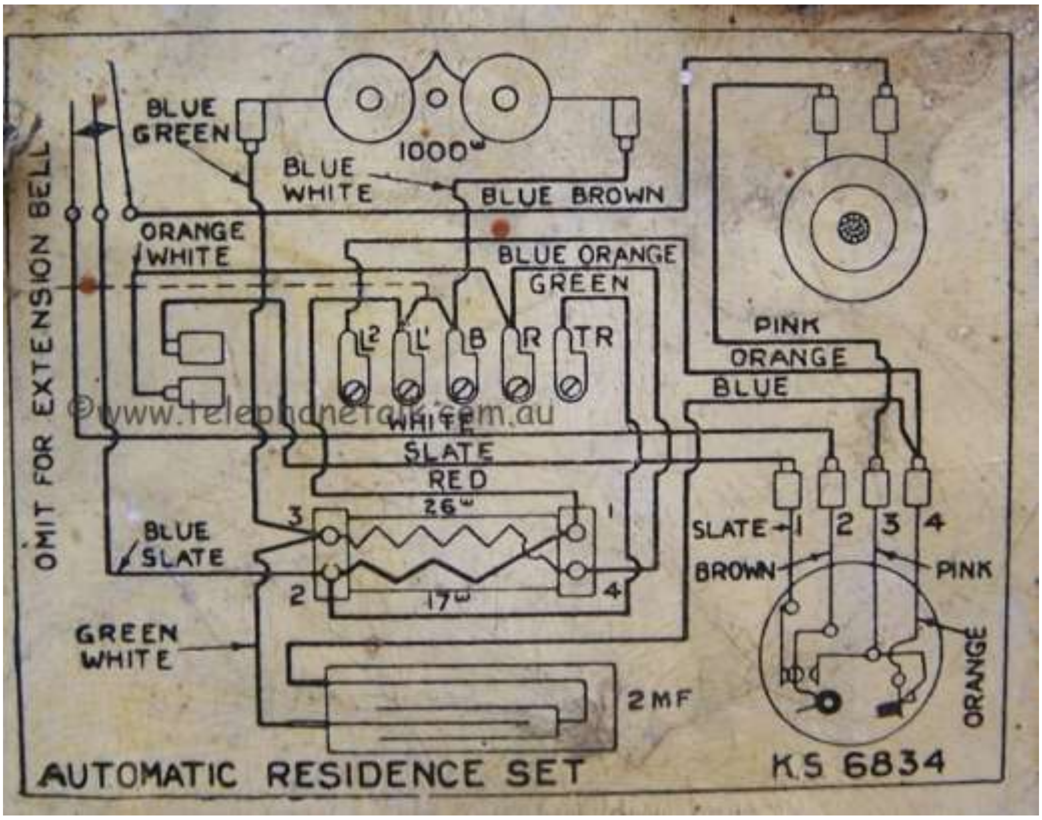
This telephone is a genuine Automatic Electric "Geelong" set in its' original black finish and as used on the PMG network.

- Points worth noting with this unique telephone
- Letter "A" moulded in the receiver hook.

- A distinctive "Mercedes Dial".
- No permanent magnets in the receiver capsule, and this one is stamped with "PMG 122143"
- No induction coil in this very early development of the Automatic and Central Battery circuit design.
- The pasted circuit diagram shows the dial as a "CALL DEVICE", and the off-normal springs as "SHUNT" – they simply place a short circuit across transmitter and receiver.

The 37/137AW (Automatic Wall) – Note the earlier type 37AW had the Solid Back Transmitter, whereas this type 137AW used an Inset Transmitter.



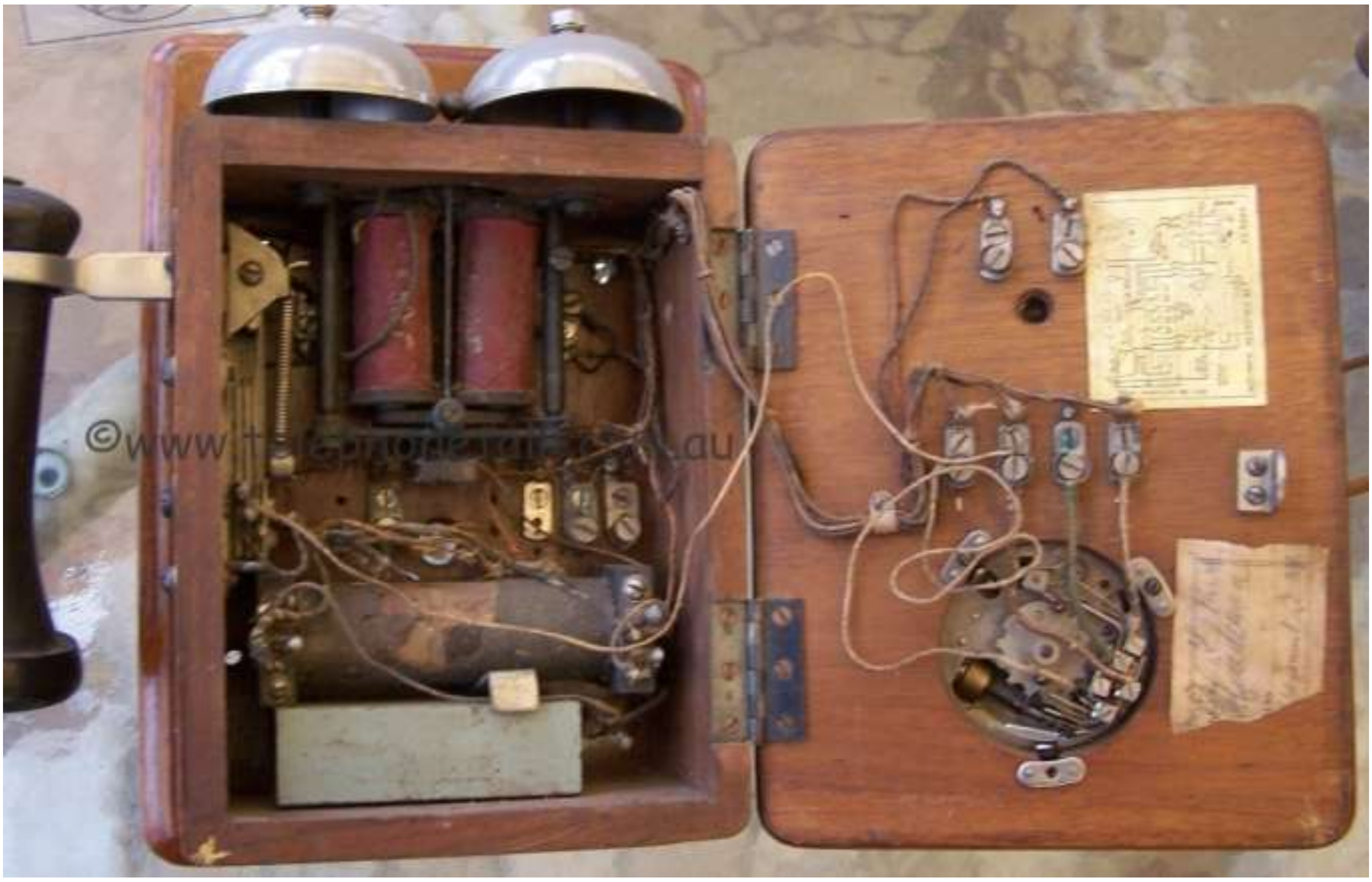


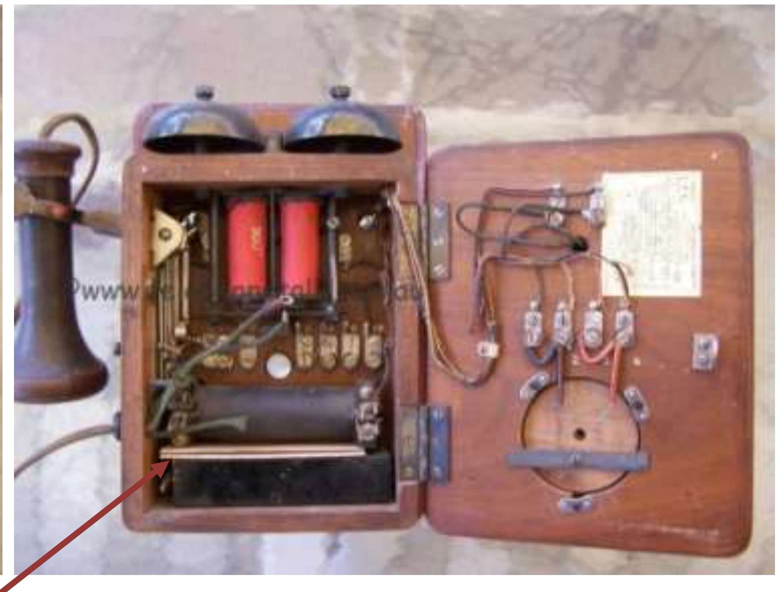
A type 37AW from one of the UK factories.

Originally Nickel plated bells, fork and transmitter.

