MINIATURE BATTERY OPERATED TAPE RECORDER

TYPE CEB.

INSTRUCTION MANUAL.

Commonwealth Electronics Pty. Ltd.
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Applies to recorders having Serial numbers higher than 170.

INSTRUCTION MANUAL

MINIATURE BATTERY OPERATED TAPE RECORDER

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SECTION 1. GENERAL

1.1 Application.

The Type CE3 Tape Recorder is a lightweight battery operated unit, suitable for recording in locations where A.C. power is not available. It incorporates a spring-driven motor. a recording amplifier channel with sufficient gain to use a high quality 50 ohm moving coil microphone and a play-back channel with loudspeaker output. Monitoring and metering facilities are also included.

1.2 General Description.

The tape recorder is housed in a maroon plastic covered wooden case, overall dimensions being 14" x 8½" x 8½" high. Its weight is 23½ lbs including batteries.

The unit is constructed around an aluminium casting, which comprises the tape deck and mounts the double-spring clockwork motor, the tape drive and speed regulating mechanisms and the tape head assembly. The amplifier chassis is fitted to the main casting, while the loudspeaker and the battery compartments are attached to the case.

Interconnecting leads are brought out via 4 pin plugs and sockets. The battery plug and sockets are coded to prevent incorrect mating.

In order to reduce the effects of microphony the amplifier tubes are mounted on shockmounted sub-chassis, and the wiring to the component panel is carried out in special multi-stranded wire woven around a nylon core. The movement of the shockmounted chassis is limited.

Operating controls, fitted to the side of the unit and available through an opening in the case, are as follows:-

START/STOP lever, which also operates the battery switch.

MICROPHONE socket, this being a standard 3 pin receptacle to suit standard studio microphones.

'PHONES jack, for monitoring purposes (high impedance 'phones).

GAIN control for adjusting the recording level.

Access to the motor drive belt and the majority of adjustment points is gained by removing the front panel which is held by 4 screws.

The following controls and meter are available from the front panel:-

Meter Switch - with positions for checking LT and HT batteries and recording level.

Play-Record Switch.

Capstan Speed Adjusting Screw.

Playback level- preset with screwdriver adjustment.

The unit is held in its carrying case by two screws fitted with grooved rings to attach the carrying strap. This allows the operator to carry and use the unit while supported from his shoulders.

The tape transport system has been designed to make the most efficient use of the limited power available from the spring motor. At the same time the performance achieved is of a high order, thus enabling recordings of professional standards to be made.

Fast forward and rewind facilities are available by carrying out a si ple re-threading of the tape to be described later (Section 3.4.).

The recording amplifier channel has been designed to give ample gain for use with a high quality 50 ohm moving coil microphone. The record head incorporates a ferrite core with resultant economy of bias power.

No erase head is provided in this unit and pre-erased tapes are to be used.

A playback head is used to monitor the recording through a separate amplifier channel and high impedance earphones. The same head and amplifier are used to drive a 5" loudspeaker for re-play purposes. Winding may be carried out whilst recording.

Lines marked on the perspex panel, directly above the spool of tape on the supply side, permit the operator to ascertain when a motor rewind is necessary.

The battery complement is as follows:-

1 - type 742 "LT" battery ($1\frac{1}{2}$V)
2 - type 467 "HT" battery ($67\frac{1}{2}$V.ea.)

The life of the batteries depends on the operating cycle of the equipment. For example, if the equipment is operated say for 2 hours per day at cycles of 10 minutes on and 50 minutes off, then the approximate life of the batteries would be:-

"LT" - 50 hours' actual recording time
"HT" - 20 " " " "

1.3 Performance Specification.

Tape Speed $7\frac{1}{2}$" /Sec

Recording	Full track
Frequency response	With ±2 db of the response at 1 Kc/s, from 100 c/s to 7 Kc/s when re-played on a recorder having C.C.I.R. characteristics.
Distortion	At full recording level, less than 5% when re-played as above.
Signal/Noise Ratio	Better than 40 db below full recording level, with the gain control set for an input of -80 dbm, when re-played as above.
Wow and Flutter	Better than 0.35% R.M.S. total.
Bias Oscillator frequency	40 Kc/s. ± 10%
Re-Play amplifier output	Approx. 60 mW into loudspeaker at full recording level.
Re-Play amplifier distortion	Less than 5%.
Playing time per wind	4 minutes.

Battery consumption		Record	Re-play
	1.5V	0.35 amp.	0.18 amp.
	135V	12.5mA	8.5 mA.

SECTION 2. DETAILED DESCRIPTION.

2.1 Tape-drive Mechanism.

Reference should be made to Drawing No. A.4105 showing details of the tape deck.

The drive of the motor is applied to the take-up spool hub (C) by means of the drive pulley (A) and a rubber belt (B).

The brake-lever (E) applies friction to the supply spool hub (D) when the start/stop lever (F) is in the "stop" position. In the "start" position a cam (G) partially releases the brake, leaving sufficient friction to provide some tape back-tension. This is controlled by means of a spring (SP1).

The linear speed of the tape is controlled by the capstan and governor assembly (H) in conjunction with the pinch wheel (J) and the servo arm (K). Details of the governor assembly are shown on Drawing No. A.5105.

A 50 cycle/sec. stroboscope is attached to the top of the fly-wheel (L) allowing for accurate pre-setting of the speed by means of a spindle (M) which in conjunction with a spring (SP2), (Drawing No. A.5105), controls the setting of the governor. The movement of one segment of the stroboscope past a given point per second is equal to a speed change of 1%.

When the equipment is switched on, the cam (G) also actuates a lever (N), which operates the filament supply switch (SWA) by means of an adjustable screw (O). In the "stop" position, a lever (P) applies braking to the motor pulley and the pinch wheel (J) is lifted clear of the capstan by means of a screw (Q) acting on the servo arm (K).

The action of the servo arm can be explained as follows:-

When the tape is threaded for normal operation as shown in Drawing No. A.3105, the upward tension on pulley "R" is governed by the amount of tape on the take-up spool. As the latter fills up the angle of contact between the tape and the pulley decreases with a resultant reduction in the upward pull. The result is a decrease in pressure between the pinch wheel and the capstan, thus equalising the tape tension. A limit to this is set by a spring (SP3).

The record and playback heads are mounted on a plate (S). Azimuth adjustment is by means of screws (AZR) and (AZP). A small terminal (T) is connected to the record head and extends through the front panel. It may be used for adjusting the record head Azimuth by feeding its output to an external amplifier.

A microswitch (SWB) is fitted to the rear of the motor. Details are shown in Drawing No. A.5105. The alarm lever (U) is under the influence of two tensions, i.e., the tension inserted by the motor spring countered by a spring (V), whose tension is adjustable by means of a screw

If required this switch can be used as a means of operating a rewind alarm system (not supplied with the equipment). The lever (U) has been locked by means of a screw.

2.2 Battery Supply Switching.

Reference to the circuit Schematic (Drawing No. CD.1105) shows that the filament circuit is closed by a microswitch operated from the start/stop lever (see previous section). The negative side of the L.T. battery is returned to ground, whilst the negative side of the H.T. supply is returned to ground via the bias resistors (R12 and R28).

Filament power is applied to the first two stages (V5 and V6) of the playback channel as soon as SWA is operated. When the "Play/Record" switch (WRA) is in the "Record" position the filaments of the record amplifier stages (V1, V2, V3 and V4) are energised. When the switch is in the "play" position, the loudspeaker amplifier is operated.

2.3 Bias Supply.

Reference to the Circuit Schematic, Drawing No. CD.1105, Issue (C) shows that the back bias resistance comprises two resistors, viz.,

(a) Fixed resistor, R.12, 470 ohms,

in series with

(b) a potentiometer, R.28, 1000 ohms, linear.

As a result, the D.C. bias can be adjusted for minimum distortion. At any time, when the distortion is found to be excessive or after replacing V3 (Type 3V4), the D.C. bias should be adjusted as described in Section 4.2.7.

2.4 Recording Channel.

There are three stages of amplification (V1, V2 and V3) employing two type 1U5 tubes and one type 3V4. A type 3V4 tube (V4) is used in the bias oscillator stage.

Resistance/capacity coupling is used throughout the amplifier. High frequency pre-emphasis is provided by means of a feedback network (R9, R10 and C8).

In order to obtain a small amount of treble boost, a network consisting of R.29, R.30 and C.19 is added as a feedback circuit, between the anode and grid of V.1. Details are shown on the Circuit Schematic (Drawing No. CD.1105, Issue C).

If the condenser (C.19) is not connected, approximately 3db constant feedback over the frequency range is available.

A condenser having a value of 400 pF will give approximately 2 db boost at 7 Kc/s.

record head (RH1) via a blocking condenser (C6), load resistor (R10), and the secondary of the bias oscillator coil (L1). C7 forms a resonant circuit with the secondary of L1 and the record head.

A relative indication of the recording level is obtained on the built-in meter (M1). The value of the multiplier resistor (R24) is such as to give a meter reading at the lower limit of the hatched portion of its scale, when full recording level is used.

2.5 Playback Channel.

A three-stage, resistance/capacity coupled amplifier is used (V5, V6 and V7). Approximately 60 milliwatts output is available to feed the loudspeaker. Loudspeaker level control is obtained by means of a preset potentiometer R19.

A network consisting of R20 and C16 across the primary of the output transformer (T3) provides de-emphasis.

The anode voltage of the second stage (V6) is applied to the output stage (V7) when the play/record switch (WRA) is in the "PLAY" position. In the "RECORD" position, the filament of V7 is switched off, and V6 becomes part of the monitor circuit (see following section).

2.6 Monitor System.

Under recording conditions, the signal is reproduced from the tape by the re-play head (PU1) and amplified in the first two stages (V5 and V6) of the play-back channel. The output of V6 is applied to the monitoring headphones through J1.

SECTION 3. OPERATING PROCEDURE.

3.1 Setting Up the Equipment.

When placing the recorder in operation, the following procedure should be followed:-

(a) Loosen the captive thumb screw at rear of recorder case, open the flap and check that the batteries are fitted. See Section 3.5 for details of fitting or changing batteries, and refer to Drawing A.7105.

