SERVICE CASEBOOK

How often, when you finish a repair, do you think "Well, I'm wiser now than when I started?" Those are the times to write a Casebook item—briefly please, one side of the paper only—and post to the Technical Editor

PHILIPS 663A

CUSTOMER stated picture was breaking up after set had been in operation two hours. Arranged visit for afternoon transmission of same day and requested customer to switch on set three hours before appointment.

On arrival found picture breaking up due to sound on sync. with sound also modulating the video signals. Removed back and small metal screen adjacent to ECH35 frequency changer and retrimmed sound rejector with resultant improvement in picture.

Having experienced trouble in the past with Philips type small ceramic pF condensers, I replaced the capacitor in sound rejector circuit and finally retrimmed which cleared the fault. Evidently heat was responsible for the change in capacitance of the faulty component and on breaking it open, I found a thin film of foil curled up in the centre.—R. H. S.

MURPHY A56V RF RADIATION

THE oscillator section was found to be producing RF radiation patterns together with a strong audio beat in neighbouring television receivers. The video patterns were weak and produced a type of mosaic effect on the picture. The audio note—sounding rather like mains hum—was strong enough to be heard above the sound signal. Sound and vision signals on the offending receiver were normal.

The A56V employs a ACTH1 frequency changer (V2). Complete screening of the oscillator section was indicated. Any attempt to cure the radiation by rough screening over the oscillator coil itself was useless.

A "tailor made" aluminium screening section, having a removable top to allow service access, was carefully fitted to enclose all components embodied in the oscillator circuit *including* the ACTH1 valve holder. This modification effected a complete cure.—J.N.R.

BUZZING BATTERY SET

A PYE four-valve battery superhet was brought in with the complaint of "buzzing." On test, the receiver behaved perfectly for several hours, so it was decided to return it to the customer and hear it on his premises, with a view of checking his batteries, aerial, and earth.

When connected up at his house and switched on, there was nothing but a rapid "motor-boating" which continued when the aerial and the earth were removed. The set was once more brought to the workshop, this time with the batteries as well. When tested again it was found that the "motor-boating" only occurred when the customers HT battery was used, and the receiver was normal on HT batteries of higher and lower voltages. Valves were substituted and voltages were checked but everything seemed in order, so it was thought that there must be some remote fault with the battery. The receiver was returned with a new HT battery and worked perfectly.

About two months later it was brought back with exactly the same complaint, and it behaved as before when tried with various batteries. It couldn't be the battery that was at fault after all, so a detailed check was carried out.

It was noticed there was an unused condenser clip on the chassis, and the remains of "snipped" leads showed that there had been an electrolytic in the HT line sometime.

An 8 mF unit was connected across the line and immediately the "motor-boating" stopped. Lack of smoothing had been the cause of the trouble, but the mystery was why it only started when the HT battery reached a certain state!—J. C. Hall.

DOUBLE-DECCA

A DOUBLE-DECCA was working on batteries, but after operating for 10-15 minutes on AC mains it would fade out. The metal rectifier showed signs of over-heating, and a 200 ohm, 5W surge resistor directly after this on the DC side, was also getting hot.

All dropping resistors were of the correct value, and there appeared to be no over-loading.

Altering the position of the surge resistor to the AC side of the rectifier cured the trouble.—J. C. Hall.

EKCO AC86

AN Ekco AC86 gave excellent results on the medium waveband but on long waves, the Droitwich transmitter was always accompanied by a low frequency note if the volume control was advanced to any degree. The effect was somewhat similar to modulation hum but was deeper in tone and rather more unpleasant.

As the effect was not evident on MW we naturally first directed attention to the FC4 frequency-changer stage, paying particular attention to the various decoupling condensers. All however were without fault; the voltages applied to the valve were correct and the valve itself was perfect.

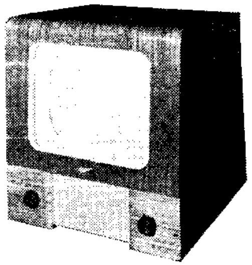
We have known AVC circuit faults to produce some queer effects at times so we checked that the AVC feed resistors were not o/c and that the de-coupling condensers were in order. Although the speaker hum ripple was scarcely audible we paralleled a good 8mfd electrolytic across each of the receiver's main condensers in turn "just in case" but the effect persisted.

Ultimately we paralleled a new 25mF 25V unit across the similar one that decoupled the auto-bias resistor of the output pentode valve—and were immediately rewarded with the disappearance of the low pitched note.

We can only conclude that the effect was confined to the Droitwich transmitter for two reasons, (*a*) this station provides a particularly strong signal in this area, and (*b*) some percentage of the 200 kc/s signal had managed to persist through to the output valve.

In many receivers there are comparatively strong RF currents in the output stage, or grid stoppers would not be required, but this is the first time we have known them produce this low pitched note.—G.R.W.