Transmitter marked –
c-25   N° 1
4001

The instrument is very similar to the UK telephone model 121

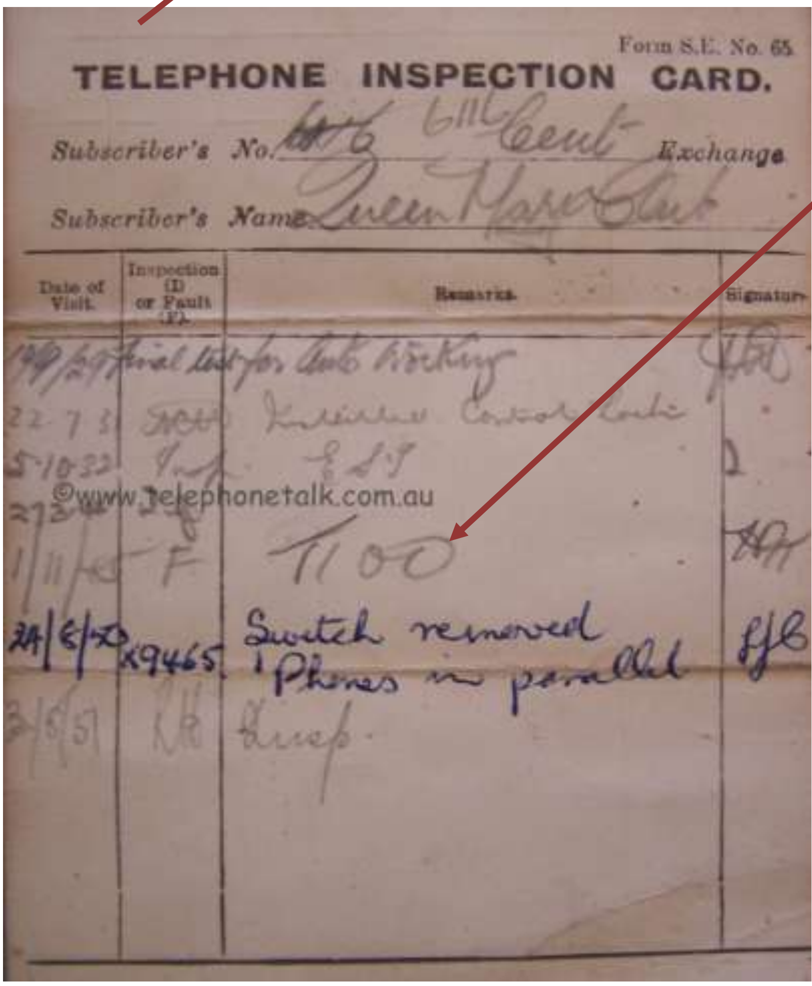




Although there is no sign of a manufacturers name on this 37CBW (Common/Central Battery) telephone, it seems to be by Peel Connor.

The earpiece is unique, with the cord terminals under a screw on cap at the top of the bell receiver. The metalwork is finished in the black plated coating.

Similarly too, the mouthpiece is designated $\frac{\text{c-25}}{\text{4001}}$ N° 1



Form S.E. No. 65

TELEPHONE INSPECTION CARD.

Subscriber's No. .... Exchange

Subscriber's Name ....

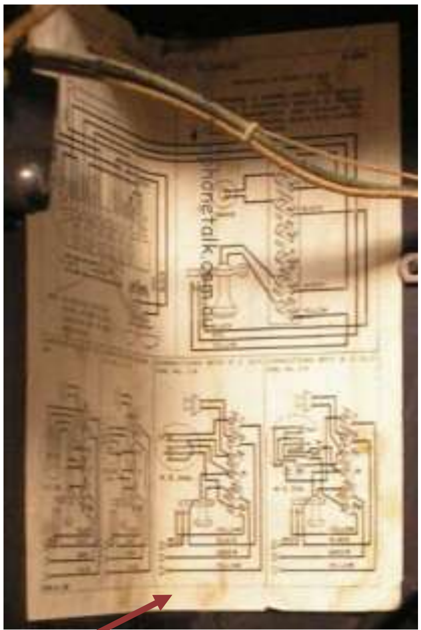
Date of Visit.	Inspection (I) or Fault (F).	Remarks.	Signature.
[illegible]		Final test for Auto Working	[illegible]
22 7 31	[illegible]	[illegible]	[illegible]
5 10 32	[illegible]	[illegible]	
[illegible]	[illegible]		
1/11/45	F	T100	[illegible]
24/6/50	X9465	Switch removed Phones in parallel	[illegible]
3/5/51	[illegible]	[illegible]	

Of special interest is the "TELEPHONE INSPECTION CARD" found neatly folded and stored in the phone in between the induction coil and condenser.

"T100" is the fault code that means ***Subscribers Equipment, Found OK*** – probably had a fault reported, but it wasn't evident when the technician checked the phone.

Stromberg Carlson USA

On the left above is another 37CBW marked with a PMG stamp into the earpiece perch. The dial telephone on the right isn't marked PMG but it is also the US Stromberg Carlson 1157. Both of the pictured telephones have badly damaged circuit diagrams pasted inside. The circuit diagram pictured below right was obtained from a SC1157 available for sale on the Internet.



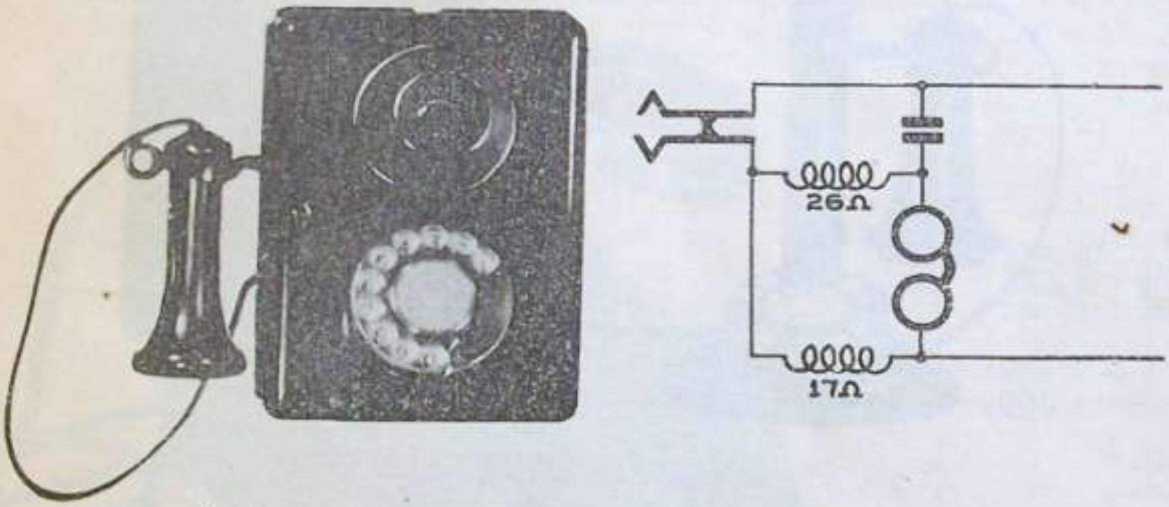
(from the Internet) SC 1157 1920's – 1930's wall, dial, black metal box, #27-A receiver, #7-C transmitter,
#43-A inductor, common battery.

10. AUTOMATIC TELEPHONES.

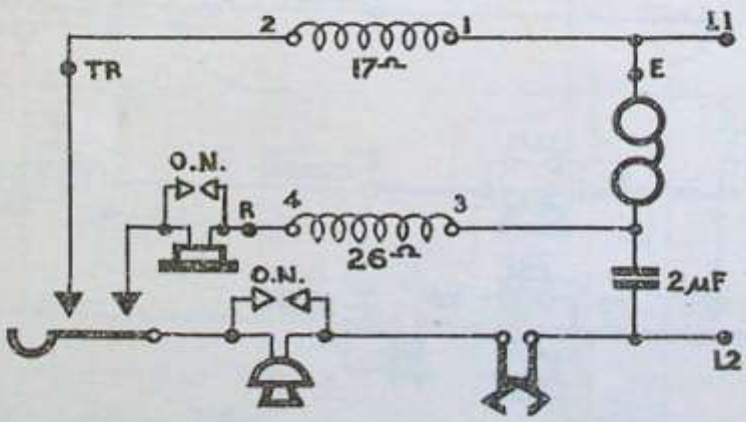
10.1 Telephones 37AW and 38AT. These two telephones, wall and table instruments respectively, use the basic schematic circuit of Fig. 10.

A typical wall telephone is shown in Fig. 18, with schematic diagram and the dialling conditions. The telephone shown has a metal case. The usual wall telephone of this type, however, generally has a wooden case.

The terminals designated R and TR in Fig. 18b are not utilised by the Australian Post Office. The British Post Office, which also uses this instrument, utilises terminals R and TR to provide a particular type of extension service.



(a) Wall Telephone. (c) Dialling Circuit.



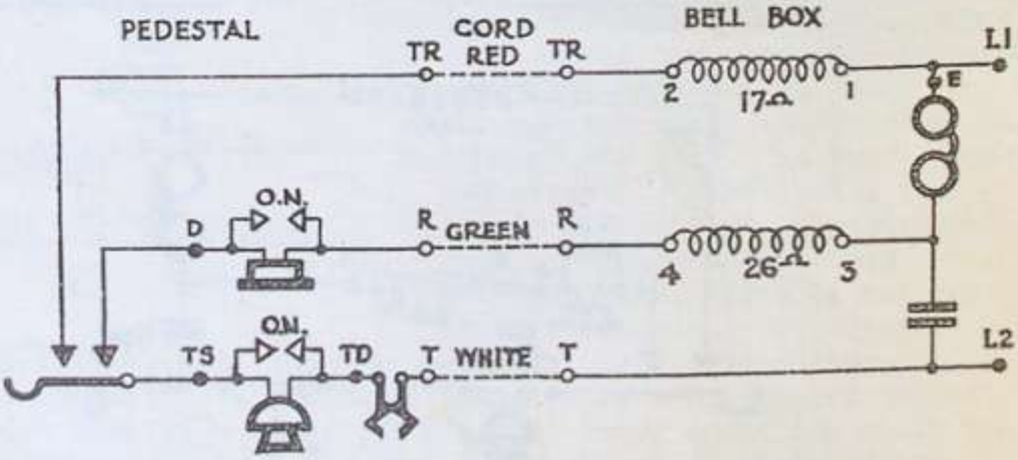
(b) Schematic Circuit.

WALL TELEPHONE (37AW).

FIG. 18.

The table instrument and circuit are shown in Fig. 19. This instrument employs two units, a pedestal and a bell set. A solid back transmitter and a switch hook are mounted on the pedestal and a bell receiver is connected thereto. The bell set contains the bell, 2 μF condenser and induction coil. A cord 3600 connects the bell box and pedestal. The dialling conditions are those shown in Fig. 18c. The bell box in Fig. 19 is of metal, and a Dial No. 24 is in the pedestal. The usual bell box is of wood, and the dial is usually the Dial No. 10.