(b) Plug a pair of high impedance headphones into the jack on the control panel at the left hand end of the case. Place the Start/Stop lever on "Start", and check battery voltages as shown on the built-in meter with the selector switch (WRB) in the "L.T." and "H.T." positions. The meter should read within the red hatch area of the scale. If the reading is low, the appropriate battery should be replaced.

Return Start/Stop lever into "Stop" position.

(c) Place a 5" spool of pre-erased tape on the left hand hub, and thread the tape as shown on Drawing A.3105. It is essential that the tape be wound coated side inward.
Place an empty 5" spool on the right hand hub.
See that the tape is correctly placed in the guides and over the heads, otherwise it may run off the capstan when the recorder is started.
IMPORTANT: Use only PVC thin base tapes with large hub spools; old type, small hub spools, will cause excessive changes in tape tension.

(d) Pull out the retractable winding handle and wind up the motor. Do not overwind. Stop winding when resistance is felt.

(e) Plug a 50 ohm moving coil microphone into the socket on the control panel. Place the Play/Record switch to "Record" position. Switch the lever to the "Start" position and meter selector switch to the "VU" position. Advance the "Gain" control until the meter peaks into the red hatch area whilst speaking into the microphone.

(f) Set the speed of the flywheel by viewing the stroboscope under a 50 c/s fluorescent or neon light. The speed should be set by means of the screw driver adjustment adjacent to the fly wheel, so that one bar appears to pass a given point each second in anti clockwise direction. This test should be made with the take-up spool (right hand) nearly empty, and the motor fully wound. Under these conditions, the tape speed will be approximately 1% fast, which will allow for a drop in speed as the motor unwinds. The recorder is now ready for use.

3.2 Recording.

(a) Place the Start/Stop lever into "Start" position.

(c) Check that the Play/Record switch is in the "Record" position.

(d) Speak into the microphone.

(e) Check.

(i) "I.T." and "H.T." meter readings.

(ii) " .U." meter reading - should peak within red-hatched area. If necessary adjust gain control.

(iii) Recording in monitor headphones.

(f) Winding is necessary when the outside of the tape on the supply spool lines up with the markings printed on the perspex window. When winding, while a recording is in progress, wind at an even rate and do not overwind.

(g) Switch off when the recording is completed by placing the Start/Stop switch into the "Stop" position.

<u>NOTE</u>: Having switched off, wait for approximately 1 minute before switching on again. This allows the flywheel to stop, and avoids spilling the tape.
Alternatively the flywheel may be stopped quickly by gentle pressure of the finger on the rim.

3.3 <u>Playing Back.</u>

(a) Thread tape to be replayed as in Section 3.1.

(b) Start recorder as in 3.2 (a) and (b).

(c) Check that Play/Record switch is in "Play".

(d) Set level control (screw-driver slot adjustment through front panel), for convenient loudspeaker level.

3.4 <u>Other Facilities.</u>

To wind the tape fast forward, remove the tape from the pinch wheel so that it passes straight to the take-up spool (not via the capstan).

To rewind, remove the spools and change them over, threading as for fast forward.

No complex brakes or clutches are used to aid rewinding; the left hand or supply spool should be braked lightly with the finger tips when running fast, to ensure even winding of the tape.

3.5 <u>Batteries.</u>

Drawing No. A.7105 illustrates the battery compartment. Access is obtained by loosening the knurled captive screw at the [illegible]

The battery complement comprises a type 742 battery (1.5 volts) for the L.T. Supply, and two type 467 batteries (67.5 volts) for the H.T. Supply.

The battery compartment socket (SKB) and the plug (PLA) attached to the interconnecting leads, are coded with red paint to prevent plugging in incorrectly.

SECTION 4. MAINTENANCE.

To Remove the Unit from the Case.

(a) Open the flap of the battery compartment, and disconnect the battery cable.

(b) Disconnect the loudspeaker cable, being careful not to damage the shock-mounted sub-chassis.

(c) Unscrew the 2 screws which fasten the casting to the case.

(d) Remove the winding handle.

(e) Lift out the unit, holding it by the meter casting. DO NOT LIFT OUT THE RECORDER BY THE TAPE PULLEY OR CAPSTAN ASSEMBLY. THIS WILL RESULT IN SERIOUS DAMAGE TO THESE MECHANISMS.

4.1 Lubrication.

Part	Shown On Drawing No:	Symbol:	Lubricant	Procedure	Period
Capstan ball bearings	A.5105	H1,H2	Solution of 10% Shell G.960 in Shellite.	Introduce 3 drops into each ball bearing, via the holes from which the shaft emerges	2 months
Governor disc.	A.5105	H3		Clean with 2-3 drops of kerosene	When requ
Spool hub.) Ball Pinch Wheel) Bear- Pulley) ings Motor)	A.4105 A.4105 A.4105 A.5105	C & D J R d	Grease : Shell Retinex A.	Should stiffness occur in any of these bearings, wash out with kerosene, and re-grease	When requi
Motor.					
Fan brake shaft pivots	A.5105	a & b	Shell G.960	Add 2-3 drops	2 Months
Fan brake shaft worm	A.5105	c	"Acheson's Oildag"	Light smear	2 Months
Other pivot bearings			Shell G.960	2-3 drops	2 Months
Gears			Grease : Shell Retinax A.	Light smear	When requi
Belt Guide Pulley	A.4105	I	Shell G.	2-3 drops. NOTE: Keep oil off pulley.	When requi

4.2 ADJUSTMENTS.

4.2.1 Supply Spool Brake

The tension on the tape leaving the supply spool is important and may be measured by applying a gram gauge to the spool, at the junction of the spool arms and the rim, the correct tension being 15-17 grams. Adjustment may be made by bending the spring lug "SP11" (Drawing No. A4105) towards the spool for greater tension or away for less tension. The adjustments must be made with the start lever in the "Start" position.

4.2.2 Servo Arm Release Screw (Q).

This screw should be adjusted to lift the pinch wheel clear of the capstan when the machine is stopped. To adjust, place lever in "start" position and turn screw to give approximately .010" clearance between the end of the screw and the servo arm. Lock in position with locknut.

4.2.3 Fanbrake Shaft. (See Drawing No. A.5105).

Note that the pivot bearings are bored eccentrically and rotation of these controls the meshing of the worm and wheel (C). The meshing should be as deep as possible, consistent with complete freedom from binding. The pivots should also be adjusted to allow free rotation without excessive end play as this will cause noisy operation.

4.2.4 Re-Wind Alarm Switch. (See Drawing No. A.5105)

To place the switch SWB into operation, remove the screw which locks the lever (U).

To adjust the operation of the switch thread the tape to an empty take-up spool. Wind motor fully and allow machine to run for approximately 4 minutes. Adjust spring tension screw (X) on back of spring motor so that the switch just operates when the motor is running.

The alarm lever (U) should move approximately 1/32" when pressure is applied with the fingers and the microswitch (SWB) should operate. If not, loosen the screw "Z" and move lug "Y" slightly until switch operates correctly, then tighten screw.

4.2.5 To Replace Record and Playback Heads. (See Drawing No. A.4105).

After prolonged use it may be necessary to replace the heads. A complete assembly consisting of the base plate and heads is supplied as a replacement unit. It is only necessary to remove the two 6BA screws (S1 and S2), unsolder the leads and remove the old assembly. When replacing, be careful to retain the shims underneath the plate.

4.2.6 To Adjust Azimuth. (See Drawing No. A.4105)

Remove battery plug.

Demagnetise heads. This may be achieved ...

off the eraser.

Thread azimuth test tape on recorder.

Connect test lug "T" to the input of a high gain amplifier (use recorder chassis as earth). Start machine and adjust azimuth screw "AZR" at the side of the record head for maximum output from the amplifier. Remove amplifier connection and replace battery plug. Switch recorder to "Play" position and align replay head ("AZP") in a similar fashion by listening to the loudspeaker output.

4.2.7 D.C. Bias Adjustment.

Connect a screened lead between the replay head (PU1) and a suitable amplifier, the output of which is fed to a distortion meter.

Prepare a recording at 800 or 1000 c/s. in the usual manner and adjust R.28 for minimum distortion reading.

NOTE. If the distortion and noise meter used is fitted with inbuilt weighting networks, it is advisable to carry out the above test with the "telephone weighting" switched in; this will eliminate the noise contents in the recording and will allow a more accurate setting of R.28.

4.3 Amplifier Test Information.

TABLE 1. RECORD AMPLIFIER.

Tests taken on amplifier with 20,000 ohm/voltmeter and with the following battery voltages:-

L.T. = 1.4 V to chassis

H.T. = 120 V " "

Back-bias = 10 V.

Stage	V. Anode	V.Screen
V1	33V	33V
V2	20V	36V
V3	26V	90V
V4	68V	68V

R.M.S. Bias oscillator voltage across Record head = 50V ± 5 V.

Output required for standard recording level = 1.5V RMS at 1000 c/s.

Maximum sensitivity (gain control turned to maximum).

Reference = 1.5V RMS at 800 c/s, measured across R10 with record head shorted out.

Input required = -76 dbm.

Frequence response

Output measured across R10 (record head in circuit).

50c/s	-3.5db
100c/s	-1.5db
1000c/s	0 db
3000c/s	+1.5db
5000c/s	+3.5db
7000c/s	+5 db
10000c/s	+2 db

Signal/Noise ratio Measured with gain control set to maximum.

Reference = 1.5V RMS across R10.

TABLE 2 PLAYBACK AMPLIFIER.

20,000 ohm/volt meter.

Battery voltages ÷ L.T. = 1.45 V to chassis.

H.T. = 125 V to chassis.

Back bias - 6.8 V.

Stage	V.Anode	V.Screen
V5	17 V.	30 V.
V6	57 V.	57 V.
V7	88 V.	90 V.

Maximum sensitivity (level control turned up to max.)

Reference output ÷ 25V RMS at 800 c/s. across primary of output transformer (= 60 mW approx.)

Amplifier Input required = - 70 dbm.

Frequency response

200 c/s	+ 3 db
800 c/s	0 db
2000 c/s	- 0.5 db
7000. c/s	- 1.5 db

Distortion

at 60 mW output = 5%

Signal/noise ratio

50 db approx. (reference 60 mW).

4.4 Overall performance test figures.

Replayed on machine having CCIR characteristics.

Recorder Serial No ....212....

Date Tested ....27-9-57........