MARCONIPHONE VT55A, VC55A, VT75A, VC75A,



Fourteen-valve television receiver fitted with a 12-in. CRT giving a 10 by 7¼in. picture. Models VT55A (London frequencies) and VT75A (Midlands frequencies) are housed in a walnut veneered table cabinet and models VC55A (VC75A) in a console cabinet. Suitable for 195 to 225V 50c/s AC, the sets are distributed by EMI Sales and Service, Ltd., Hayes, Middlesex (service department, Sheraton Works, Wadsworth Road, Greenford, Middlesex).

THE receivers employ a superheterodyne circuit operating on lower sideband of vision carrier. RF amplifier V1, frequency-changer V2 and first IF amplifier V3 are common to both vision and sound frequencies. Vision interference and sound noise suppression circuits are incorporated. EHT is obtained from line flyback pulses.

Input circuit is designed for 75-80 ohm co-axial feeder with outer screening coupled to chassis through C2. Inner conductor of feeder is coupled to input coil L1 through isolating capacitor C1.

Attenuator. A tag strip with removable screening cover is provided in an accessible position on rear of chassis to enable an attenuator to be fitted when receiver is operated in high signal strength areas. Normally the aerial socket is wired direct through the tag panel to tap on input coil L1. When attenuation is necessary then R1, R2, R3 can be soldered in position on tag strip. Values of these resistors depend on attenuation required.

Aerial signal is coupled by RFT1 to grid of RF amplifier V1 in the cathode of which is RF **Gain** control VR1. R5, which is not decoupled, provides compensation for changes in input capacity with variation of gain. Amplified signal at anode V1 is coupled by single-peak transformer RFT2 to grid of frequency-changer V2. Secondary L3 of RFT2 is damped by R7 to maintain wide band-width to cover both vision and sound frequencies.

Frequency-changer is V2 operated as a combined oscillator and mixer. The screen (g2) and control grid (g1) form a triode oscillator, the oscillatory tuned circuit L4, C6, C7 being connected in the screen or oscillator anode circuit. Automatic bias for oscillator grid is developed on C5 with R8 as leak. The RF signals applied through C5 to g1 are mixed with oscillator signal and the resultant IF of 14mc/s (mean) vision and 10.5mc/s sound are developed on L5 in the anode circuit.

IF signals at anode of frequency-changer V2 are capacitively coupled by C9 to common vision and sound IF amplifier V3 in the cathode of which is **Contrast** control VR2. R12 provides compensation for changes in input capacity with variation of gain. Damping to maintain bandwidth is provided by shunt effect of low-value grid resistor R11.

Vision channel. Separation of vision and sound IF signals is carried out in anode circuit of V3. The vision signal is bandpass transformer coupled by IFT2 to a further IF amplifier V4 which in turn is bandpass transformer coupled by IFT3 to vision signal rectifier V5A. Sound-on-vision rejection is given by IFT4 in anode V3 and by L10, C14, in cathode of V4.

Rectified signal developed across R19, R20 is fed through IF filter and frequency correcting network L14, R23, C17, C20 to grid of video amplifier V6, the output of which is DC coupled through "anti-flutter" filter R25, C19, to cathode of CRT.

Interference limiter is diode V5B. Resistors R21, R22, R24 are connected from anode of video amplifier V6 to chassis through C18. The diode is across the resistors with its anode down to C18. C18 charges to average picture signal level. When a high frequency interference pulse arrives, due to the relatively long time constant of the resistance-condenser network, the diode cathode becomes negative to its cathode and anode of V6 is momentarily connected to chassis via C18.

Three choices of load are provided and switched by **Picture tone** switch S2 to allow suppression to be adjusted to suit local conditions.

Sound channel. Sound signal is taken from anode of common IF amplifier V3 and fed by C12 to L6 in grid circuit of sound IF valve V10. Amplified signal is bandpass transformer coupled by IFT5 to signal rectifier V11A.

The rectified signal is developed across R46, C36 and fed by C37 through noise suppressor diode V11B and C38 and RF filter R49, C39, C40 to **Volume control** in grid circuit of beam-tetrode output amplifier V12, the audio output of which is transformer fed by OP1 to a 6½ or 10½in. energised speaker L28.

Noise suppressor. Anode of diode V11B is positively biased from HT line through R47 and conducts, setting up a voltage across R48 in its cathode. The time constant of R48, C38, C39 is such that voltage across R48 follows that of the audio signal fed to it through C37 and V11B. When a large-amplitude high-frequency interference pulse appears due to comparatively long time constant of R48, C38, C39, the cathode of V11B remains unchanged, although the anode goes negative. The diode cuts-off thus removing interference pulse.