(a) Automatic Table Telephone.

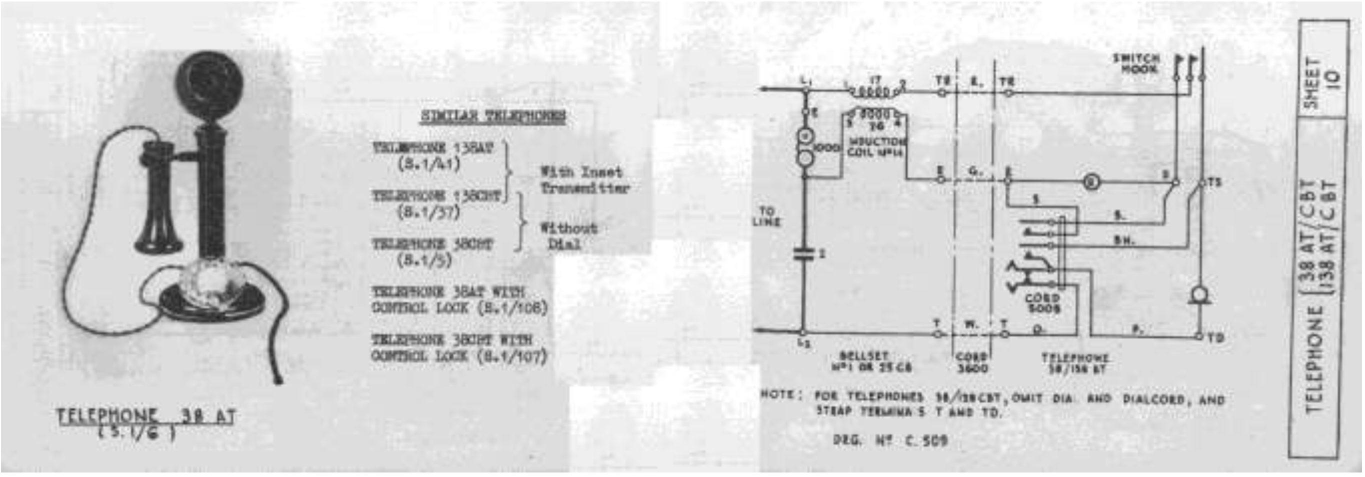


(b) Circuit.

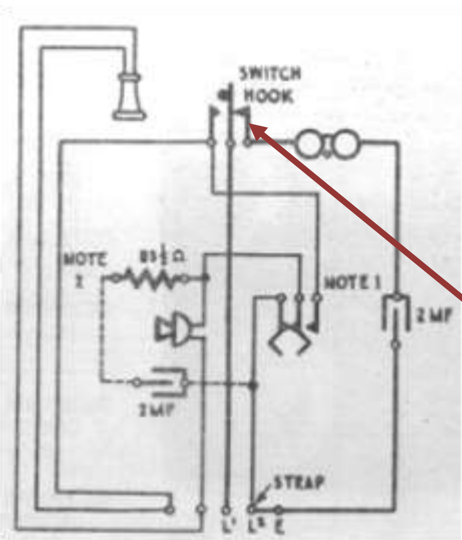
TABLE TELEPHONE (38AT).

FIG. 19.

The 38/138AT (Automatic Table) – Note this earlier type 38AT had the Solid Back Transmitter, whereas the later type 138AT used an Inset Transmitter. Manufactured in a number of factories by British Ericsson, GEC, Siemens, Peel Connor, British Insulated and Helsby in the UK. Also made by Western Electric, Stromberg Carlson and Automatic Electric in the US.



Automatic Electric (USA)



Although this telephone was obtained in Australia, some 20 years ago, there isn't any marking to indicate use/ownership by the PMG. In any case though, this is the same instrument imported by the PMG and made by Automatic Electric in the US

The circuit wiring appears to be the same as the 35AW, with just single change-over contact set for the switch hook. Unfortunately the cap is seized onto the bell receiver so we can't see if it has the correct capsule.

Siemens (UK)

Again this telephone was obtained in Australia, some 20 years ago. There isn't any marking to indicate use/ownership by the PMG.

This telephone has been presumed to be Siemens, but again, there are no markings to substantiate this. It has the stair step base and is very heavy in construction. The only marking on the telephone is E30 M7 on the transmitter faceplate.

Peel Connor/GEC/British Ericsson (UK)

The circuit diagram above looks very similar to the British Ericsson version

This Type 38AT is clearly designated as an Australian version, but again, the manufacturer is difficult to determine. In spite of the circuit diagram similar to BE, this phone is more like the Peel Connor/GEC in appearance.

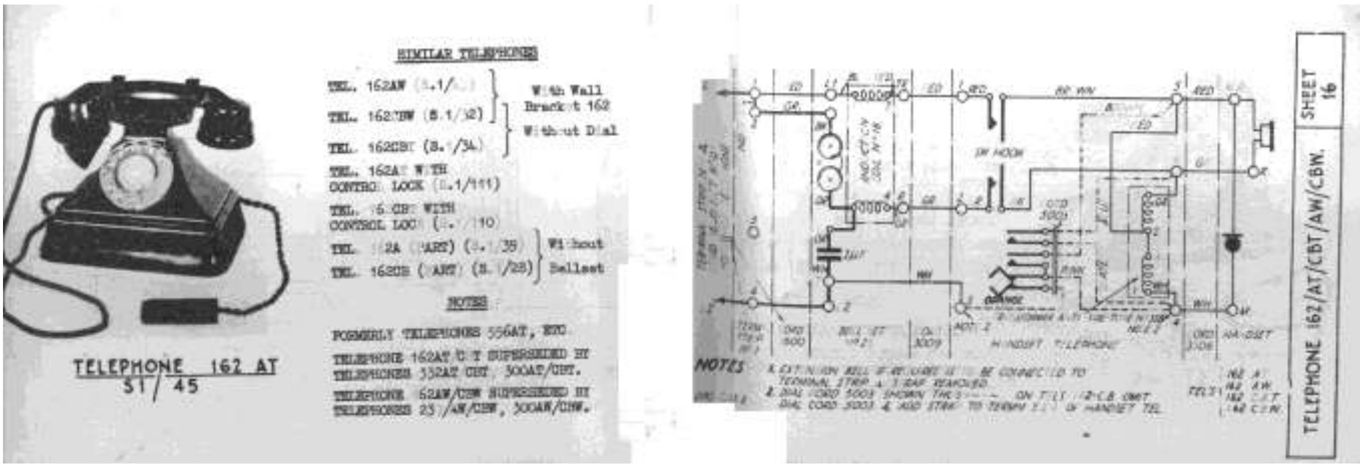
Black enamel paint stem, Nickel plated transmitter back cup and a black plated pedestal top piece.

Peel Connor (UK)

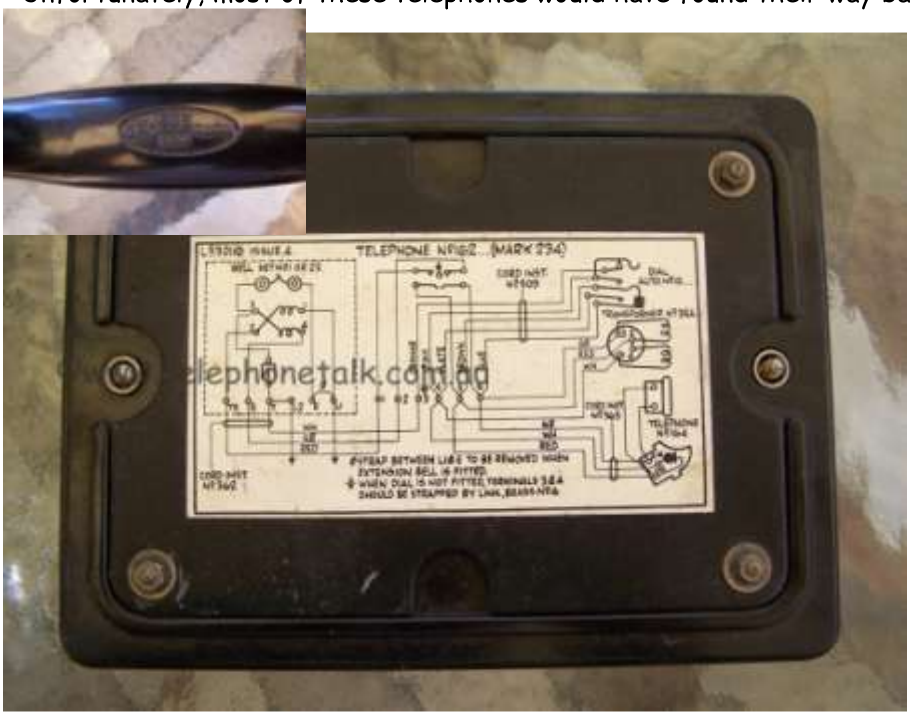
Stromberg Carlson (USA)

An elegantly styled Stromberg Carlson manufactured in the USA, but with the receiver hook marked PMG indicating Australian usage. Note the difference in size. This Stromberg Carlson is much shorter than the British versions, and the non-dial version is even shorter again.

The 162 AT (Automatic Table) – Initially made by Siemens in the UK, and subsequently (type 232) in Australia by STC, AWA and TMC. Not often seen documented, but this telephone was previously known as the 556.