Wow and Flutter (R.M.S.) Wow: .22.% Flutter .18.% Total .3...%

Distortion (Reference: 800 c/s. -60 dmb input, gain control set to reference on V.U. meter).

R.M.S. distortion ...3½.%

Signal to Noise ratio (Reference as above).

= ....-50......db unweighted.

Frequence response (Reference 1 Kc/s, - 66dbm input, gain control set as above).

100 c/s. - ....2.....db

1000 c/s. - .....0.....db

7000 c/s - .....+1.....db

Tested by ....

4.5 Fault Locating Table.

Fault Condition		Possible Causes and Remedies
1.	Excessive flutter	Tape on supply spool sticking. Pinch wheel running out of true - replace. Dirt in capstan ball races) Replace capstan assembly Bent capstan shaft)
2.	Excessive wow	Insufficient clearance between servo arm and release screw - see Section 4.2.2 for correct adjustment. Faulty or dirty ball race in pinch wheel, supply spool hub, or tape pulley - replace or clean and re-lubricate. Faulty drive belt - replace. See Drawing No. A.4105 for correct placement of belt. Faulty supply spool brake pad - replace. Worm drive in spring motor or gears out of adjustment.
3.	Machine does not start	Faulty motor - re-adjust or check for broken spring. Faulty capstan bearing - replace assembly. Brake shoe not clearing drive belt - re adjust.
4.	Machine will not reach operating speed	Incorrect adjustment of tension on supply spool. (See Section 4.2.1). Capstan bearings dirty - replace assembly. Governor disc dirty- wash with kerosene or petrol. See also Fault No.2.
5.	Excessive distortion	Recording level too high - check setting of gain control

	Fault Ccondition	Possible Causes and Remedies.
5.	Excessive distortion (contd.)	Batteries low - check and, if necessary, replace. No or low bias oscillator output - check circuit and V4. Faulty Valve (V3) - replace. Incorrect valve of bias- re adjust R128 for minimum distortion.
6.	Excessive microphony	Check adjustment of shockmounted sub-chassis - see that they clear chassis and limit studs. Faulty valve (V1 or V2).

APPENDIX 1.

SCHEDULE OF COMPONENTS.

Key to Suppliers' Code No.

Code No.	Supplier's Name.	Address.	Telephone No.
1	Commonwealth Electronics Pty.Ltd.	3-5 James Street, Baulkham Hills, N.S.W. Derwent Park Annexe.Hobart TAS.	YA 4211 Hob. W. 9444.
2	Mullard-Australia Pty. Ltd.	35 Clarence Street, Sydney	BX. 2006.
3	Manufacturers Special Products Pty.Ltd.	47 York Street, Sydney	B. 0233.
4	United Capacitor Co. Pty.Ltd.	433 Punchbowl Road,Enfield N.S.W.	UW. 3511.
5	Ducon Condenser Ltd.	Christina Road, Leighton Field N.S.W.	UB. 1321
6	W.J.McLellan & Co.Ltd.	126 Sussex Street, Sydney	BX. 1131
7	Master Instruments Pty. Ltd.	13 Blackfriars Street, Chippendale. N.S.W.	MA. 8001
8	Transmission Products Pty.Ltd.	Denison Street, North Sydney	XB. 4018
9	Trimax Transformers	Charles Street, North Coburg. VIC.	Melbourne FL.1203
10	Bellco Pty.Ltd.	30 Carrington Street,Sydney	BX, 2811
11	Morgan Crucible Co. (Aust.) Pty.Ltd.	Bourke Road, Alexandria N.S.W.	MU. 1371

Circuit No.	Description	Value	Tolerance	Supplier Code.	Suppliers Type No.
V1, V2, V5 V6	Valve type 1U5			2	1U5
V3, V4, V7	" " 3V4			2	3V4
T1	Record Input Transformer	50:50,000 ohms		9	TA1393
T2	Replay " "	50:25,000 ohms		9	TA1133
M1	Meter, 0-50uA movement red case, red hatched area, 70-90% scale. Case S.21.			7	S.21
L1	Bias oscillator coil 40 Kc/s.			1	S128
RH1	Record head assembly			1	S129
PU1	Playback head assembly			1	S130
J1	Twin circuit jack			8	
T3	Transformer, 10,000 ohms/V.C.			3	XA20
LS1	Loudspeaker 5"			3	20861/ 525/PT.
SWA, SWB	Microswitchette			10	Burgess V3.
WRA	Play/record switch	3 pole, 3 position N/S		3	Oak type H
WRB	Meter switch	2 pole, 3 position, 1 wafer		3	Oak series 20 type 28.
R23	Record gain control potentiometer	0.5 meg.		5	500 K/C
R19	Loudspeaker volume control, potentiometer	1 meg.		5	1 meg/C
R28	Variable bias resistor	1000 ohms		5	1000 ohms/A
R12	Bias resistor.	470 ohms	10%	11	Type T

Circuit No.	Description.	Value	Toler-ance	Supplier Code	Suppliers Type No.
R20 R27 R10	H.T. Dropping Resistor) De-emphasis Resistor) Anode Load)	4,700 ohms	10%	11	Type T
R6	Feedback resistor	10,000 ohms	2%	6	DCC
R7 R9 R13	Screen dropping resistor) Decoupling ") " ")	10,000 ohms	10%	11	Type T
R8	Anode load "	22,000 ohms	10%	11	Type T
R11 R16 R18 R22	Oscillator ridleak ") Anode decoupler ") " load ") " decoupler ")	47,000 ohms	10%	11	Type T
R14	Screen dropping "	1.5 meg ohms	10%	11	Type T
R5, R17	Gridleak resistor	2.2 " "	10%	11	Type T
R25	L.T. Metering "	30,000 ohms	2%	6	DCC
R24	V.U. " "	36,000 ohms	2%	6	DCC
R2, R4	Anode Load "	0.1 meg. ohms	2%	6	DCC
R15 R3 R29	Anode load ") Screen dropping ") Feedback ")	0.47 meg. ohms	2%	6	DCC
R30	Feedback resistor	1 meg. ohm	1%	11	Type T
R26	H.T. Metering resistor	3 meg. ohms	2%	6	DCF
C9	Oscillator Grid Capacitor	2,200 pF	20%		CTH.310
C12	" Tuning "	0.002mF, 350V	10%	4	PMM
C7	" Bypass "	0.005 mF, 350V	10%	4	PMM
C8 C16	Feedback ") De-emphasis ")	0.01 mF, 350V	10%	4	PMM
C2,C4,C15	Coupling "	0.02mF, 350V	10%	4	PMM
C11 C13	Bypass ") Coupling ")	0.05 mF, 350V	10%	4	PMM

Circuit No.	Description	Value	Tolerance.	Supplier Code	Suppliers Type No.
C3	Screen bypass Capacitor)	0.1 mF, 350V	10%	4	PMM
C14	Coupling ")	0.1 mF, 150V	10%	6	1B50C
C6	" "	1.0 mF	10%	4	CP91N
C5,C10, C17,C18	Bypass Capacitor))	8 mF, 525V	20%	5	ET2D
C19	Feedback "	400 pF	10%	5	S/S

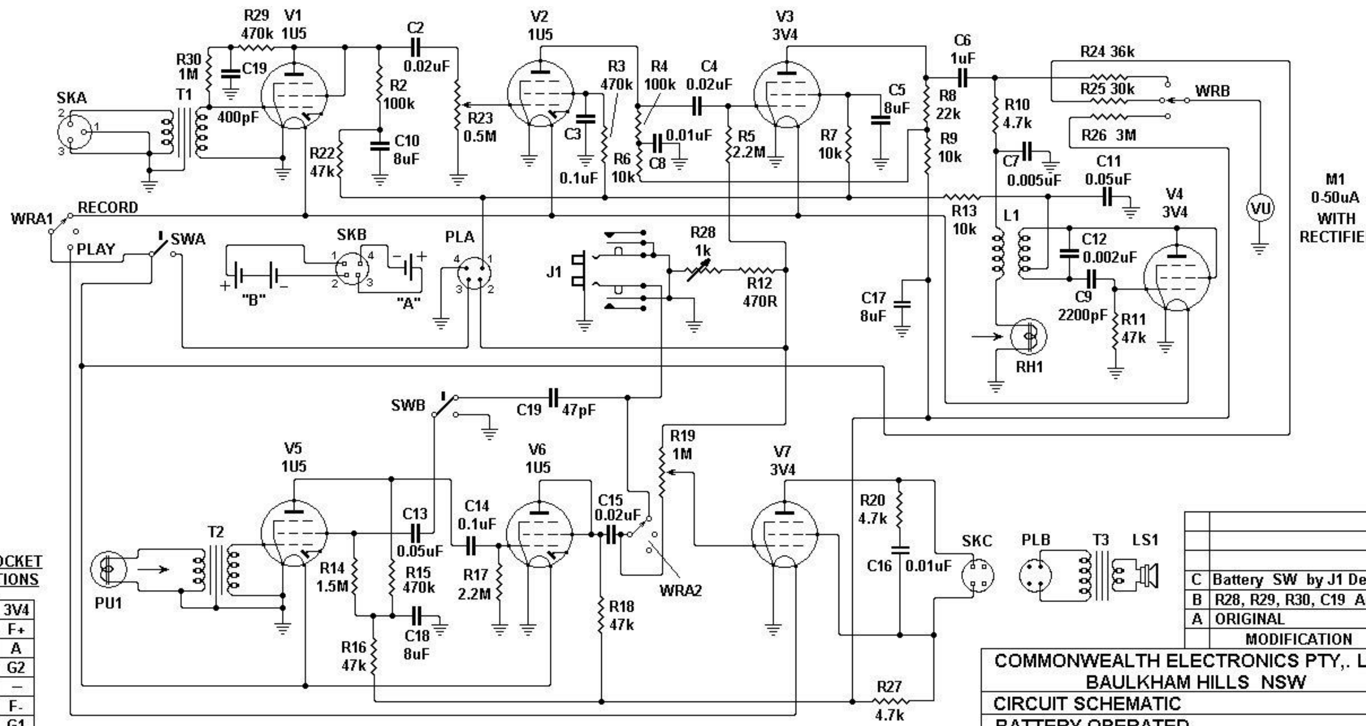
APPENDIX 2.

General Notes on the Capstan and Flywheel.