Sync separator. Video signal at anode of V6 is fed through R28, C22 to sync separator V7. The positive sync pulses drive V7 into grid current which sets up a bias across R29 sufficient to place the negative picture signal beyond cut-off. Anode and screen voltages of V7 are kept low to give a short grid base to ensure sync separation on weak signals.

Negative frame sync pulses are developed across

R34, C24 and fed by C25 to grid of V13A, the first section of twin triode multivibrator frame scan oscillator.

Negative line sync pulses are developed across R32 and fed by C27 to screen of line oscillator and output amplifier V8.

Frame scan is generated by a double-triode V13 connected as a multivibrator oscillator. Scan voltage is developed on C47. Adjustment of grid circuit time constant by VR7 gives **Frame hold.**

Frame amplifier. Scan voltage developed on C47 is applied to a waveform correcting network consisting of R59, VR8, R60, C48, and then tapped from **Height** control VR8, and fed to grid of triode amplifier V14. Amplified scanning voltage at its anode is transformer coupled by FT1 to low-impedance frame deflector coils L20 on neck of CRT. Linearity of frame scan voltage is adjusted by variation of cathode bias of V14 by VR9, the **Frame linearity** control.

Line oscillations which appear on frame coils due to mutual inductance are damped by R62.

Frame shift. One end of frame deflector coil L20 is connected to centre tap on potentiometer VR11 in the negative HT return lead to chassis and the other end is connected through secondary L30 of FT1 to slider of VR11. By adjustment of slider of VR11 the DC voltage applied in series with deflector coils can be varied and its polarity reversed. The DC magnetic field produced in deflector coil by this voltage enables the beam to be displaced by an amount sufficient to centre the frame in tube mask.

Line scan waveform is generated by pentode V9 which operates as a combined oscillator and amplifier. The valve is caused to oscillate by positive feedback which is obtained from secondary winding L24, L25 of line output transformer LT1 in the anode, and which is applied to grid through C30. Frequency of oscillation is adjusted by variation of grid circuit time constant by VR4 the **Line hold.**

Output waveform is developed across primary L21 of LT1 and fed by secondary L24, L25 through adjustable **Width control** inductance L15B to line deflector coil L19 on neck of CRT. Width control consists of two equal coils with a common adjustable iron dust core. Adjustment of the core results in a differential change of inductance in the two coils. One of the coils L15B is in series with the line deflector coil L19—the other is shunted across section L25 of output secondary of LT1. Thus a change of loading due to adjustment of core of L15A is balanced by opposite change by L15B and transformer loading is maintained approximately constant.

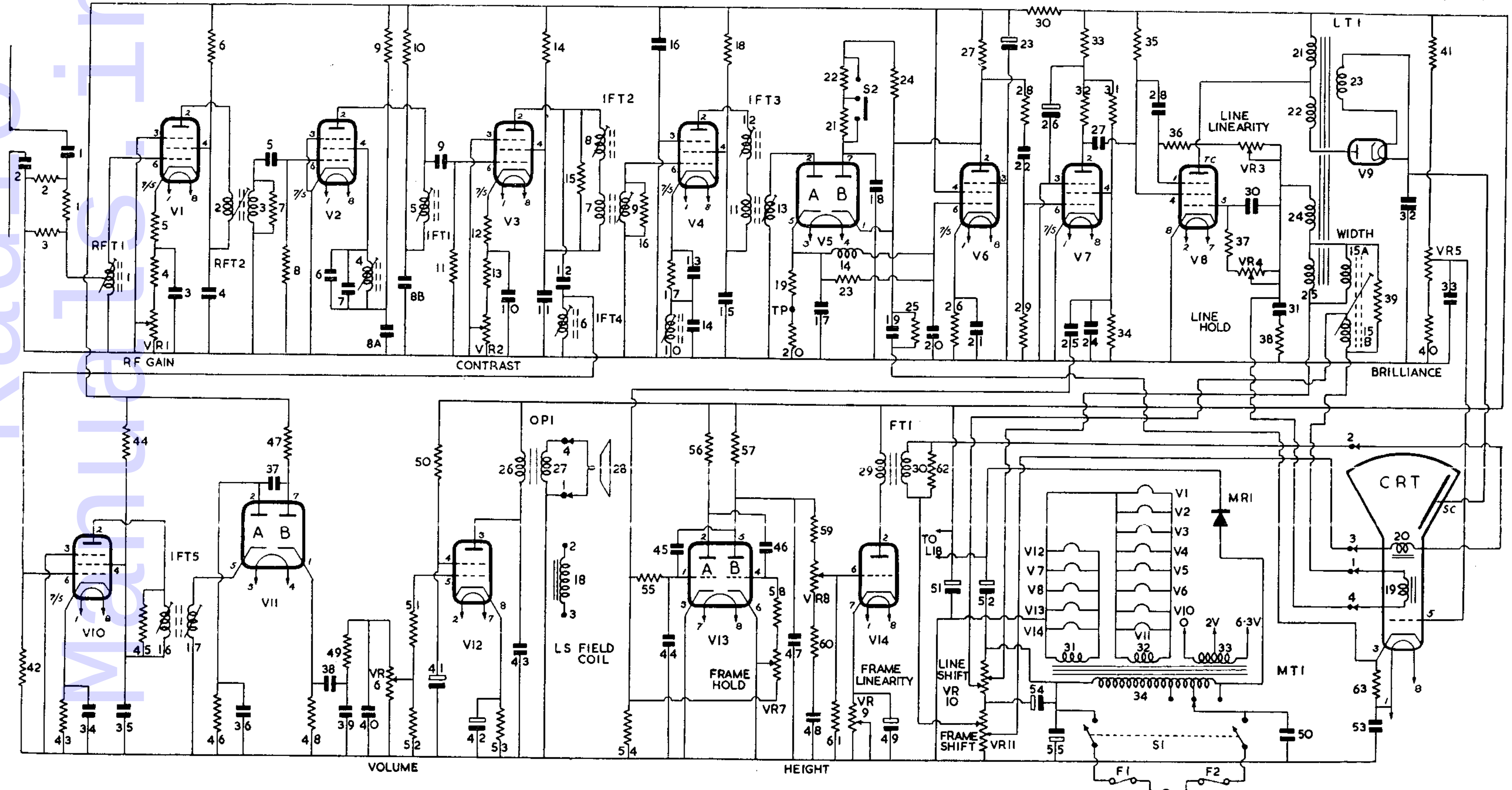
Line linearity is adjusted by VR3.