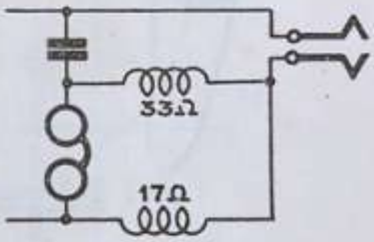
Unfortunately, most of these telephones would have found their way back to the telephone workshops for repair. There would have been many parts intermixed and that makes it very difficult to be sure whether it started as a 162, or 232. This one is certainly designated as a 162 on both of the pasted circuit, and it also has the earlier induction coil N°18



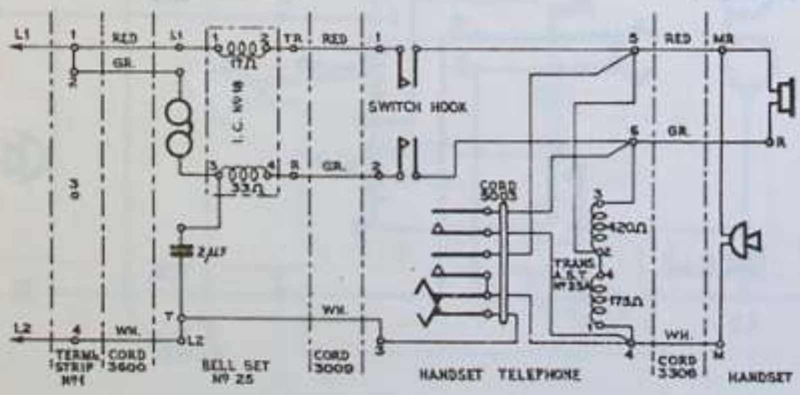
10.2 Telephone 162AT. This table telephone, previously known as the Type 566, was the first moulded handset telephone to be introduced into Australia and uses the anti-sidetone arrangements described in paragraph 4.2 of Paper No. 2 of this book. The telephone and schematic and dialling circuits are shown in Fig. 20.

The telephone consists of three parts, a bell set containing the bell, induction coil and condenser; a pedestal containing the switch hook, anti-sidetone transformer and dial; and a hand converser containing the transmitter and receiver. A cord 3306 connects the handset to the pedestal, a cord 3009 connects the pedestal to the bell set external to the instrument, and a cord 3600 connects the bell set to a terminal strip on which the exchange line terminates. Terminals 1 and 2 of this strip, which correspond with L1 and E of Figs. 18b and 19b, are strapped when extension bell facilities are not required.

(a) Telephone.



(c) Dialling Conditions.

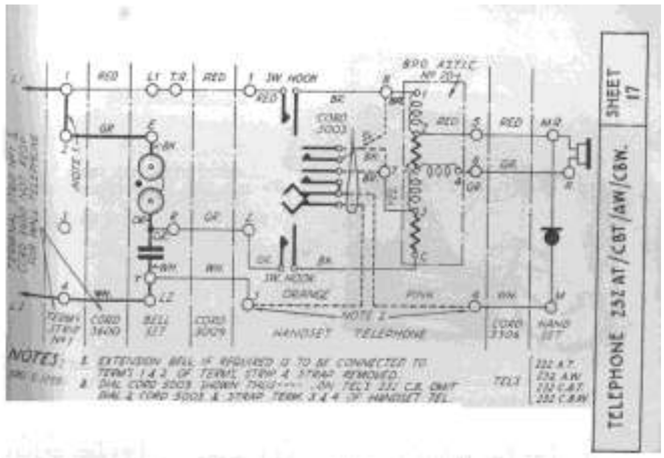


(b) Schematic Circuit.

HANDSET TELEPHONE (162AT).

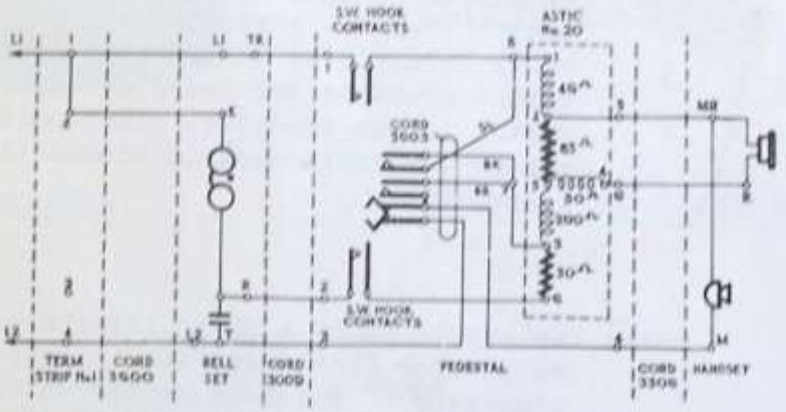
FIG. 20.

The 232CBT (Common, or Central Battery Table)

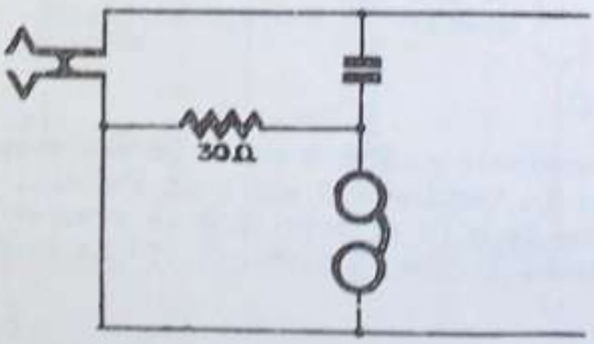


Although this telephone is marked as a 232 on the metal base, there is little difference between it and the one on the preceding page. It has an AWA manufacturers moulding mark inside the Bakelite body, underneath the lead-weighted base plate and also on the underside of the hook-switch cradle. There is also a very subtle difference in the angles and corners of the Bakelite body where it meets the cradle

10.4 Telephone 232AT. This telephone is similar in appearance to the 162AT shown in Fig. 20a. The only differences are the elimination of the moulded and weighted base plate supplied with the 162 telephone, and the connection of the bell set to the pedestal by an internally run cord in the 232 telephone, instead of the external cord of the 162 telephone shown in Fig. 20a. As with the 162 telephone, the three parts of the instrument are the bell set, pedestal and handset. The bell set contains the bell and condenser and is connected to the pedestal by a cord 3009. The pedestal contains the dial, switch hook and anti-sidetone induction coil, and is connected to the handset by a cord 3306. The handset contains the transmitter and receiver. The exchange line terminates on a terminal strip which is connected to the bell set by a cord 3600. The strap for extension bell facilities is provided on this terminal strip. For a picture, Fig. 20a applies, whilst Fig. 22 shows a wiring-schematic diagram and the dialling circuit.



(a) Schematic.

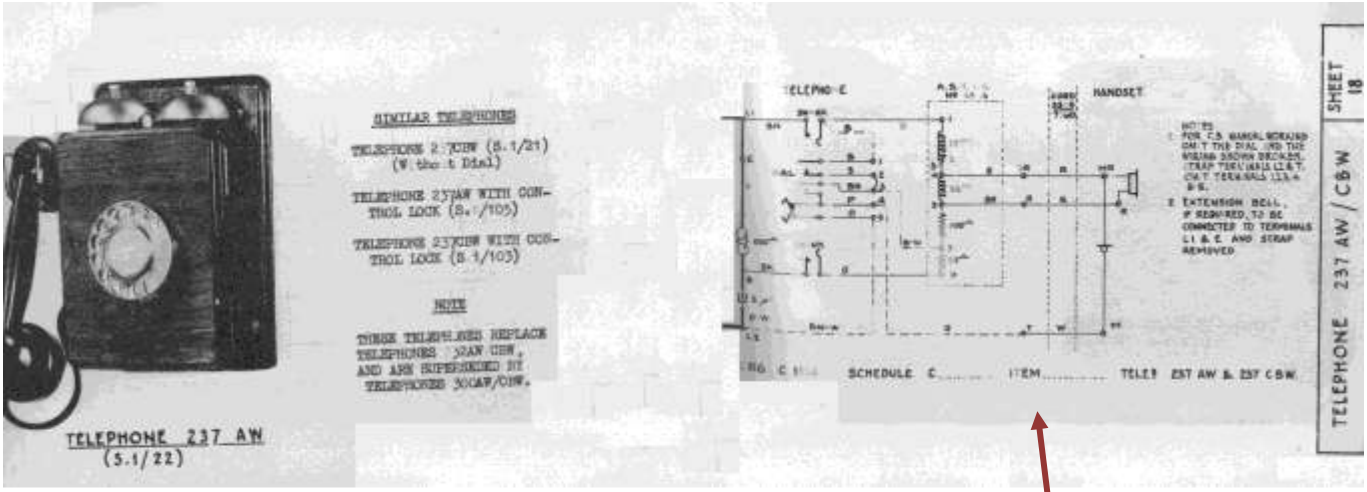


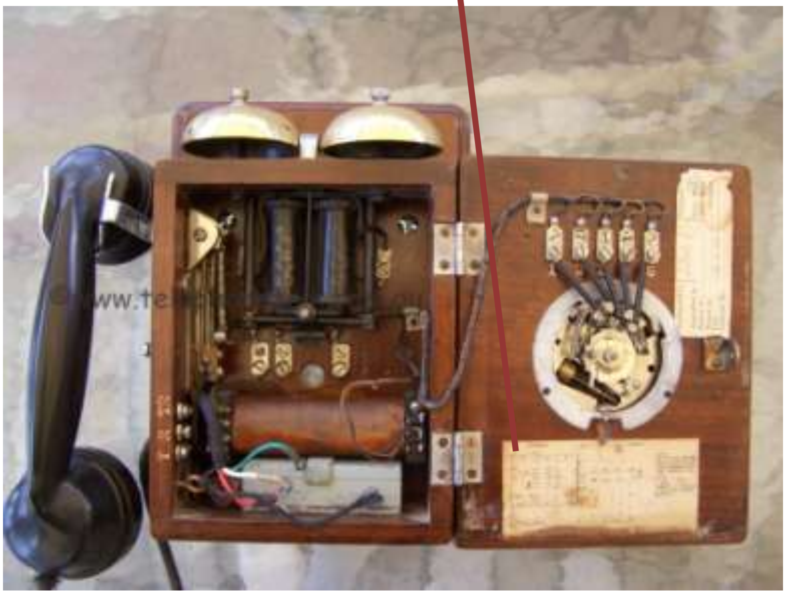
(b) Dialling Conditions.