The capstan and flywheel assembly is mounted on self aligning ball bearings in a cast aluminium housing. It is absolutely essential that the capstan and flywheel revolve with complete freedom. As a check on correct operation, the flywheel should take at least 25-30 seconds to come to rest after switching off the recorder.

In the event of trouble with this assembly, it is strongly recommended that a replacement unit be obtained and the faulty one returned for repair. Due to the extreme accuracy required, each capstan is precision ground in its own bearings and it is therefore not recommended to change the bearings. A new shaft assembly must be fitted complete with bearings. Occasionally the capstan should be carefully wiped clean with a rag damped in petrol and a smear of oil applied with the finger tip to prevent rust forming on the surface. On no account use coarse abrasives such as emery paper.

The governor disc (H3 - Drawing No. A.5105) should be left unlubricated but a few drops of kerosene may be applied occasionally if erratic operation of the governor is noticed. The governor pad ring (H4) is fitted with leather pads spaced at 180° to give a balanced action. It is unlikely that the pads will need attention but the ring should be quite free to move on its pivot screws. Do not tighten these up.



VALVE SOCKET CONNECTIONS

PIN	1U5	3V4
1	F-	F+
2	A	A
3	G2	G2
4	D	–
5	–	F-
6	G1	G1
7	F+	F+

Note, currently unresolved are the two C19s

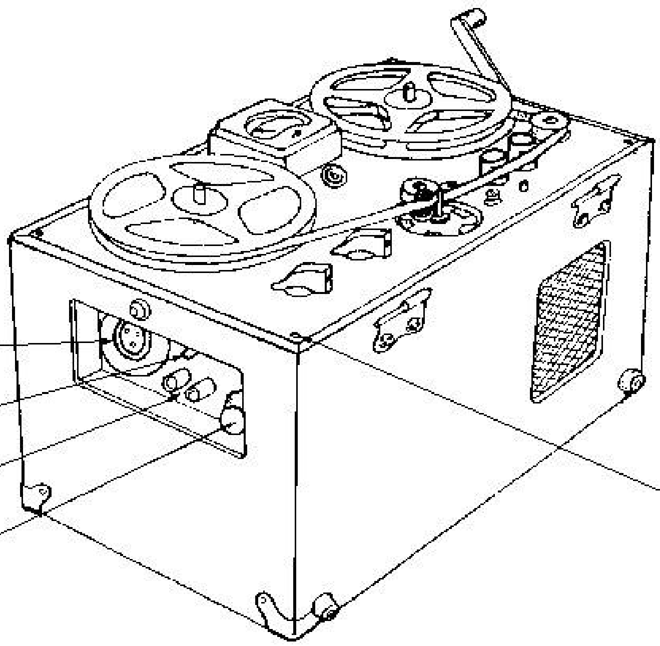
C	Battery SW by J1 Deleted
B	R28, R29, R30, C19 Added
A	ORIGINAL
	MODIFICATION

COMMONWEALTH ELECTRONICS PTY,. LTD.
BAULKHAM HILLS NSW

CIRCUIT SCHEMATIC
BATTERY OPERATED
TAPE RECORDER. TYPE CEB

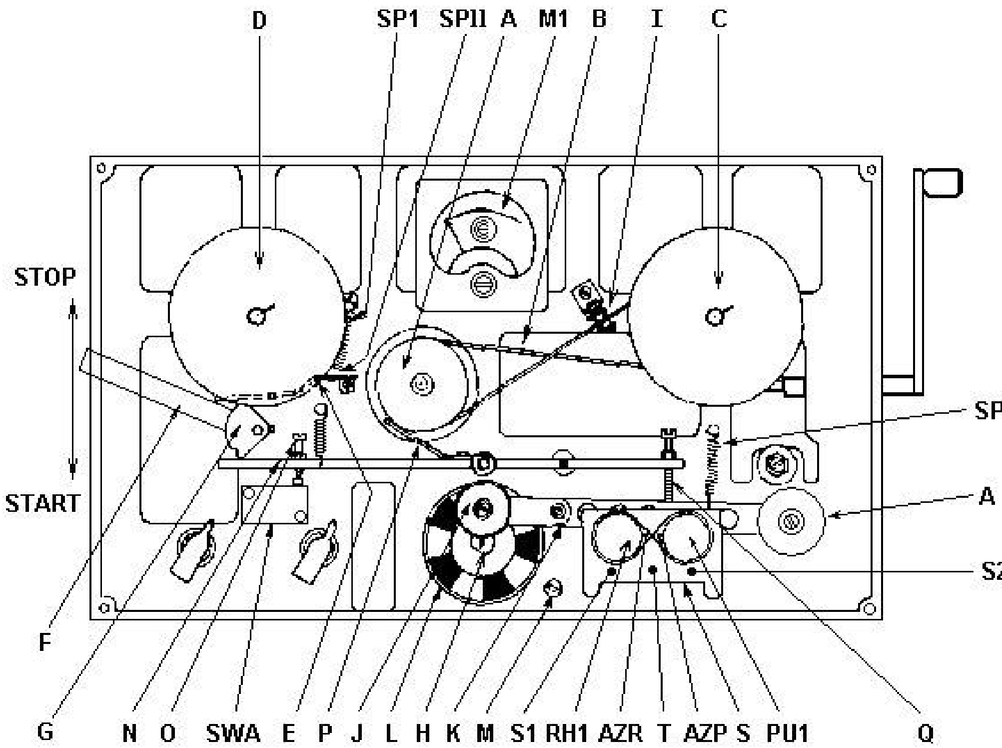
SCALE
DRN.
CKD.
CHGS ENG.

PART No.
CD 1105

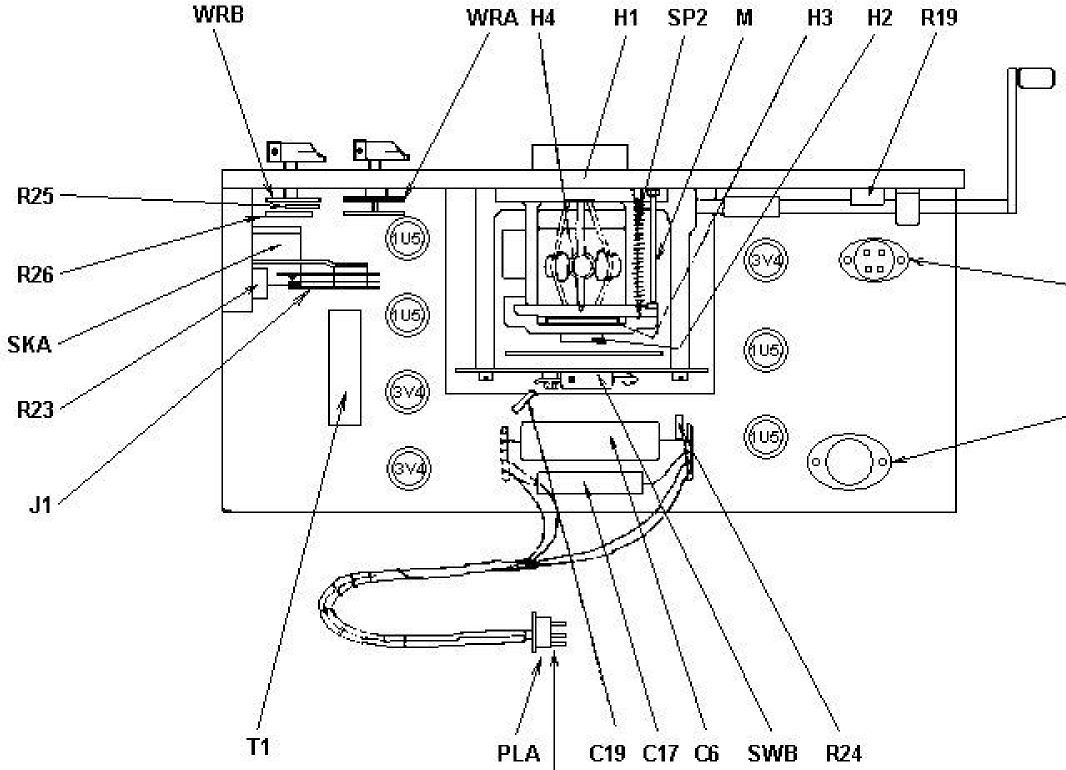


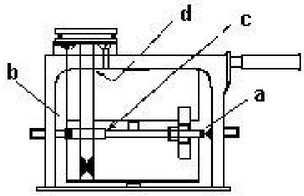
2	FAST SPOOLING
ISSUE	MODIFICATION

Used On	No. Per	MATERIAL / TYPE / SIZE / FINISH	Commonwealth Electronics Pty., Ltd. SYDNEY HOBART	SCALE / DRN. / CKD. / APPD. / APPD MFG. / CHGS ENG.
TOLERANCE UNLESS OTHERWISE STATED			MINATURE TAPE RECORDER TYPE CEB GENERAL ARRANGEMENT (LID REMOVED)	PART No. A 3105
			SEE ASSEMBLY No: ITEM	

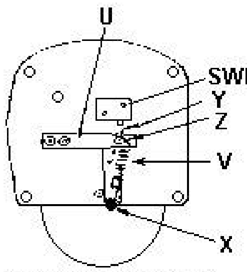


Used On	No. Per	MATERIAL TYPE SIZE FINISH	Commonwealth Electronics Pty., Ltd. SYDNEY HOBART	SCALE DRN. CKD. APPD. APPD MFG. CHGS ENG.
TOLERANCE UNLESS OTHERWISE STATED			MINATURE TAPE RECORDER TYPE CEB TOP VIEW WITH FRONT PANEL REMOVED	PART No. **A 4105**
			SEE ASSEMBLY No: ITEM	