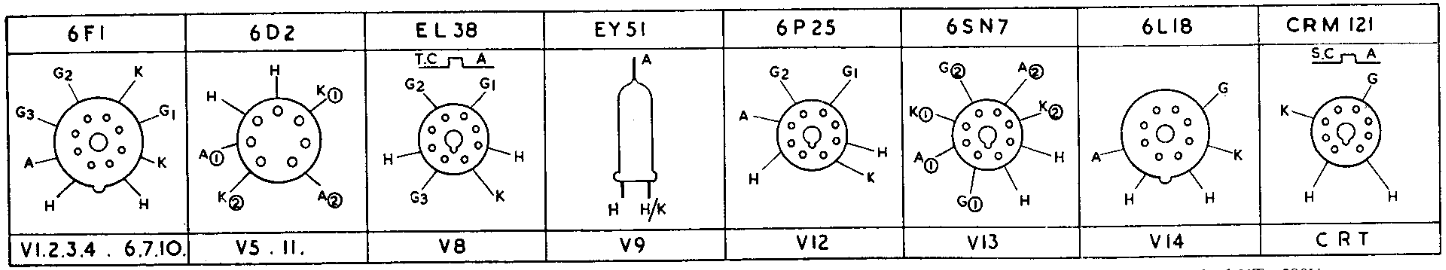
Line shift. One end of line deflector coil L19 is connected to centre tap on potentiometer VR10

Continued on page 32

CAPACITORS

C	*Capacity*	*Type*
1	100pF	Tub. Ceramic
2	.005	Tubular 1000V
3	1000pF	Tub. Ceramic
4	1000pF	Tub. Ceramic
5	100pF	Tub. Ceramic
6	15pF	Tub. Ceramic
7	30pF	Silver Mica
8A	.005	Tubular 500V
8B	.005	Tubular 500V
9	100pF	Tub. Ceramic
10	.005	Tubular 500V
11	.005	Tubular 500V
12	2pF	Tub. Ceramic
13	.005	Tubular 500V
14	800pF (250+550)	Silver Mica
15	.005	Tubular 500V
16	.05	Tubular 500V
17	5pF	Tub. Ceramic
18	.05	Tubular 500V
19	.1	Tubular 150V
20	5pF	Tub. Ceramic
21	750pF	Mica
22	.1	Tubular 350V
23	16	Electrolytic 350V
24	.005	Tubular 1000V
25	.05	Tubular 350V
26	16	Electrolytic 350V
27	200pF	Silver Mica
28	300pF	Mica
29	100	Electrolytic 50V
30	.25	Tubular 350V
31	.002	Tubular 1000V
32	.001	'Visconol' 12.5KV
33	.05	Tubular 350V
34	.005	Tubular 1000V
35	.005	Tubular 1000V
36	50pF	Tub. Ceramic
37	.01	Tubular 500V
38	.01	Tubular 500V