HANDSET TELEPHONE (232AT).

FIG. 22.

The type 237AW (Automatic Wall) A later version with moulded handset , following on from the 37/137AW.





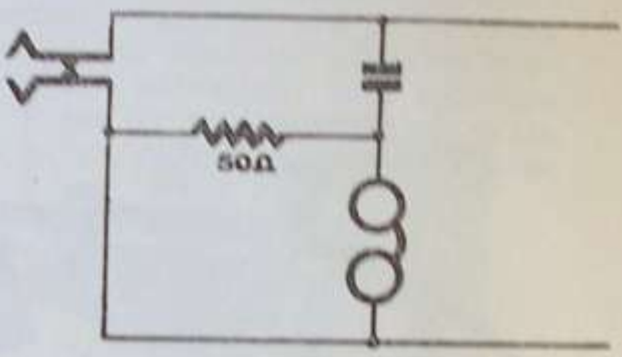
Fitted with a number 12 dial – circuit diagram pasted inside, is the same as the diagram above (SUBSTATION TELEPHONE EQUIPMENT CIRCUITS – Technicians' handbook)

PAPER NO. 4.
PAGE 28.

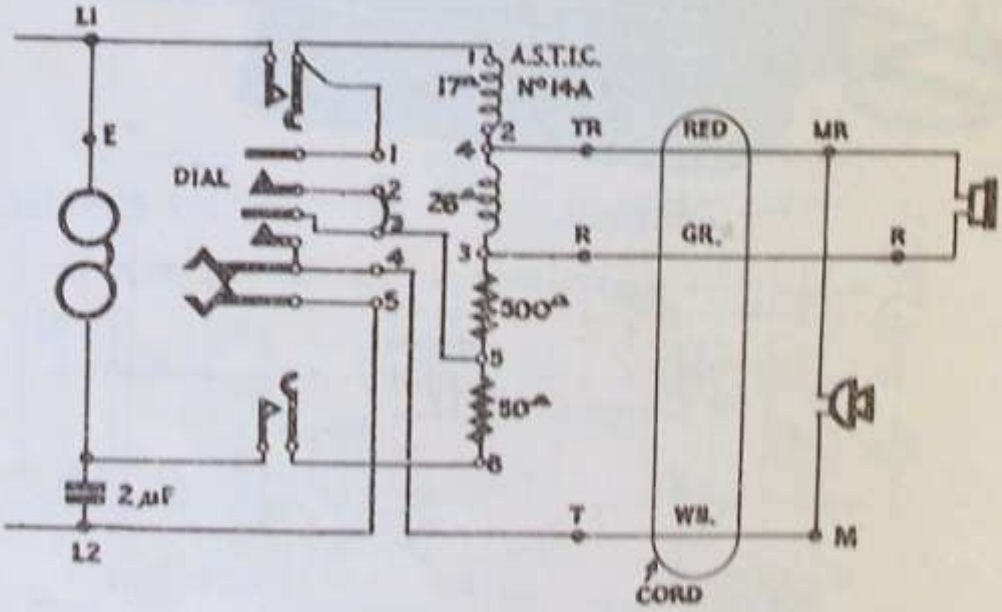
TELEPHONY II.

10.3 Telephone 237AW. This telephone, as stated previously, was developed to meet the needs of subscribers requiring a wall hand-set telephone and to obviate the use of moulded handset table telephones mounted on brackets for such purposes. Fig. 21 shows a picture of the telephone, a schematic diagram and the dialling circuit. It will be noticed that the 50 ohm resistance provided on A.S.T.I.C. No. 14A used in this telephone provides the necessary resistance in series with the condenser when dialling.

(a) Telephone.



(c) Dialling Conditions.



(b) Circuit.

WALL TELEPHONE (237AW).

FIG. 21.

Bibliography

1. Circuit diagrams and telephone picture scans from (PMG Department) SUBSTATION TELEPHONE EQUIPMENT CIRCUITS, FACILITIES & STOCK TITLES (ISSUED 1951).
2. Magneto wall telephone recoveries for conversion to type 233 MW – The Telecommunications Journal of Australia, February 1939.
3. Attachment 1 is a scanned copy of a Telecommunication Journal of Australia, dated October 1947.
4. Commonwealth of Australia Course of Technical Instruction "Telephony II" (1940's

Attachment 1

AUTOMATIC TELEPHONE DIALS

J. H. T. Fisher, B.E., A.M.I.E. (Aust.)

GENERAL INFORMATION ON SIX PARTICULAR MAKES

Introduction: It is proposed to compare the general features of dials available from overseas. In particular, this article describes the various methods of giving the "inter-digital pause" or minimum time interval between successive trains of dialled impulses, and discusses the relative merit of introducing this pause at the beginning or at the end of each train, having regard to the various types of automatic switchgear with which the dial might be required to operate in Australia.

The dials included in this discussion are listed in Table I, and a general summary of the comparisons is given in Table II.

In all dials considered, the rate of impulsing is nominally 10 impulses per second.

Reliability of Electrical Contact: Experience indicates that the use of double contacts and the presence of a slight rubbing action when the contacts close, materially assist in ensuring reliability of contact.

The rubbing action exists in the Siemens No. 10 dial and, to a lesser extent, in the W.E. 5E dial, the impulse contacts having a slight "follow" after making. There is no rubbing action in the A.T.M. 24C and A.E.C. 24 dials except when the impulse contacts are lifted clear of the impulse cam at the end of each train. No rubbing action is provided in the S. & H. 180a and Ericsson S2836 dials. Of the dials examined, only the W.E. type has double point impulse contacts.

TABLE I.

Illustration	Type	Manufacturer	Country of Manufacture
Fig. 1	No. 10	Siemens Brothers & Co. Ltd.	Great Britain
Fig. 2	24C	Automatic Telephone & Electric Co. Ltd. (A.T.M.)	Great Britain
Fig. 3	24	Automatic Electric Co.	U.S.A.
Fig. 4	5E	Western Electric	U.S.A.
Fig. 5	Fg. Sch. 180a	Siemens and Halske	Germany
Fig. 6	S2836	Telefon AB. L. M. Ericsson	Sweden

The specimens compared are the latest types available in each case, but do not necessarily represent current practice of the manufacturers concerned. The 24C and 24 types are almost identical, differing only in the finger plate, ratchet wheel, and other respects indicated in Table II.

Impulse Contacts

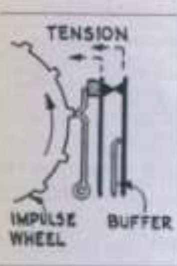
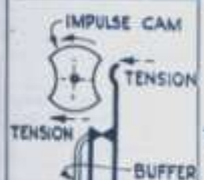
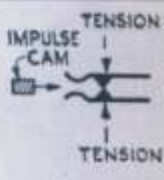
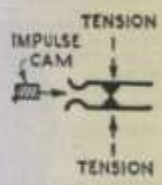
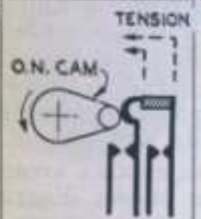
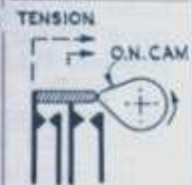
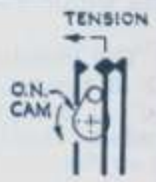
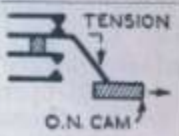
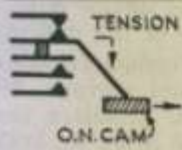
The make to break impulse ratio and the rate of impulsing are inherently bound up in the physical dimensions and adjustment of the dial parts and in the governor adjustment respectively, and are not considered here. Desirable features of these contacts, however, are:—

(a) reliability of electrical contact,
(b) uniformity of impulse ratio,
(c) freedom from contact "bounce"; and
(d) efficient suppression of impulses during forward motion of dial.

Uniformity of Impulse Ratio: The maximum of impulse ratio uniformity would be obtained if each impulse were formed by the same cam surface operating on the same impulse springs. This is not the case in any of the dials examined but, in the A.T.M. 24C and A.E.C. 24 dials, a rotating double cam is used, so that only two cam surfaces are involved and each surface produces every alternate impulse (Figs. 2 and 3).

In the S. & H. 180a and Ericsson S2836 dials, rotating triple cams are used, so that three cam surfaces are involved and each surface produces every third impulse (Figs. 5 and 6). In these two dials the impulse springs are separated by the cam teeth entering between them. This calls for the impulse springs to be symmetrically disposed with respect to the cam teeth before separation, which necessitates equal tension on each spring. As impulse-ratio is normally adjusted by means of impulse spring tension, this means that impulse-ratio adjustment would be more complicated in the S. & H. and Ericsson dials than in the other dials examined. In the case of the S. & H. dial, a detent spring (Fig. 5), operated by a cam on the main shaft, engages a notch in any one of the impulse-cam teeth at the end of the return motion of the finger plate; this locks the cam at the correct orientation for commencement of the next

TABLE II.
Summary of Comparisons of Six Makes of Automatic Telephone Dials

TYPE OF DIAL.	Siemens No. 10.	A.T.M. Type 24C. A.E.C. Type 24.	W.E. Type 5E.	Siemens and Halske Fg. sch. 180a.	Ericsson (Sweden) Type S2836
Impulse Contacts					
Break length per cent.	66.6 (63 to 70).	A.T.M. 66.6 (63 to 70). A.E.C. 61.5.			
Mode of operation.	Toothed impulse wheel on main shaft.	Double cam on governor worm-gear shaft.	Toothed impulse wheel on main shaft, operating impulse lever.	Triple cam on governor worm-gear.	Triple cam on governor worm-gear shaft, driven by ratchet wheel secured to shaft.
Spring Assembly.					
Type of contacts.	Single point.	Single point.	Double point.	Single point.	Single point.
Method of suppressing impulses in forward direction.	Slipping-cam masks impulse wheel teeth.	Pawl on main shaft trails and does not transmit drive to double cam and worm-gear shaft.	Impulse lever trails over impulse teeth in position clear of impulse springs.	Pawl on pinion trails and does not transmit drive to triple cam and worm gear.	Pawls on either side of triple cam. One pawl engages ratchet slots in frame - locking cam. Other pawl trails over ratchet secured to worm-gear shaft.
Off-Normal Contacts					
Mode of operation.	Cam on main shaft.	Cam on main shaft.	Cam on main shaft.	Cam on main shaft.	Cam on main shaft.
Spring Assembly (Dial normal).					
Type of contacts.	Single point.	Single point.	Double point.	Double point.	Single point.
Inter-Digital Pause					
Duration (pulse periods, approx.).	2½.	A.T.M. 2½. A.E.C. 1½.	1.	2.	1½.
Position with respect to impulses.	Before.	After.	Before.	After.	After.
Method of production.	Slipping-cam on impulse wheel, masking impulse teeth.	Cam on main shaft, lift-in impulse springs clear of impulse cam.	Reversal of trailing direction of impulse lever against impulse wheel.	Short circuiting of impulse contacts by cam operated off-normal contacts.	Short circuiting of impulse contacts by cam operated off-normal contacts.
Remarks.	Depends on friction between cam and disc on main shaft.	Positive operation by cam.	Positive operation by impulse wheel and lever.	Depends on off-normal contacts.	Depends on off-normal contacts.