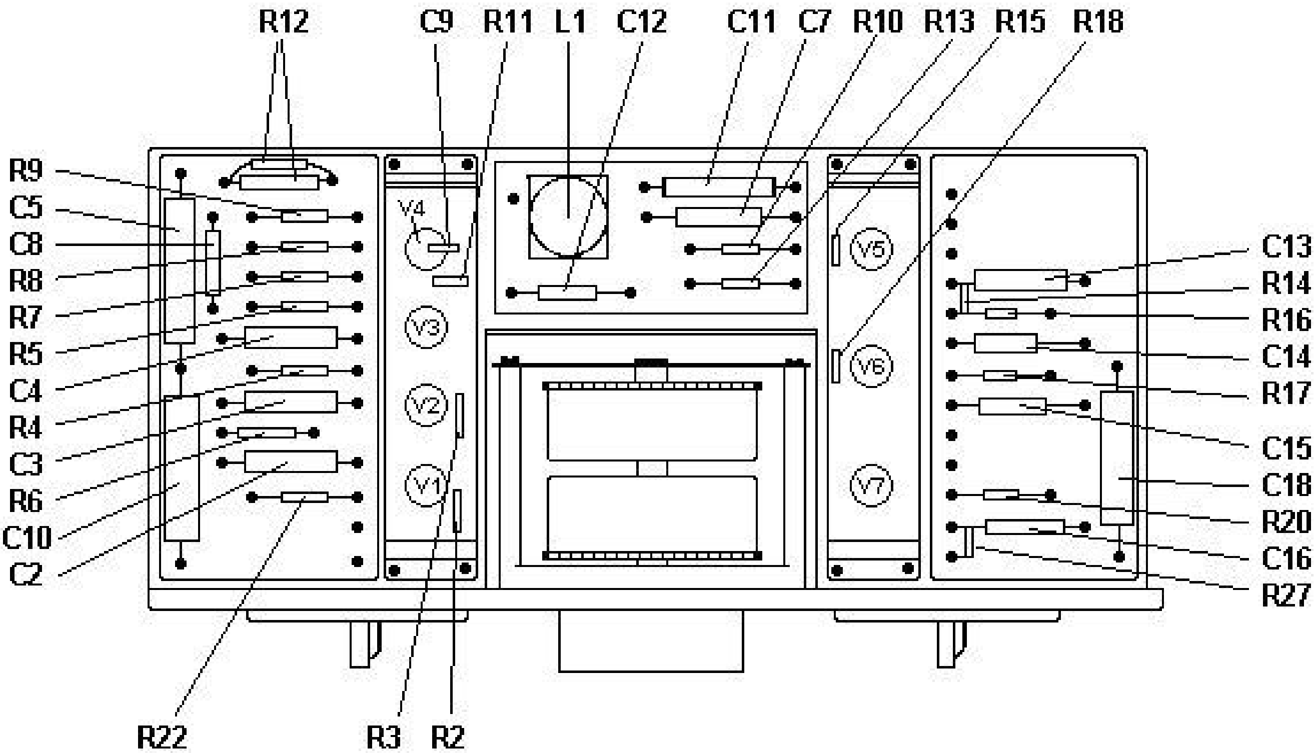
MOTOR SIDE VIEW



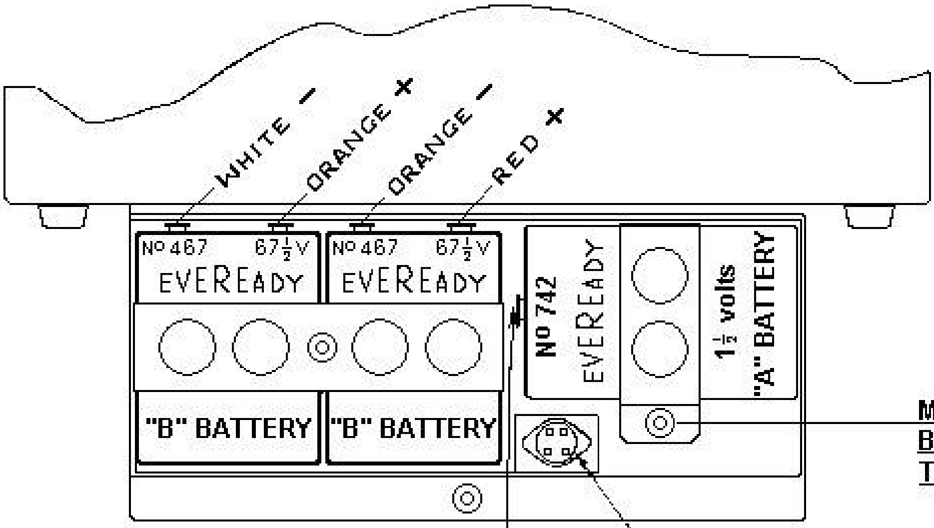
MOTOR REAR VIEW

BATTERY PLUG CODED WITH RED PAINT TO PREVENT INCORRECT MATING

Used On	No. Per	MATERIAL	Commonwealth Electronics Pty., Ltd.	SCALE
		TYPE	SYDNEY HOBART	DRN.
		SIZE	**MINATURE TAPE RECORDER TYPE CEB PLAN OF CHASSIS SHOWING CAPSTAN ASSEMBLY ETC**	CKD. APPD. APPD MFG. CHGS ENG.
TOLERANCE UNLESS OTHERWISE STATED		FINISH		PART No.
			SEE ASSEMBLY No: ITEM	**A 5105**



Used On	No. Per	MATERIAL TYPE SIZE FINISH	Commonwealth Electronics Pty., Ltd. SYDNEY HOBART	SCALE DRN. CKD. APPD. APPD MFG. CHGS ENG.
TOLERANCE UNLESS OTHERWISE STATED			MINATURE TAPE RECORDER TYPE CEB BOTTOM VIEW	PART No. **A 6105**
			SEE ASSEMBLY No: ITEM	



MOVEMENT OF "A" BATTERY MUST BE PREVENTED BY TIGHTENING THUMBSCREW FIRMLY.

BATTERY SOCKET CODED WITH RED PAINT TO PREVENT INCORRECT MATING

"A" BATTERY MUST BE MOUNTED IN POSITION SHOWN WITH +1 1/2V TERMINAL ON TOP.

BROWN LEAD TO +
BLACK LEAD TO -

Used On	No. Per	MATERIAL	Commonwealth Electronics Pty., Ltd. SYDNEY HOBART	SCALE
		TYPE	MINATURE TAPE RECORDER TYPE CEB GENERAL ARRANGEMENT OF BATTERY COMPARTMENT	DRN.
		SIZE		CKD. APPD. APPD MFG. CHGS ENG.
TOLERANCE UNLESS OTHERWISE STATED		FINISH		PART No.
			SEE ASSEMBLY No: ITEM	A 7105

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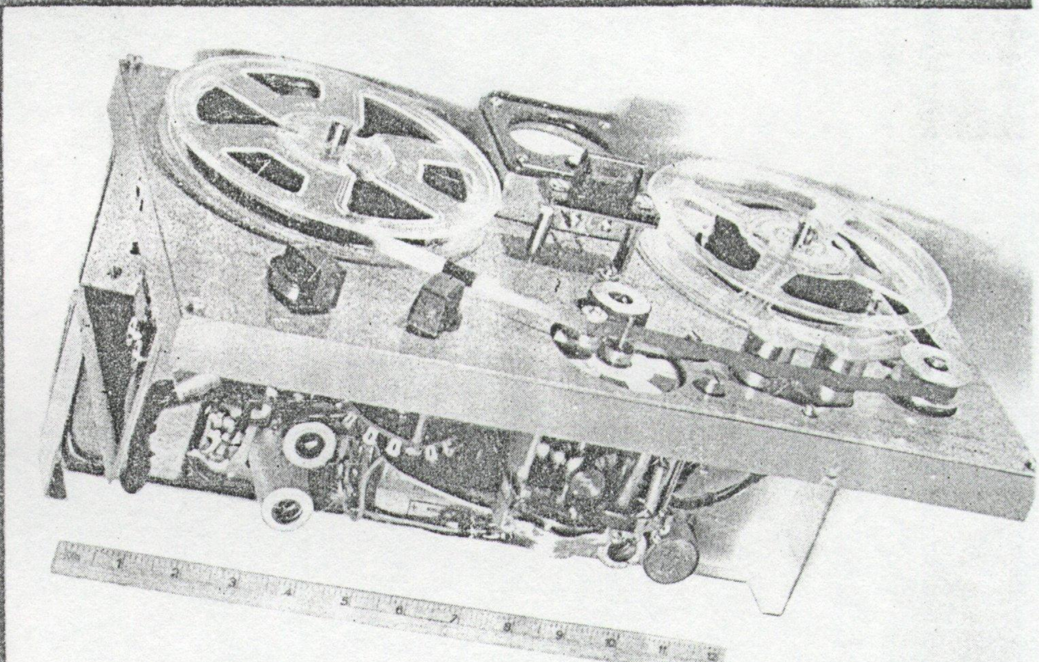

Portable Battery Operated Tape Recorder

The Development of a Miniature Battery-Operated Tape Recorder*

W. R. Nicholas†, A. D. Hildyard‡

Summary

The widespread use of magnetic recording in the production of broadcast programmes has produced a demand for a small self contained battery-operated tape recorder. The general requirements for such a recorder are discussed, followed by an outline of the development of both the mechanical and electrical design of a suitable machine.

1. Introduction

The production of high quality tape recordings is generally effected by mains operated equipment of either portable or stationary design. It is frequently found that in the sphere of broadcasting in particular a light weight battery-operated recorder will find many uses for short duration recordings of interviews, sound effects, etc. With these thoughts in mind it was decided to attempt to develop a suitable machine which would comply with the requirements as closely as possible.

As the proposed recorder was to be used primarily for broadcasting the specification naturally fell into the professional class, and it was soon realised that some of the requirements would be difficult to achieve and that some compromises would be inevitable.

2. Mechanical Design

Before proceeding with any design details the requirements were listed in the form of a specification which had to be met as closely as possible. The following was considered to be a suitable mechanical specification,

(1) Tape speed $7\frac{1}{2}$ inches per second full track recording.
(2) Total playing time 15 minutes.
(3) Playing time per wind of spring motor not less than 6 minutes.
(4) Spool size 5 inch holding 600 feet.
(5) Wow and flutter not to exceed 0.35 per cent rms total.
(6) Weight not to exceed 20 lbs complete with batteries.
(7) High speed rewind.
(8) Robust construction.

In the design it was decided to make the tape drive mechanism the starting point, and a decision had to be made between a purely mechanical system using a spring motor or an electro-mechanical system using an electric motor and suitable governor. As it was considered essential to keep battery replacement costs low, it was decided to utilise a spring motor in the form of the highly developed double spring phonograph motor as used for many years in acoustic phonographs.