VOLTAGE READINGS

V	Type	A	G2	K	
1	6F1	210–240	210–240	2–5	VR1 Min. to Max.
2	6F1	236	80	0	
3	6F1	210–240	210–240	2–5	VR1 Min. to Max.
4	6F1	225	225	2.2	
5A	6D2	0	—	0	S2 Operated
5B	6D2	60 25-10	—	190	S2 Operated
6	6F1	190	240	3.2	
7	6F1	140	60	0	
8	EL38	—	70	0	
9	EY51	—	—	7.5kV	
10	6F1	225	225	2	
11A	6D2	—	—	—	
11B	6D2	40	—	40	
12	6P25	260	200	6.5	
13A	6SN7	55	—	0	
13B	6SN7	15	—	0	
14	6L18	235	—	0–50	VR9 Min. to Max.
CRT	CRM121	7.5kV	—	125	

Unsmoothed HT = 290V
Smoothed HT = 275V
Total HT Current = 225mA
HF Unit only = 55mA

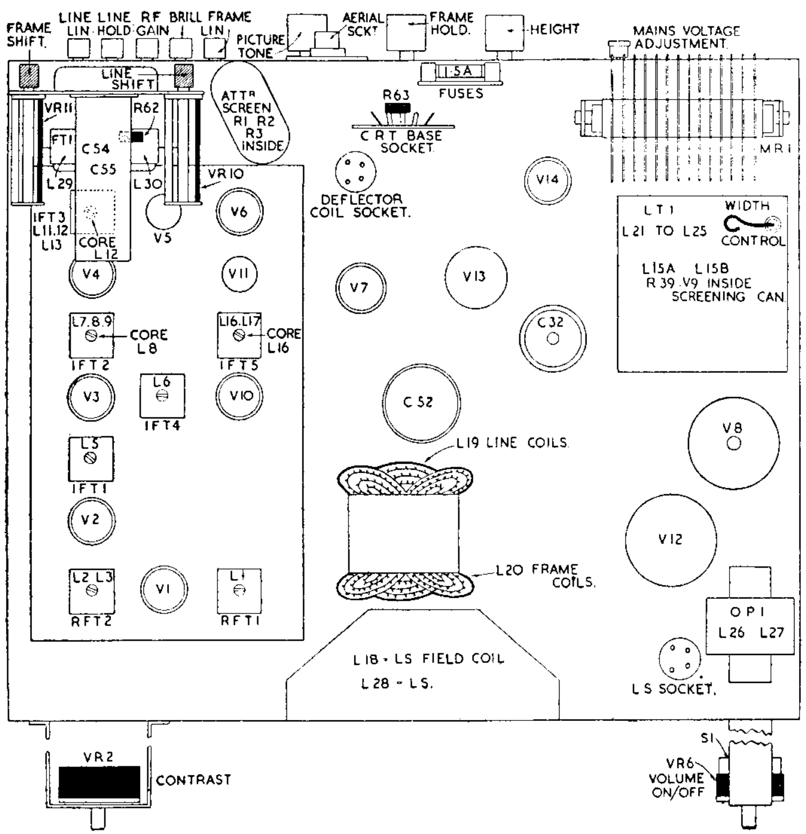
C	Capacity	Type
39	500pF	Mica
40	500pF	Mica
41	16	Electrolytic 350V
42	25	Electrolytic 12V
43	.002	Tubular 1000V
44	.002	Tubular 1000V
45	500pF	Mica
46	.05	Tubular 350V
47	.05	Tubular 500V
48	.02	Tubular 750V
49	100	Electrolytic 100V
50	.01	Tubular 750V
51	100	Electrolytic 275V
52	60	Electrolytic 350V
53	.1	Tubular 350V
54	1000	Electrolytic 6V
55	1000	Electrolytic 6V