Governor

Speed ratio to main shaft.	90:1.	A.T.M. 126:1. A.E.C. 117:1.	19.4:1.	112:1.	91:1.
Rotation.	Forward (with slight slipping) and return.	Return only.	Forward and return.	Return only.	Forward slightly (slipping and return).
Bearing thrust.	Both ways.	One way.	Nil.	One way.	Mostly one way.
Drive.	Spur gears and worm.	Spur gears and worm.	Spur gears only.	Spur gears and worm.	Spur gears and worm.
Remarks.	Spring clutch on worm-gear shaft permits some slipping in drive on forward rotation and allows governor to over-shoot after dial returns to normal position.	Ratchet wheel on spur gear, and pawl on main shaft, transmit only return drive to governor. Self-lubricating worm gear.		Ratchet wheel on worm gear and pawl on pinion transmit only return drive to governor. Self-lubricating worm gear.	Spring clutch on worm-gear shaft transmits only return drive positively to governor and allows governor to over-shoot after dial returns to normal position.

General

Fitting and overall diameter.	3 point standard 3¼".	A.T.M. 3 point standard 3¼". A.E.C. Non-standard 3".	Non-standard 3".	Non - standard 3-7/32".	3 point standard (adapter casing) 3".
Type of terminals.	Screws.	Screws.	Screws.	Solder lugs.	Solder lugs.
Type of main spring.	Spiral.	Helical.	Helical.	Spiral.	Helical.
Remarks.	Moderately noisy in operation.	A.T.M. Noisy in operation. A.E.C. Quiet in operation.	Complex construction. Moderately quiet in operation.	Extreme simplicity of construction and mechanism. Quiet operation.	Quiet in operation.

forward rotation. A similar function is performed by the stepped spring-pawls on the impulse-cam of the Ericsson dial (Fig. 6), which fall into ratchet slots in the dial frame and retard the cam at the correct orientation.

In the Siemens No. 10 (Fig. 1) and W.E. 5E dials, each impulse is produced by a separate tooth on the impulse wheel, so that up to ten cam surfaces are involved. As the full number of teeth is employed only when "0" is dialled, wear will not be uniform on all teeth, and hence impulse ratio may not remain uniform. The toothed impulse wheel in the W.E. 5E dial is concealed within the body of the dial in Fig. 4.

Freedom from Contact "Bounce": The impulse contact springs, which must operate at the rate of 10 impulses per second, "remake" at a high speed after separation, and, being made of elastic material, tend to rebound on impact, or "bounce." When "bounce" actually occurs, it results, of course, in distorted signals.

In order to eliminate "bounce," it is necessary to arrange for the kinetic energy of the moving parts on impact to be absorbed. This may be effected by

(a) an elastic damping system,
(b) friction damping, or
(c) some combination of (a) and (b).

The fundamental principles of these methods are illustrated diagrammatically in Fig. 7.

In Fig. 7 (a) a spring, which is pre-loaded with the contacts unoperated, holds the stationary contact against a stop. When the contacts close, with proper design the energy of the moving contact is absorbed in extending the spring and in overcoming the inertia of the stationary contact, which is deflected away from the stop (References 4 and 5).

In Fig. 7 (b) a flexible buffer behind the stationary contact is deflected on impact of the moving contact, and the rubbing friction between the stationary contact and buffer absorbs some of the kinetic energy.

In Fig. 7 (c) the same device is used in the stationary contact, and, in addition, the moving contact is pre-loaded, i.e., the moving contact is borne on a leaf spring which is tensioned against the stationary contact when in the static "made" position. When the contacts close, the energy of the moving contact is absorbed in flexure of the leaf spring and in friction between the stationary contact and its buffer.

The impulse contact arrangements in the dials examined are shown diagrammatically in Table II, the contacts being shown in the closed position as when the dial is normal.

(i) In the Siemens No. 10 dial, when the impulse contacts are open, the stationary contact spring is pre-loaded by tension against a buffer (compare Fig. 7 (a)).

(ii) In the A.T.M. 24C and A.E.C. 24 dials, when the impulse contacts are closed, the moving contact spring is pre-loaded by tension against the stationary contact, which has a buffer behind it (compare Fig. 7 (c)).

(iii) In the W.E. 5E dial, when the impulse contacts are closed, the moving contact spring is pre-loaded by tension against the stationary contact which is pre-loaded by greater tension against a buffer.

(iv) In the S. & H. 180a and Ericsson S2836 dials, when the two moving impulse contact springs are closed, they are both pre-loaded by mutual tension.

In all these cases, conditions of "bounce" are governed by such factors as degree of contact spring pre-loading, impact force on closure, and the inertia, deflection characteristics and natural period of vibration of the contact springs and buffers, and it is obvious that the effect of such factors cannot be estimated from a visual examination.

Oscillograph measurements are often used to detect contact bounce, but no check was made of the adjustment of the contact springs of the sample dials under discussion, and, consequently, no cathode ray oscillograph measurements were made of these dials.

Suppression of Impulses during Forward Motion of Dial: As will be seen from Table II, each of the dials examined uses a different means to achieve this (except the A.T.M. 24C and A.E.C. 24 dials, which are equivalent in this respect), although the S. & H. 180a and Ericsson S2836 dials use somewhat similar means. In the Siemens No. 10 Dial (Fig. 1), maintenance of the correct frictional adjustment would be most necessary, as, if the slipping cam were badly worn or out of adjustment, it would be possible for this cam to slip too much. In such cases, the inertia of the slipping cam resisting the frictional pull during forward motion might result in failure of the cam to mask all teeth of the impulse wheel during

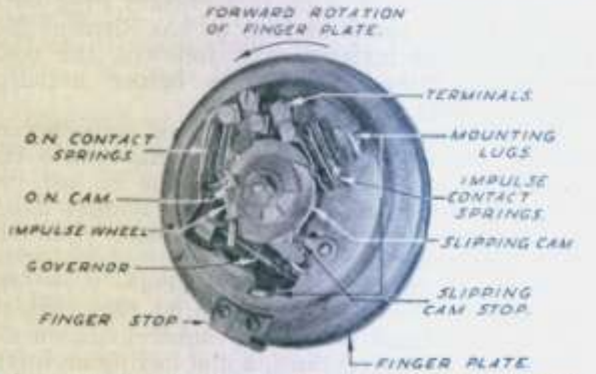


Fig. 1.—Siemens No. 10 Dial—rear view. (Normal position.)

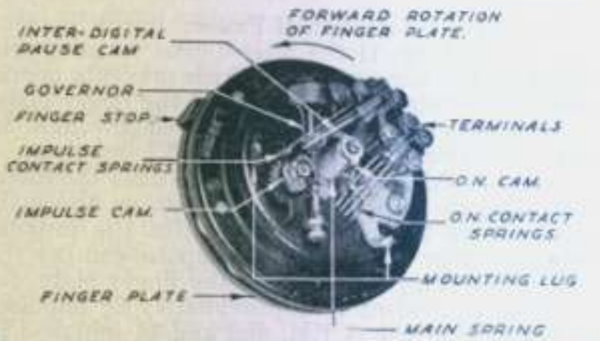


Fig. 2.—A.T.M. Type 24C Dial—rear view. (Normal position.)

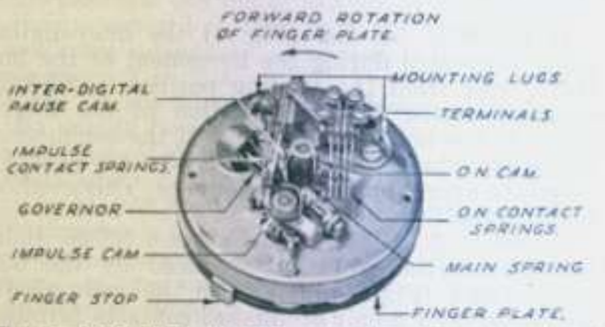


Fig. 3.—A.E.C. Type 24 Dial—rear view. (Normal position.)

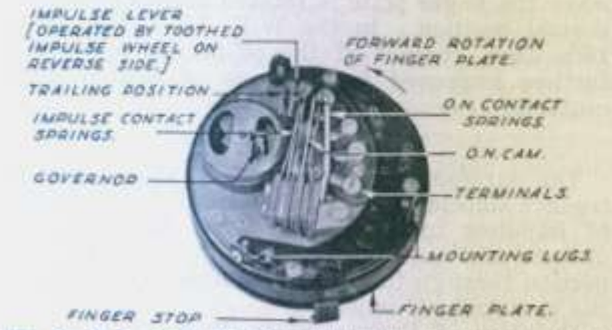


Fig. 4.—W.E. Type 5E Dial—rear view. (Normal position.)