The next step was to design a suitable method of coupling the motor to the capstan and take-up assembly. The first system made up followed conventional practice as shown in Fig. 1. The capstan "A" was fitted directly to the original turntable spindle, it was therefore necessary to choose a capstan diameter to provide the correct tape speed of $7\frac{1}{2}$ inches per second when revolving at the designed speed of 78 rpm.

The capstan diameter was calculated from the following formula

$$D = \frac{TS}{RPS} \times \frac{1}{3.142} \qquad (1)$$

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where

D = capstan diameter in inches
TS = tape speed in inches per second
RPS = capstan speed in revolutions per second

$$D = \frac{7.5 \times 60}{78 \times 3.142} = 1.836 \text{ inches.}$$

This looked good so far, a capstan diameter approaching two inches indicated no trouble with machining or with tape slip.

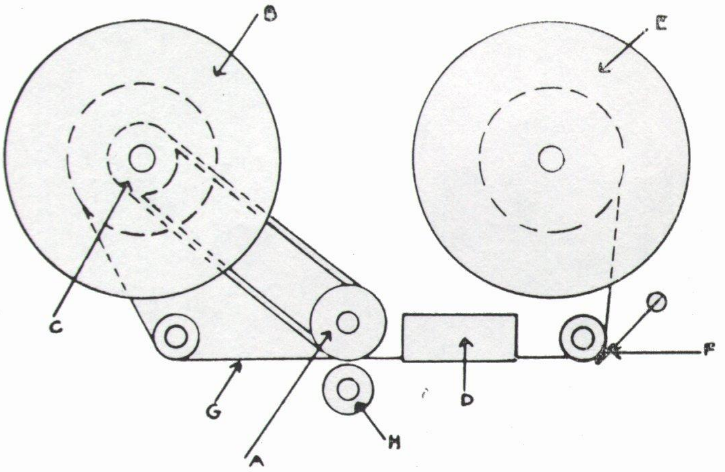


Figure 1.—Original tape driving system. A, capstan; B, take-up spool; C, slipping clutch; D, head assembly; E, supply spool; F, tensioning device; G, tape; H, pinch roller.

The take-up spool " B " was driven by means of a belt and slipping clutch from a pulley mounted integral with the capstan. The head assembly " D " was mounted between the capstan and the supply spool " E " and a constant tensioning device was fitted at " F " to provide approximately constant tape tension throughout the entire spool. A normal pinch roller " H " was used to apply the tape " G " to the capstan.

This system was put on test and the following troubles were experienced.

(1) Flutter from the governor drive gear was very bad at approximately 90 c/s.
(2) Variations of friction in the take-up clutch reacted on the motor governors thus causing random low frequency wow.
(3) When the take-up clutch was set tightly enough to spool the tape satisfactorily the playing time per wind was reduced to around 3 minutes.

Before proceeding further with practical efforts to reduce the wow and flutter some brief references were made to the theory of flywheels.

It was known that the performance of the spring motor was very satisfactory when playing records as the flywheel effect of the 12 inch steel turntable plus the record was sufficient to filter out the gear flutter and to store sufficient energy to eliminate low frequency wow due to variations of the needle drag on the record. It was felt that a somewhat similar amount of stored energy would be required to filter out the variations of tape tension which would be expected to occur.

The kinetic energy of a flywheel may be calculated from the following

$$\text{Kinetic Energy} = \tfrac{1}{2} I\omega^2 \qquad (2)$$

where ω = speed in radians per second
I = moment of inertia

$$\text{moment of inertia of a wheel} = \tfrac{1}{2} MR^2 \qquad (3)$$

Where M = mass
R = radius.

From (2) and (3) it will be seen that the kinetic energy of the flywheel varies directly as the square of the rotational speed and as the square of the radius of the wheel.

As the recorder had to be of small dimensions it was not possible to accommodate a flywheel of a size approaching that of the original turntable so it was decided to instal a wheel of 5 inches diameter fitted with a large section rim to make up as far as possible the loss of kinetic energy due to the reduction of flywheel radius.

The installation of this wheel brought about a partial cure for the troubles but at the expense of a considerable increase in the weight of the complete recorder. The work was carried a stage further by the installation of a mechanical filter consisting of a neoprene coupling between the motor shaft and the flywheel/capstan assembly. The gear flutter was now completely cured, but it was found that the low frequency wow was still present in sufficient quantity to prevent satisfactory recording of music or certain sound effects. In addition it was found that the recorder could not be moved appreciably during recording without the inertia of the heavy flywheel reacting on the motor governors and causing violent speed variations.

Further difficulties were encountered with the manual tape rewind mechanism which had to engage with the appropriate spool, release the pressure roller from the capstan and release the clutch tension on the take-up spool. The provision of all these mechanical functions proved to be somewhat complicated and expensive, and added considerable weight.

Progress so far indicated that further development along these lines was not justified, and an alternative tape drive system was worked out and made up for test.

The work done so far plainly showed the need for a flywheel which would store sufficient energy without being large and heavy. Further reference to equations (2) and (3) provided the answer, by increasing the rotational speed of the flywheel the stored energy could be greatly increased and the physical size and weight correspondingly reduced, with the added advantage that the machine would be less sensitive to external movements.

The next step was to evolve some means of revolving the flywheel at a high speed without the introduction of additional gearing to cause losses and flutter troubles. This was achieved by a complete reversal of normal practice in that the tape was made to drive the capstan instead of the latter driving the tape as in normal practice.

The operation of the system was very simple (Fig. 2); the take-up spool " A " was driven via a belt from a pulley on the motor spindle " C," thus placing a tension in the tape " G " which is held against the capstan " E " by the pinch roller " F " thus causing the capstan to revolve at a speed determined by the governor and flywheel to which it was directly coupled. The record and playback head assembly was now situated at " D."

A study of the system showed it to possess several advantages over the original system as follows

(1) Small flywheel revolving at 1000 rpm; advantages already explained.
(2) Full torque of motor was available to wind tape on take-up spool. This completely eliminated loose spooling and spilling of tape.
(3) No slipping clutch needed.
(4) Section of tape between take-up spool and capstan carried ample tension at all times to provide good head contact without recourse to additional tensioning devices which would cause further losses and a consequent loss of playing time.
(5) High speed forward motion of the tape was instantly available by releasing the pressure roller from the capstan and high speed rewind by unthreading and changing the spools over.

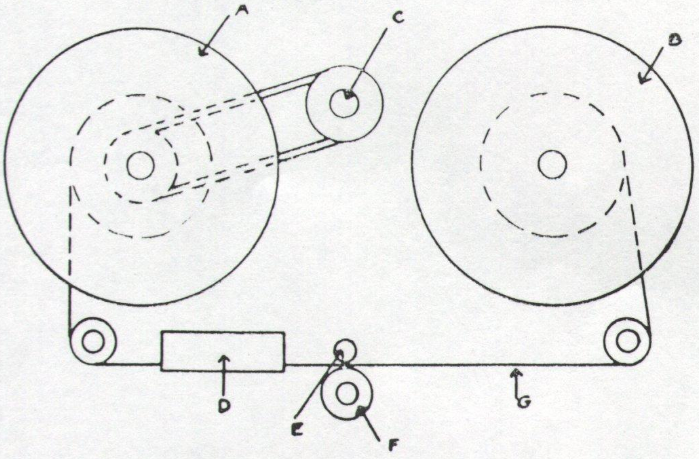


Figure 2.—Modified tape driving system. A, take-up spool; B, supply spool; C, motor spindle; D, head assembly; E, capstan; F, pinch roller; G, tape.

The latter point was considered to be a definite drawback but of less evil than the complication and expense of a separate manual rewind system. It was also felt that most "on the spot" recordings for broadcasts would be taken back to the studio for rewind and editing if required.

In the practical application of the idea the first point to be decided was the rotational speed of the capstan assembly, the object being to utilise the original governors from the spring motor which were designed to run at 1300 rpm. Calculation from equation (1) showed that the capstan diameter for this speed to be inconveniently small and the problem of machining such a capstan to the required standard of accuracy to be too difficult. A compromise was made for a speed of 1000 rpm giving a capstan diameter of 0.143 inches still rather small but within reason.

It was realised from the start that friction in the capstan bearings would be a problem, and this proved to be the case. Ball races were absolutely essential, and careful selection and fitting of the races was necessary.

Difficulty was also experienced with tape slip on the small capstan and quite high pinch roller pressures had to be used. It was also found that considerable losses occurred in the pinch roller tyre and some form of servo mechanism appeared desirable, arranged in such a way that the pinch roller pressure was controlled by the tape tension itself. In this way the pressure could be made high when the tape tension was high such as occurred when the motor was fully wound and the take-up spool empty, similarly the pressure would be low when the tape tension was low.

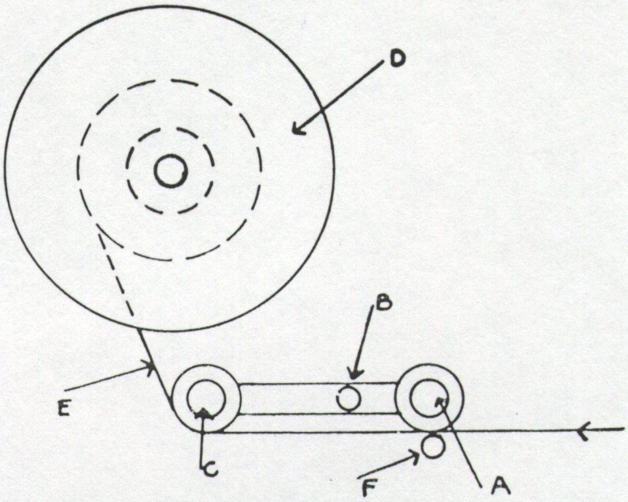


Figure 3.—Mechanism for providing pinch roller pressure proportional to tape tension. A, pinch roller; B, pivot; C, guide roller; D, take-up spool; E, tape; F, capstan.

Fig. 3 illustrates one suitable servo arrangement where the pinch roller "A" is carried on one end of an arm pivoted at "B," a guide roller "C" is mounted at the other end of the arm and the tape "E" passes over this as it comes from the take-up spool "D." The capstan is at "F."