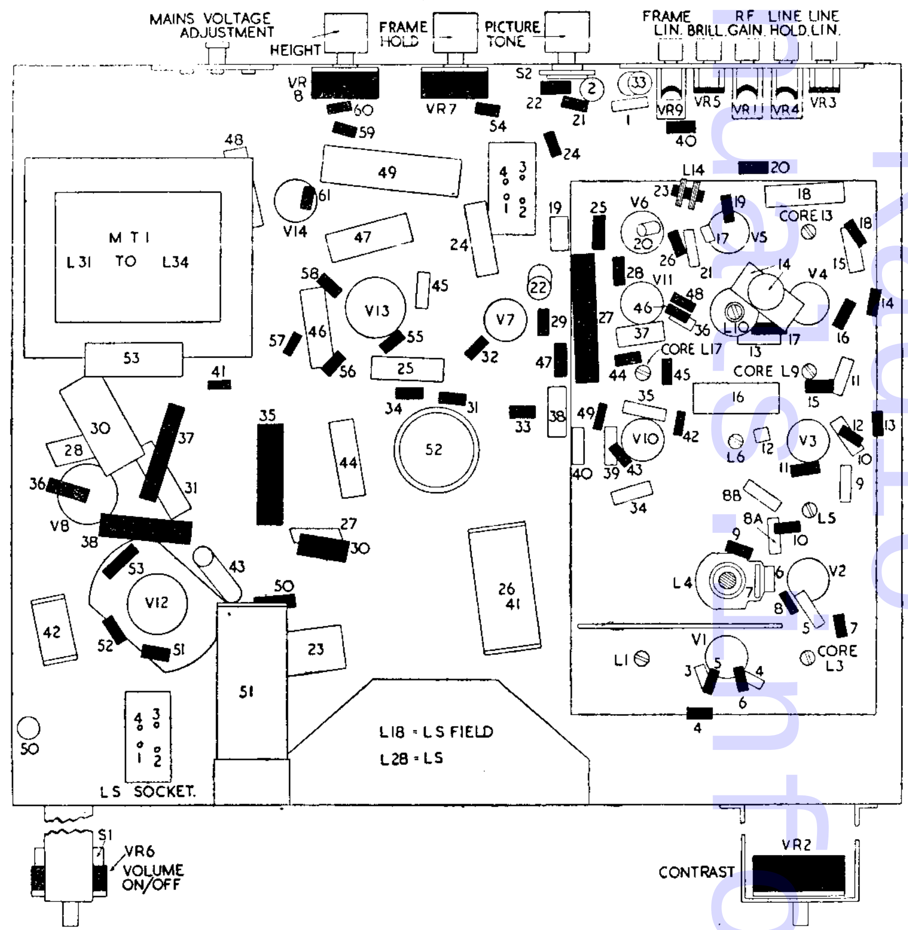
RESISTORS

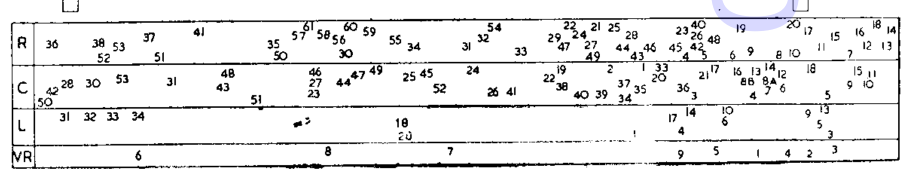
R	Ohms	Watts
1	100 } For 3 times attenr.	¼
2	150	¼
3	150	¼
4	120	¼
5	39	¼
6	1.5K	¼
7	6.8K	¼
8	22K	¼
9	100K	¼
10	1.5K	¼
11	2.2K	¼
12	39	¼
13	120	¼
14	1.5K	¼
15	5.6K	¼
16	5.6K	¼
17	150	¼
18	1.5K	¼
19	4.7K	¼
20	330	¼
21	3.3M	¼
22	1M	¼
23	47K	¼
24	470K	¼
25	330K	¼
26	330	¼
27	6.8K	2W
28	10K	¼
29	1M	¼
30	470	WW 3W
31	100K	¼
32	15K	¼
33	47K	¼
34	100K	¼
35	6.8K	WW 5W
36	47K	½
37	220	1
38	5K	WW 5W
39	2.2K	½
40	15K	¼
41	15K	¼
42	68K	¼
43	150	¼
44	1.5K	¼
45	68K	¼
46	68K	¼
47	1M	¼
48	1.5M	¼
49	47K	¼
50	8.2K	½
51	10K	1
52	470K	¼
53	180	½
54	100K	¼
55	100K	¼
56	100K	½
57	1.5M	¼
58	47K	¼
59	1M	¼
60	470K	¼
61	2.2M	¼
62	470	¼
63	100K	¼

INDUCTORS

L	Ohms
1	Very low
2	Very low
3	Very low
4	Very low
5	.5
6	1.5
7, 8	1
9	.5
10	Very low
11, 12	.75
13	.75
14	7
15A	7.5
15B	7.5
16	2.2
17	2.2
18	65
19	8
20	8
21	54
22	250
23	Very low
24	3 with L15A shunted
25	across L25
26	420
27	Very low
28	2.75
29	1000
30	3 shunted by R62
31	Very low
32	Very low
33	Very low
34	21 total







MARCONIPHONE TV—*Contd.*

in negative HT return lead to chassis, and other end is connected through L15B, R39 and secondary L24, L25 to slider on VR10. Adjustment of slider VR10 produces variation of DC in line coil and allows horizontal axis of picture to be moved to left or right.

EHT of approximately 7.5kV is obtained by rectifying by V9 the surge voltages set up across primary L21 and its overwind L22 when V8 is cut-off. EHT is smoothed by C32 and fed direct to final anode of CRT.

HT is provided by half-wave metal rectifier MR1 which is fed from 250V tapping on primary L34 of mains input transformer MT1. Choke-capacity smoothing is given by L18, the energising field of speaker, together with C51, C52. RF decoupling of RF chassis HT is given by C16.