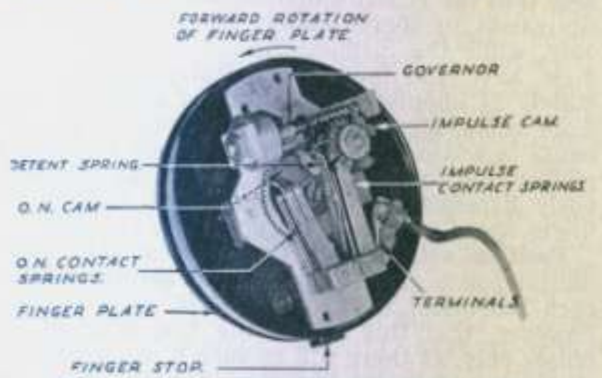


Fig. 5.—Siemens & Halske 180a Dial—rear view. (Normal position.)

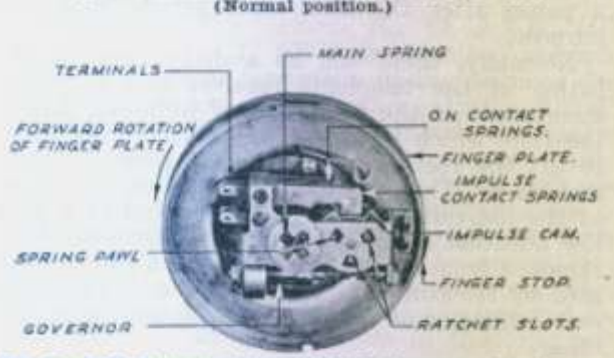


Fig. 6.—L.M. Ericsson Type S2836 Dial—rear view. (Three-point mounting adapter cap removed—normal position.)

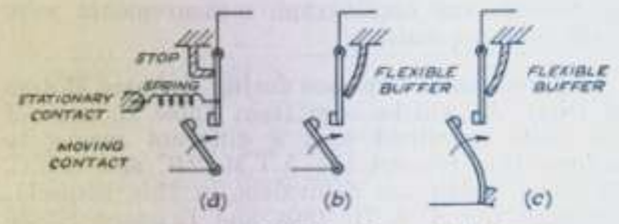


Fig. 7.—Methods of eliminating contact bounce.

this period, which would produce false impulse during the forward rotation.

Off-Normal Contacts

In all dials examined, the off-normal contact springs are operated by some form of cam attached to the main shaft, and there is appreciable "follow" in the pair of springs which "make" when the finger plate is rotated forward from its normal position. In the W.E. 5E and S. & H. 180a dials, contact of the off-normal springs is further improved by the use of double point contacts.

Inter-Digital Pause

The purpose of the inter-digital pause is to introduce sufficient delay between successive trains of impulses to permit exchange switchgear to operate and extend the calling subscriber's connection through to the circuit which is to receive the next train of impulses.

Duration of Pause: From Table II it will be seen that the W.E. 5E dial has the shortest pause, equivalent to approximately one dialling impulse only, while the Siemens No. 10 and A.T.M. 24C dials have the longest, equivalent to approximately 2¼ impulses (the length of impulses in all dials being approximately the same). To this pause is added the time taken to pull the finger-plate round to the stop and let go, but this obviously depends on the digit dialled and on the finger speed of the person operating the dial.

Position with respect to Impulses: The inter-digital pause may be introduced **before** or **after** each individual train of impulses. It is obvious, however, that this affects the first train of impulses only, as there will be such a pause between successive trains of impulses in either case, and a pause after the final train serves no useful purpose.

Normally, there will be a delay between the lifting of the telephone receiver and the commencement of the first train of impulses, due to the time which the operator or subscriber takes to lift the receiver, pull the dial round to stop, and let go. This, however, depends on the speed of the individual, and may be reduced to a very low duration if the receiver has previously been removed from the switch-hook and a call is initiated by releasing the switch-hook with one hand and commencing to dial immediately with the other.

In such a case, the pause between initiation of the call and commencement of the first impulse train will be negligible unless the inter-digital pause is located **before** the impulse train, as in the Siemens No. 10 and W.E. 5E dials. At Footscray Exchange, Melbourne, in which the subscriber is initially connected to a Discriminating Selector Repeater via a 2000 type Bi-motional Finder, the time from the lifting of the receiver to the connection to the first impulse accepting switch is appreciably longer than any pause practicable in any rotary type of dial design.

To meet such cases "dial-tone" is introduced in an automatic telephone system. Dial-tone is fed back to the calling subscriber only when the switching connection to the circuit which is to receive the first impulse train has been completed in the exchange, and it thus provides a signal which indicates that dialling may safely be commenced. Instructions provided for subscribers read, "Always listen before attempting to dial." This instruction is necessary even with dials having a pause as long as has Siemens No. 10, and, if the instruction is followed, the positioning of inter-digital pause **before** impulse-trains becomes unnecessary.

The positioning of the inter-digital pause **before** impulse trains may, to some extent, reduce the probability of false connections due to lost impulses in cases where subscribers do not listen for dial tone, but it will by no means eliminate all such false connections, and, in the case of some exchange equipment, it may eliminate very few. Dial-tone is therefore an essential requirement, and if this signal is used by subscribers, in accordance with instructions, a dial having an inter-digital pause **after** impulse trains is quite satisfactory.

Method of Production of Pause: In the Siemens No. 10 dial (Fig. 1) the inter-digital pause is produced by the slipping cam, which prevents operation of the impulse contacts until the finger plate, on its return rotation, has moved through an angle equivalent to approximately 2¼ impulses.

In the A.T.M. 24C and A.E.C. 24 dials the inter-digital pause is produced by a cam on the main shaft (Figs 2 and 3), which lifts the impulse contacts clear of the double impulse-cam at the end of the return rotation of the finger plate, for a period equivalent to approximately 2¼ impulses in the case of the A.T.M. dial and 1¼ impulses in the case of the A.E.C. dial. This method is quite positive.

In the W.E. 5E dial (Fig. 4) the inter-digital pause is created during the movement of the impulse lever from the trailing position (which it occupies during forward rotation of the finger plate) to the impulsing position, at the commencement of return rotation, and is equivalent in length to approximately one impulse. This method is quite positive.

In the S. & H. 180a and Ericsson S2836 dials, the inter-digital pause is produced by the off-normal cam (Figs. 5 and 6) on the main shaft, which operates a pair of "make" contacts forming part of the off-normal contact spring assembly.

These contacts short-circuit the impulse contacts at the end of the return rotation of the finger plate, for a period equivalent to approximately 2 impulses in the case of the S. & H. dial and 1½ impulses in the case of the Ericsson dial.

Governor

Each of the dials is provided with a centrifugal governor of the spring controlled friction type, to regulate the return speed of finger-plate rotation.

Governor Speed: The governor speed of the W.E. 5E Dial is approximately 19.4 times the mainshaft speed. As centrifugal force is proportional to the mass of the rotating weights, to their radius about the governor centre, and to the square of the speed of angular rotation, this means that in order to obtain a similar speed control, this governor is necessarily larger in diameter and has heavier weights than the governors in the other dials examined, which are all driven at considerably higher speeds (i.e., from 90 to 126 times the mainshaft speed—see Table II).

The normal method of speed adjustment is by altering the set or tension of the governor springs. In the Siemens No. 10 and W.E. 5E dials, the springs are not particularly accessible, but in the other dials the springs are more exposed, and they may be more susceptible to accidental damage when the dial is removed from the telephone.

Direction of Rotation: In the A.T.M. 24C, A.E.C. 24 and S. & H. 180a dials, due to the use of a ratchet, the governor rotates during the return motion of the finger plate only. This reduces wear on the worm gearing teeth, the governor bearings and the friction surfaces, and also means that the axial thrust on the governor shaft, due to the worm gear drive employed, is in one direction only, so that only one bearing has to withstand thrust.

In the Siemens No. 10 and Ericsson S2836 dials, the drive is transmitted to the governor through a spring clutch on the shaft of the worm gear. During forward motion of the finger plate this clutch slips, so that the governor is driven positively only during the return motion, but the clutch also permits the governor to overshoot when the finger plate returns to its stop, so that the governor is not stopped too abruptly. In the Ericsson dial the slip of the clutch is almost 100% during forward motion, so that the governor has the same advantage as regards wear and thrust as the A.T.M. 24C, A.E.C. 24 and S. & H. 180a dials. In the Siemens No. 10 dial, however, the slip during forward motion is very slight and the governor rotates almost the same amount in both directions.

In the W.E. 5E dial the governor is driven during both forward and return motions. However, as the governor speed is relatively low and spur gearing only is employed, the wear would be correspondingly slight, and there is no axial thrust on the bearings.

Governor Drive: In the W.E. 5E dial the governor is driven from the main shaft through a train of two pairs of spur gears and pinions. In the other five dials examined the drive is through one spur gear and pinion pair, and a worm gear and worm. Of these dials, the A.T.M. 24C, A.E.C. 24 and S. & H. 180a dials employ a worm gear of laminated construction, having a layer of oil impregnated fibre between two outer layers of metal. This makes the worm gear self lubricating.

General Details

Fitting and Overall Diameter: The Siemens No. 10, A.T.M. 24C and Ericsson S2836 dials examined would fit the standard 3 point mounting provided on telephones of the P.M.G. Department in Australia. The three point fitting of the Ericsson dial, however, is provided by means of a rear adapter cap, having a hole for wiring leads; this adapter causes the dial, when mounted, to project approximately 7/16" further from its mounting than the Siemens No. 10 or A.T.M. 24C dials, but it would serve to protect the dial mechanism from dust and possible damage when removed from the telephone, the latter two dials having no such protective rear cap.