Another arrangement is shown in Fig. 4 in which the pinch roller "A" is allowed to float between the idler roller "B" and the capstan "C." The tape "E," guide roller "F" and take-up spool "D" being arranged as in normal practice. Operation of this system depends on the tape tension wedging the pinch roller between the capstan and idler roller.

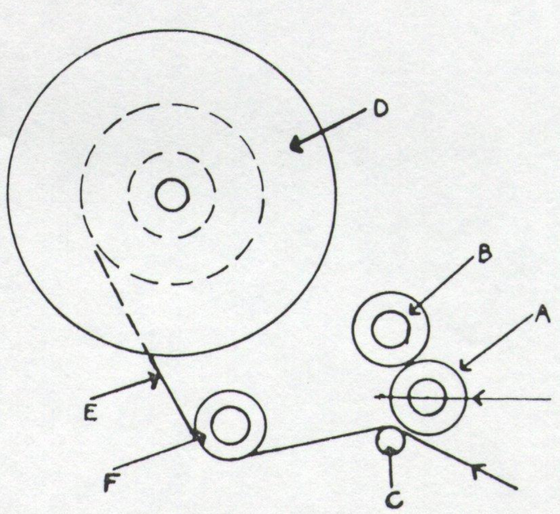


Figure 4.—An alternative mechanism making pinch roller pressure proportional to tape tension. A, pinch roller; B, idler roller; C, capstan; D, take-up spool; E, tape; F, guide roller.

After fitting the arrangement shown in Fig. 3 the mechanical losses of the tape mechanism were quite low and a playing time of 7-8 minutes could be had per wind of the spring motor. Some tests made on the prototype showed results satisfactory for the class of work for which the machine was intended, the rms total of wow and flutter was around 0.3 per cent and the long term speed variation better than + or − 2 per cent.

Some form of indication of the necessity to rewind the motor before the speed dropped was found desirable and a great deal of thought was put into this before a successful system was evolved. Several methods of indication were possible, both visual and aural, and it was decided that an aural warning in the form of a " buzz " in the monitoring headphone would be the better.

The mechanical portion of the system was operated from the torque of the main spring in the following manner. The main drive pinion bearing of the motor was removed from the motor frame and fitted to a pivoted lever which was allowed a very small movement (insufficient to upset the meshing of the gears), the lever was then spring loaded and arranged to operate a microswitch when the main spring torque dropped below that required to balance the spring tension on the lever.

The final mechanical design of the recorder consisted of details such as layout, position of controls, etc. The more important controls such as " start stop " lever, gain, winding handle were located in the ends of the machine to allow operation with the lid closed.

Fig. 5 will make clear the layout where the spool hubs are shown at " A," tape guide rollers at " B," the capstan at " C," pinch roller at " D," heads at " E," record/play and meter switches at " F," amplifier gain, start stop lever, microphone and headphone sockets at " G," microphone compartment at " H," level indicator at " I " and the winding handle on the end of the case at " J." The batteries were mounted on a removable panel in the bottom of the case. A removable lid with an observation panel was provided to cover the tape deck.

Due to the necessity for accurate alignment of the heads etc., it was decided to use an aluminium casting for the deck assembly, suitable brackets being provided to support the amplifiers, etc., as sub assemblies. The complete assembly was then arranged to fit into a light plastic covered plywood carrying case fitted with carrying handle and webbing shoulder strap for use when making recordings while standing or walking.

To sum up the mechanical features it was felt that a design had been evolved, which was simple, reliable, light in weight, cheap to produce, and capable of satisfactory performance in the field for which it was intended.

3. Electrical Design

The electrical design was taken as a completely separate problem and the requirements for this section were set down as for the mechanical section. The following was considered to be a suitable electrical specification:

(1) Frequency response 50-7000 c/s + or − 2 db when replayed on typical professional studio recorder.
(2) Distortion not to exceed 3 per cent at 1000 c/s at full recording level when replayed as in (a).
(3) Signal to noise ratio not less than 40 db below full recording level measured at 1000 c/s when replayed as in (b).
(4) HF erasure.
(5) Sufficient gain to allow operation from 50 ohm high quality microphone at −70 dbm.
(6) Separate replay head and amplifier to allow monitoring from tape while recording.
(7) Aural warning for motor rewind.
(8) HT voltage not to exceed 135 volts, LT 1.5 volts.
(9) Battery drain not to exceed 12 ma HT and 450 ma LT.
(10) Preferred tube types.
(11) Good accessibility to components.
(12) Level indicator and battery test.

In making a tentative design for the amplifier it was thought best to follow common practice in mains operated

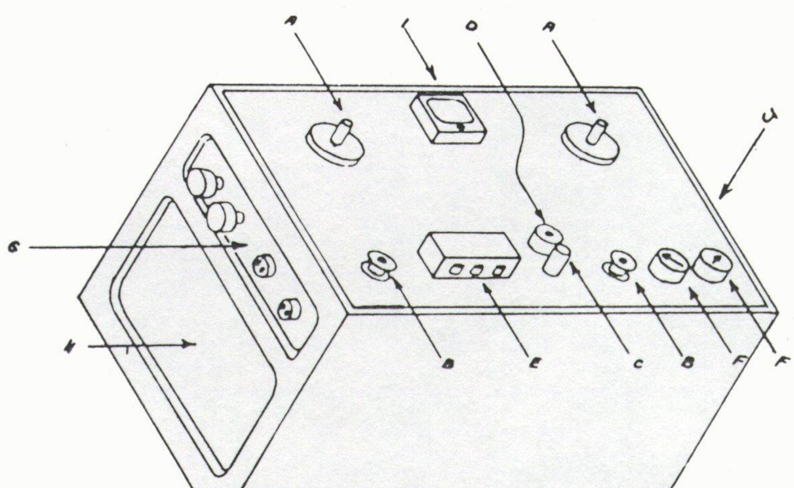


Figure 5.—Final layout. A, spool hubs; B, tape guide rollers; C, capstan; D, pinch roller; E, head assembly; F, record-play and meter switches; G, controls; H, microphone compartment; I, level indicator; J, winding handle.

recorders whereby the high frequency equalisation was obtained from a tuned circuit in the plate load of the first stage of a three stage amplifier. The recording head was to be fed via a constant current resistor from the pentode output stage, inverse feedback to be applied over the last stage.

This amplifier was made up for test, tapes were recorded and checked against calibrated test tapes, it being found comparatively easy to meet the frequency response and distortion requirements. However the signal to noise ratio was poor owing to microphony of the first and second stages. Shock mount type sockets were fitted and this trouble cleared up, the signal to noise ratio then being around —43 db. The gain of the amplifier was insufficient due to the combined losses of the equaliser and feedback network. The amplifier in this form was rather complicated, containing the equaliser tuned circuit, feedback loop components and a bias trap circuit in the record head coupling circuit.

During these experiments earlier fears about the power requirements of the bias oscillator were borne out, it was found necessary to use 180 volts of HT and a drain of around 15 ma to provide adequate HF bias for a normal mu metal recording head and high coercivity tape.

Before going further with the project it was decided to investigate the use of the ferrite materials as a core material for the record head, and some experimental heads were made up. Great difficulty was found in lapping and assembling the heads, but finally these troubles were overcome and more tests were made on the recorder.

The results as far as efficiency at the bias frequency was concerned, were quite surprising, as the optimum bias could now be obtained with an oscillator input of 90 volts at 3.5 ma. The results were quite similar in other respects to the mu metal head except that the high frequency recording losses (above 5 kc/s) were somewhat greater due to a less perfect gap edge than that on the mu metal head; however, by adjusting the equalising circuit the specification could be met.

During the research work on the record head considerable time was saved by establishing the relationship between the impedance Z and the number of turns T. The relationship was found to be approximately $Z = T^2/100$ at the highest recorded frequency of 8 kc/s. A constant current resistor of five times the head impedance at 8 kc/s was chosen and the value of the resistor made to equal the proper load resistance for the 3V4 tube. This ensured that the tube was operating into its correct load at the lowest frequency, where the head impedance dropped to a low value.

It was also found that due to the decreased losses of the ferrite cores at high frequencies the head windings showed higher value of Q and could be tuned quite sharply at both the bias frequency and high audio frequencies. This led to an investigation on the possibility of obtaining the necessary high frequency equalisation by resonating the record head at the highest recorded frequency of 8 kc/s.

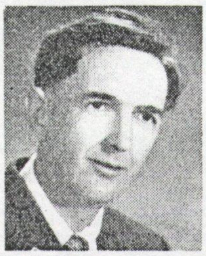
The Authors:

William Rupert Nicholas was born at Hobart, Tasmania on November 16, 1913, and educated at the Friend's High School, Hobart.

He joined the staff of Findlays Pty. Ltd. in 1930, and also acted as Junior Engineer to Broadcasting Station 7HO. He was appointed Chief Engineer to 7HO in 1935, and resigned in September 1939.

In January 1940, Mr. Nicholas became Chief Engineer of Broadcasting Station 7HT, resigning in 1951 to join Commonwealth Electronics Pty. Ltd. as Chief Mechanical Engineer.

Mr. Nicholas is a Member of The Institution of Radio Engineers Australia.



Athol David Hildyard was born at Hobart, Tasmania on June 21, 1919, and educated at the Hobart Technical College.

He joined the staff of Oldham, Beddome & Meredith Pty. Ltd., Radio Department, in 1936 and resigned to become Junior Engineer of Broadcasting Station 7HT in 1938. He was promoted to Technician in 1939 and joined the R.A.A.F. in 1942 as Radar Technician.

Mr. Hildyard returned to 7HT in 1946, and was appointed Chief Engineer in 1951, from which position he resigned to join Commonwealth Electronics Pty. Ltd. as Design Engineer.

A new amplifier was designed with this idea in view using preferred type tubes in the 1.4 volt series. A 1S5 pentode in the first stage was resistance capacity coupled to a similar tube as a triode in the second stage, the latter also resistance capacity coupled to the last stage using a type 3V4.

Fig. 6 is a schematic of the head coupling system. The output stage V_3 has a conventional plate load resistor R_1, and coupling condenser C_1. Audio is fed to the record head RH via the constant current resistor R_2. The number of turns on the secondary of the oscillator coil L_1 was chosen to provide a little over the optimum bias required, final adjustment being obtained by varying the oscillator HT voltage.