Reservoir capacitor C52 is rated to handle 500mA ripple current. Frame and Line Shift bias voltages developed across VR10 and VR11 in negative HT return to chassis are smoothed and decoupled by C54, C55.

Heaters of V1 to V6, V10, V11 are parallel connected and obtain their current from secondary L32 of MT1. Heaters of V7, V8, V12 to V14 are also connected in parallel and obtain their current from secondary L31 of MT1.

CRT is a 12in. triode with permanent-magnet ring focusing. **Brilliance** is controlled by variation of grid bias by VR5. CRT heater is fed from a separate secondary L33 on MT1. R63 is fitted to prevent high potential developing between heater and cathode.

Primary L34 of MT1 is tapped for inputs of 195-215, 216-235, 236-255V 50c/s AC.

S1 which is ganged to volume control spindle is ON/OFF switch. Mains input is fused in each lead with 1.5A fuse and fitted with filter capacitor C50.

Earlier models of this receiver did not incorporate the electrical method of frame and line shift; centring of picture is carried out by movement of the permanent magnet focus ring. In these models VR10, VR11, C54, C55 are deleted and earthy side of mains is fed to chassis direct. In addition the bottom end of secondary L25 of LT1 and L15A are connected down to chassis together with upper end of L15B, and DC isolating capacitor C29 is inserted in lead between top of L24 and line deflector coils L19. Frame coils L20 are coupled across secondary L30 of frame input transformer FT1 one side of which is earthed to chassis.

TRIMMING INSTRUCTIONS

The frequencies given in brackets refer to the Midlands models, VT75A, VC75A.

Connect O-20mA meter in series with anode of video amplifier V6 or alternatively connect a 0-1mA meter between junction R19-R20 and chassis. Shunt meter with .005mF capacitor.

Connect a high resistance AC voltmeter across LS speech coil.

Set VR2 Contrast and VR6 Volume controls to maximum. Place VR1 RF Gain in maximum vertical position and S2 Picture Tone fully anti-clockwise.

(1) Inject modulated signal of 10.5mc/s to grid of V2 and adjust cores L6, L16, L17 for maximum sound output.

(2) Inject as above and adjust L6, L10 for minimum vision output.

(3) Inject 13.5mc/s unmodulated as above and adjust L8, L11 for maximum vision output.

(4) Inject 11mc/s and adjust L9, L13 for maximum vision output.

(5) Inject 12.5mc/s and adjust L5 for maximum vision output.

Check for approximately flat 2mc/s response by swinging input either side of 12.5mc/s.

(6) Inject modulated 41.5mc/s (London) or 58.25mc/s (Midlands) to top on L1 and adjust L4 for maximum sound output and minimum vision output.

(7) Inject 43 (60)mc/s unmodulated and adjust L3 for maximum vision output.

(8) Inject unmodulated 44 (61)mc/s and adjust L1 for maximum vision output.

Check for approximately flat response over 2mc/s by swinging input signal either side of 44 mc/s (61mc/s).

Peaking of L5 and L1 should be slightly altered if necessary to give flattened response.

REGENTONE U22

A REGENTONE U22 AC-DC superhet would fade in and out on all wavebands. Preliminary tests showed that the cause was an intermittent connection somewhere in the heater supply circuit.

After tightening and checking all connections on the breakdown resistor and the voltage selector panel and after checking all soldered joints on the valveholder heater pins, we gave the set another test. The intermittency persisted, so we next tried new valves.

No improvement resulted; then after some circuit tracing we ultimately found that a wire-wound 4W resistor under the chassis was intermittently o/c.

A similar model was brought in with a 100 per cent. HT short circuit from rectifier cathode to chassis and we found it was the reservoir electrolytic that was at fault.

As the receiver was not very old, we wondered why the condenser had broken down, and took the precaution of testing the .1 mF condenser that is shunted across the rectifier from cathode to anode as a modulation hum precaution.

Although this condenser seemed quite OK when tested on the ohms range of a small meter, it broke down completely when subject to the 500 volts test of a " Megger."

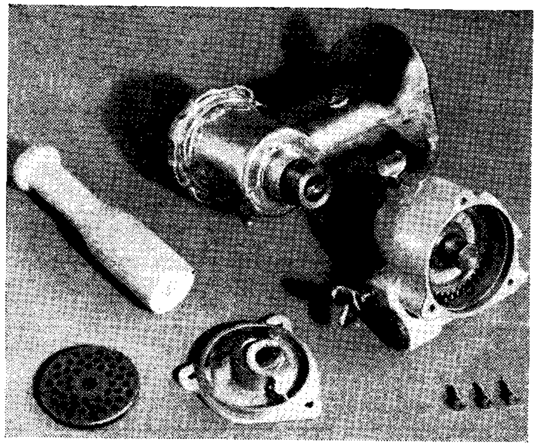
Almost certainly it must have broken down before when applied with the full mains voltage with the result that pure AC was connected to the electrolytic reservoir.—G. R. W.