The A.E.C. 24, W.E. 5E and S. & H. 180a dials examined had no provision for standard 3 point mounting. However, the A.E.C. dial could be provided with a body having a 3 point fitting similar to that of the A.T.M. 24C dial, and, by means of rear adapter caps similar to that fitted to the Ericsson S2836 dial, the W.E. and S. & H. dials also could be made to fit standard 3 point mountings. Adapter caps large enough to contain the mechanisms of these dials would cause the W.E. 5E dial to project about 13/16", and the S. & H. 180a dial about 11/16" further from the mounting than the Siemens No. 10 and A.T.M. 24C dials.

The overall diameter of a dial is of importance when it is required to mount flush in a telephone, e.g., in wall type Public Telephones used in Australia. The overall body diameter of the Siemens No. 10 and A.T.M. 24C dials is standard in this respect, i.e., 3¼". The A.E.C. 24, W.E. 5E and Ericsson S2836 dials, however, have an overall body diameter of 3", and in the S. & H. 180a this dimension is 3-7/32".

Terminals: The Siemens No. 10, A.T.M. 24C, A.E.C. 24 and W.E. 5E dials examined are provided with screw terminals. In the Siemens dial the terminals are close together. In the A.T.M., A.E.C. and W.E. dials the terminals are spaced further apart and are not likely to cause trouble.

The S. & H. 180a and Ericsson S2836 dials are fitted with solder lug terminals and, in order to avoid a soldering operation when replacing dials, it would generally be necessary to provide the dial with a short flexible five-conductor cord having spade lug terminations at the free end for connection to terminal screws in the telephone instrument. The S. & H. dial examined had such a cord connected and anchored to it, and the

Ericsson dial was provided with an anchor clip for a similar cord. Such a method of connection, however, would be inconvenient compared with the method of connecting leads already in the telephone to screw terminals on the dial.

Main Spring: The Siemens No. 10 and S. & H. 180a dials were fitted with flat clock type spiral springs. These are housed in cylindrical casings which serve also to retain lubricant. The A.T.M. 24C, A.E.C. 24, W.E. 5E and Ericsson S2836 dials, on the other hand, were fitted with wire type springs wound in a helix, and without lubricant.

Number Plate and External Finish: In all dials the number plates are of metal and detachable, obviously with the intention of providing numerals with or without letters or symbols to suit the telephone administration concerned. In all but the Ericsson S2836 dial, these plates are in the form of a flat ring secured by some form of clip to the body of the dial behind the finger plate. In the Ericsson S2836 dial the number plate is in the form of a disc secured at the centre of the finger plate, with numbers at its periphery, there being no provision for mounting a plate similar to those in the other dials. All number plates are of enamel or similar hard finish, the Siemens No. 10, A.T.M. 24C, A.E.C. 24 and W.E. 5E dials having black letters on a white background, while the S. & H. 180a and Ericsson S2836 dials have white letters on a black background. The Siemens, A.T.M., A.E.C. and W.E. dials only are provided with a clipped holder for a disc instruction card at the centre of the finger plate. The external finish of dials could obviously be varied to suit the telephone administration concerned. It is interesting to note that the Siemens and Halske dial has a moulded plastic body and finger plate.

General Construction and Operation: From the subscriber's point of view, it is desirable for a dial to be quiet in operation. In the A.E.C. 24 dial, noise is largely eliminated by the use of a rubber mask adjacent to the brass ratchet wheel. This mask has teeth which project beyond the teeth of the brass ratchet, and cushion the blows of the pawl during forward rotation. The rubber is possibly a synthetic material to obviate the deterioration produced by oil in natural rubber.

References

1. The Siemens Brothers Dial—Pamphlet 596A. Siemens Brothers & Co. Ltd., Woolwich, London.
2. The Type 24C Dial—Engineering Bulletin No. 405. Automatic Telephone and Electric Co. Ltd., Liverpool and London.
3. Subscribers' Station Equipment—Engineering Bulletin 302. Automatic Electric Inc., Chicago, U.S.A.
4. "Contact Bounce," G. Windred, The Electrical Engineer, 26.4.40.
5. "The Vibration of Electric Contacts," M. N. Russell and S. Kleilien, Electrical Engineering, Transactions, April, 1944.

TABLE I.

Illustration	Type	Manufacturer	Country of Manufacture
Fig. 1	No. 10	Siemens Brothers & Co. Ltd.	Great Britain
Fig. 2	24C	Automatic Telephone & Electric Co. Ltd. (A.T.M.)	Great Britain
Fig. 3	24	Automatic Electric Co.	U.S.A.
Fig. 4	5E	Western Electric	U.S.A.
Fig. 5	Fg. Sch. 180a	Siemens and Halske	Germany
Fig. 6	S2836	Telefon AB. L. M. Ericsson	Sweden

From TABLE I.

Illustration	Type	Manufacturer	Country of Manufacture
Fig 1a	No 8	Siemens Brothers & Co Ltd	Great Britain
Fig 1b	No 10	Siemens Brothers & Co Ltd	Great Britain
Fig 1c	No 12	Siemens Brothers & Co Ltd	Great Britain
~~Fig 2~~	~~24C~~	~~Automatic Telephone & Electric Co Ltd (ATM)~~	~~Great Britain~~
Fig 3	24	Automatic Electric Co	USA
Fig 4	5E (4H)	Western Electric	USA
~~Fig 5~~	~~Fg Sch 180a~~	~~Siemens and Halske~~	~~Germany~~
Fig 6	S2836	Telefon AB LM Ericsson	Sweden

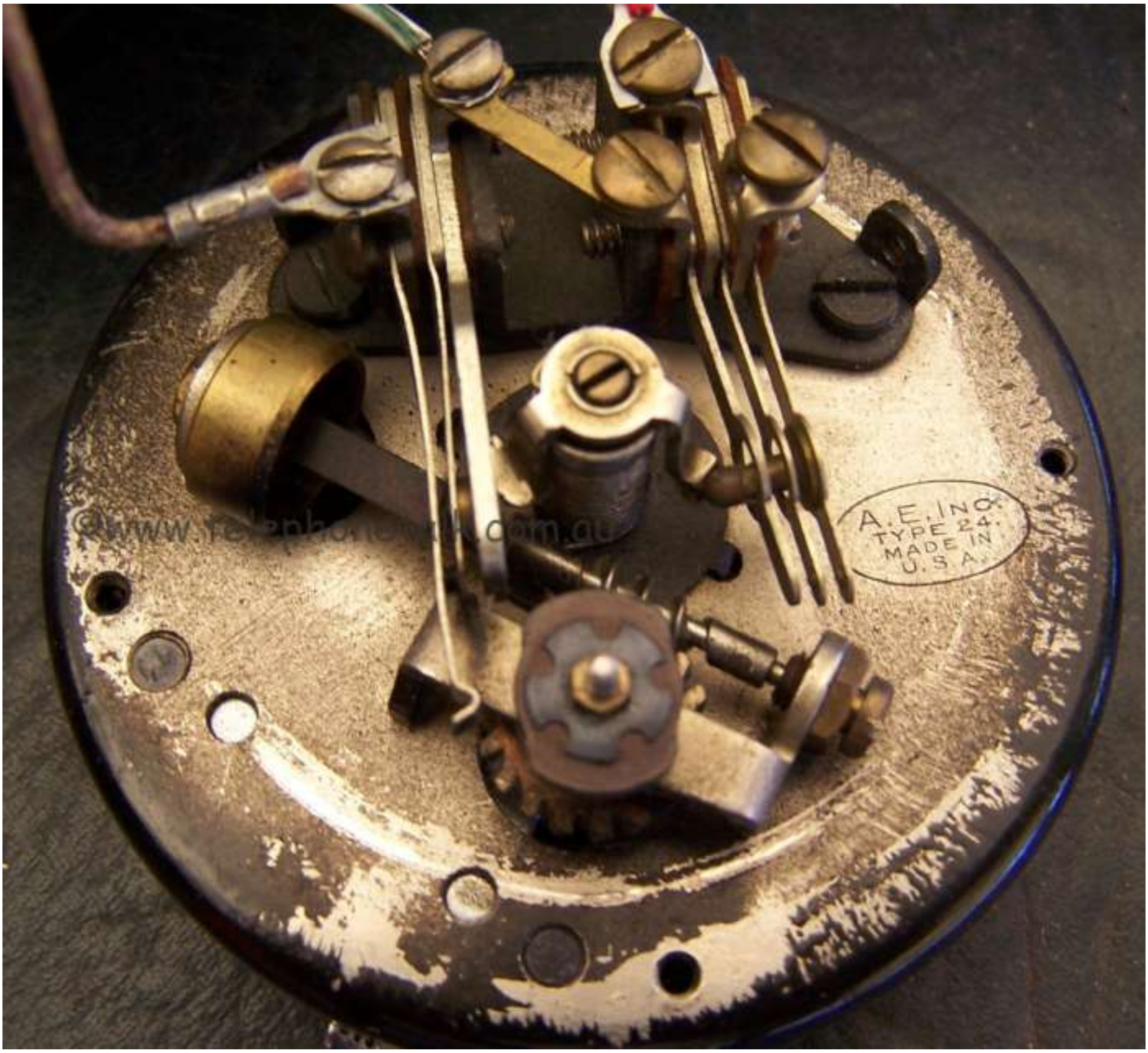
Fig 1a Siemens Brothers & Co Ltd - **No 8**

Fig 1b Siemens Brothers & Co Ltd - **No 10**

Fig 1c Siemens Brothers & Co Ltd - **No 12**

Fig 3 Automatic Electric Co (USA) – **24**

Fig 3 (cont) Automatic Electric Co (USA) – **24**



Slightly different to the first two AECO type 24 dials. This one is actually fitted to an Ericsson (Beeston Notts) candlestick telephone; clearly an example of a mixed breed, with a UK phone fitted with a US dial.

Fig 4 Western Electric (USA) – **type 4H**

This picture is added only to show the different position for the Western Electric finger stop; obviously it is fitted to an American telephone, but it is the same in construction as the example shown in Attachment 1.

Fig 6 Telefon AB LM Ericsson