The condenser C_2 serves the dual purpose of bringing the junction of the constant current resistor R_2 and the record head to ground potential at the bias frequency of 50 kc/s, thus preventing the 50 kc/s component from appearing at the anode of V_3. The value of C_2 was chosen to resonate the record head plus the oscillator coil secondary at the highest recorded frequency of 8 kc/s. Due to the comparatively high Q of the record head and oscillator coil combination quite a spectacular rise in head current was achieved at resonance and the equalisation so gained was not at the expense of amplifier gain as in the first system tried.

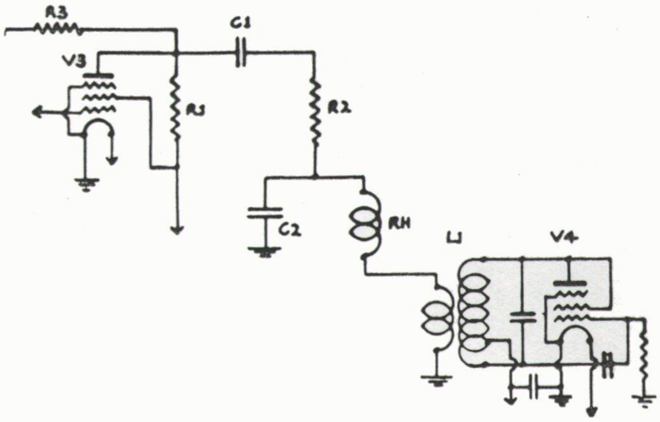


Figure 6.—*Record head coupling circuit.*

In order to provide some control of the degree of equalisation a feedback resistor R_3 was added from the anode of V_3 to the anode of the second stage, this was found to give excellent control of the resonant peak at 8 kc/s. The oscillator V_4 was designed as a conventional Hartley circuit also using a 3V4 tube the various values being selected to give a good bias wave form.

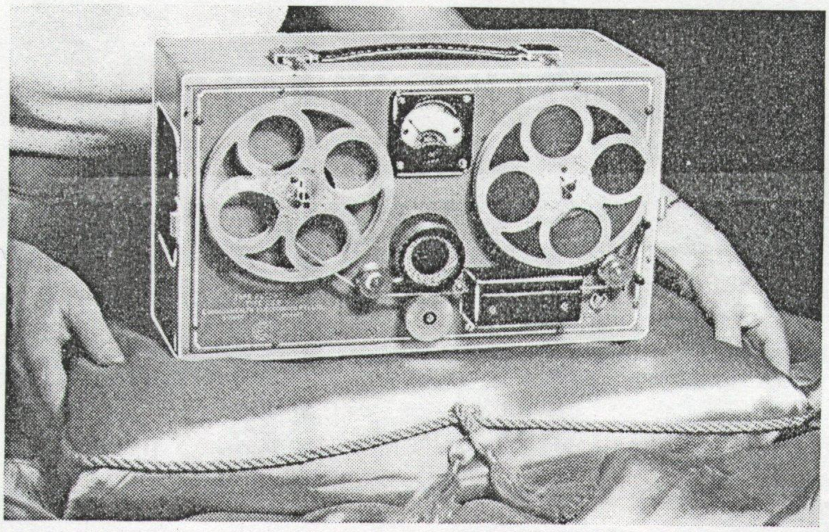
As mentioned previously, a separate playback head and amplifier were provided, the amplifier consisting of a pentode connected 1S5 resistance capacity coupled to a second 1S5 as a triode feeding the monitoring headphone. This amplifier also provided the " buzz " for the rewind indication, positive feedback being applied to the screen of the first stage via the microswitch operated from the main spring as described earlier in the mechanical section.

A small 0-100 microamp meter was provided to read recording level and HT and LT battery voltages, the various functions being selected by a rotary switch on the tape deck. The recording amplifier and bias oscillator was designed as one subassembly and the monitoring amplifier as another, both units being screwed to the side of the aluminium tape-deck casting in such a position that all components were accessible when the recorder was withdrawn from the case.

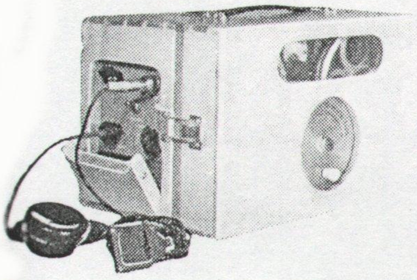
COMMONWEALTH ELECTRONICS PTY. LTD.

present a Professional

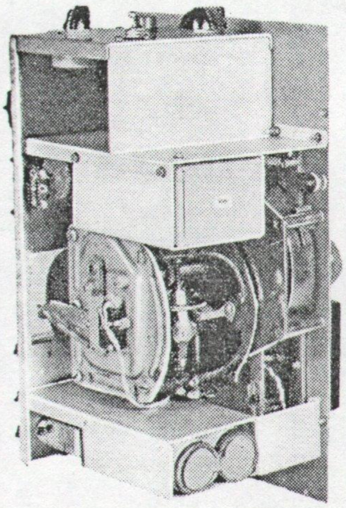
Miniature BATTERY TAPE RECORDER



THE TYPE CEB.



COMPLETE FOR INSTANT OPERATION



EQUIPPED WITH STURDY SPRING MOTOR.

CHECK THESE FEATURES . . .

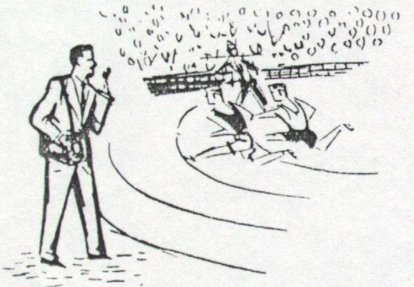
★ Size 13½″ X 8½″ X 8¼″ H (inc. all accessories)
★ Weight 25 lbs. (inc. all accessories.)
★ Exclusive Ferroxcube heads with Azimuth Adjustments.
★ Separate Recording & Monitoring/Playback Channels.
★ Spring Motor Drive with 6 min. Running Time.
★ Motor Rewind Alarm.
★ Combined Recording Level Meter & Multimeter.
★ Stroboscopic Speed Check.
★ High-Speed Tape Rewind.
★ Operates in any Position.
★ Battery Complement, one type 490P, two type 701.

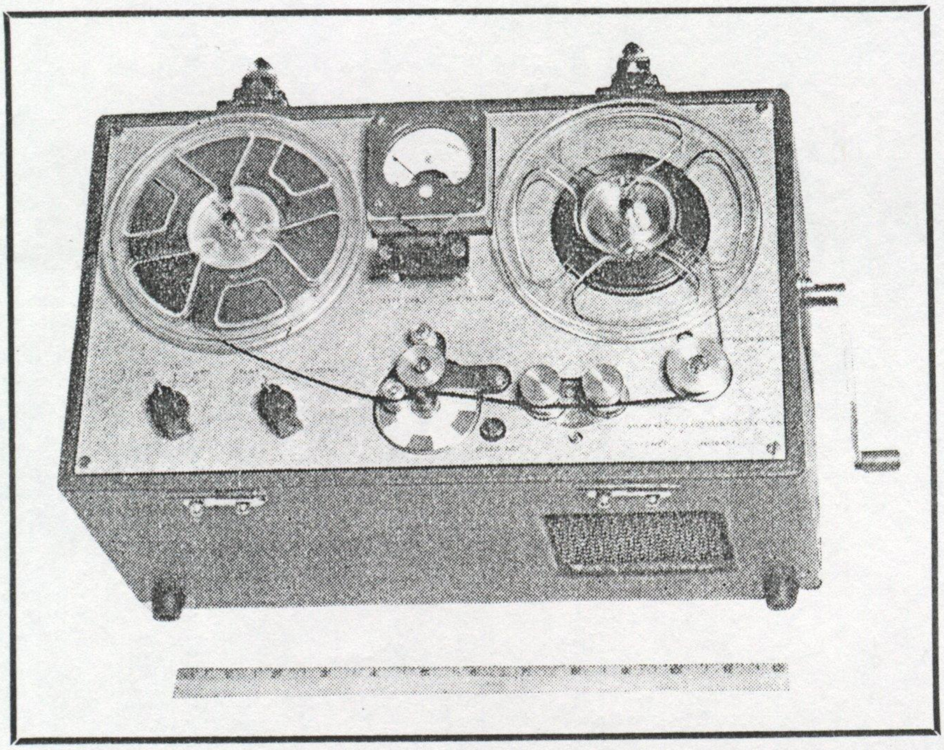
CHECK THIS PERFORMANCE . . .

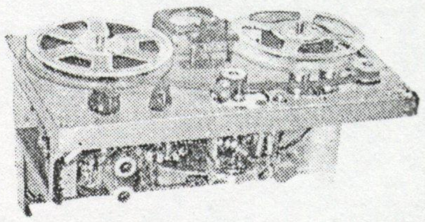
★ Battery Life 50 hours, Intermittent Operation.
★ Frequency Response— ± 2 db, 50 to 7000 c.p.s.
★ Distortion 1000 c.p.s.— Better than 3%
★ Signal to Noise Ratio— Better than — 40 db.

FOR FURTHER DETAILS WRITE TO—
BOX 1647 G.P.O. SYDNEY, N.S.W.

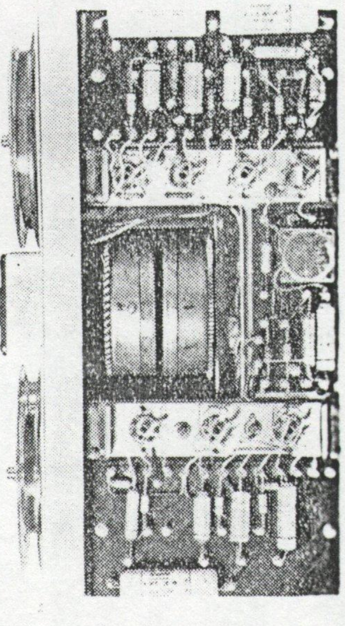
COMMONWEALTH ELECTRONICS PTY. LTD.
N.S.W.: JAMES ST., BAULKHAM HILLS.
TAS.: DERWENT PARK ANNEXE, HOBART.







SHOCK MOUNTED VALVE CHASSIS



EQUIPPED WITH STURDY 2 SPRING DRIVE MOTOR