PHILIPS 206A

I HAD a Philips 206A in for an annoying crackle which varied in violence. On checking forward from the output stage, I discovered two of Philips' pitch immersed condensers had received a minute portion of fluid from an adjacent electrolytic and the lead out wires were not sealed completely with pitch. These were replaced but still a faint crackle persisted.

I discovered the anode lead to the frequency changer was insulated by porcelain beads inside a short length of metal braid sleeving. This had a leakage path of 700,000 ohms, also due to moisture from the condenser. Replacing this and the condenser completely cured the set.—G. W. APPLEYARD Withernsea

ENGLISH ELECTRIC—*Contd. from p. 34.*



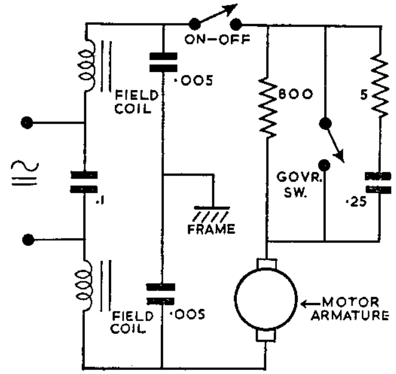


Fig. 5 (left), the mincer attachment with its power unit—cover of power unit is removed to display interior gears; and above (Fig. 6), the circuit diagram of the appliance

switch operating stud attached to it, inwards towards fixed governor spring. At the same time the switchplate follows the movement of the former until arrested by control cam. At this point further increase in speed of motor causes governor to move further inwards and, when thrust of governor spring becomes less than that of springiness of governor switch blade—the switch contacts open to bring into circuit an 800-ohm series dropper resistor. Immediately the motor speed starts to drop, and as a result the governor spring moves outwards with increasing thrust against switch blade. When governor thrust overcomes switch blade springiness then switch contacts close, short-circuiting series dropper resistor and applying full power to motor again.

The average motor speed depends on the frequency with which the governor switch is operated, and this is controlled by the position of governor switch blade relative to the governor and by the thrust of the governor. On slow speeds the momentum of the motor is lower and the rate of opening and closing of governor switch must of necessity be slower, due to time taken in gaining and losing speed to operate switch and also due to the relative balance of governor spring to switch spring thrust. On slower speeds the governor switch remains open for a much longer period than closed, whereas on high speeds the opening and closing periods are of nearly equal duration. The advantage gained by this method of speed control is that the effective motor torque is maintained irrespective of load throughout the range of control. Governor switch is fitted with an arc-quench filter and radio suppression capacitors are fitted across motor.

MAINTENANCE

As gears are enclosed in grease-packed gearcases and motor bearings are grease-packed roller and self lubricating sintered bronze types, these should not need any attention. If, however, the apparatus is dismantled for repair or replacement of a worn or defective part then it may be necessary to repack the gearcase concerned with Shell " Alvania " grease. Replace fibre gasket under gearcase cover-plate if original is damaged.

ADJUSTMENT OF BEATERS

Place turntable in centre bearing cup and place small mixing bowl on turntable. Loosen locknut on bearing cup below platform and adjust height of turntable by screwing bearing cup up or down, so that inner beater just touches bottom of bowl-retighten locking nut. Remove small bowl-place turntable in other bearing cup and place large bowl in position on turntable and adjust as above.

DISMANTLING

Removal of top cover—Undo and remove the four bolts positioned on underside of body at opposite ends of support bracket (Fig. 2) and lift off cover (Fig. 3).

Access to gearbox—Undo the three screws securing gearbox cover in position and remove cover (Fig. 4)—be careful to avoid damage to fibre gasket. The two fibre reduction gear wheels with drive spindles can be withdrawn upwards out of gearbox. When replacing cover make sure that the small spring is placed correctly in position on top of motor bearing and that it is not displaced out of position when cover is pressed down—failure to check this can result in the spring being caught up in gears with consequent damage to the teeth on fibre gears. The gears are marked with dots, which must be positioned opposite each other to ensure correct intermeshing of beater blades.

Removal of motor—Remove gearcase cover and gears as described above. Then undo and remove screws holding spring clamp bracket over motor field coil assembly. Remove brush holders by lifting them out of slots. Undo the screw securing control-knob-shaft clamp spring and cable-cleat bracket in position and also undo and remove screw fastening governor and line switch-plate spring to floor of body—it is not necessary to undo stop bracket screw. Carefully raise up field coil assembly and withdraw armature out of coils. Field coils, brush holders, interference suppressor capacitors, switch assembly, etc., can then be removed from out of body.