

Practical TELEVISION

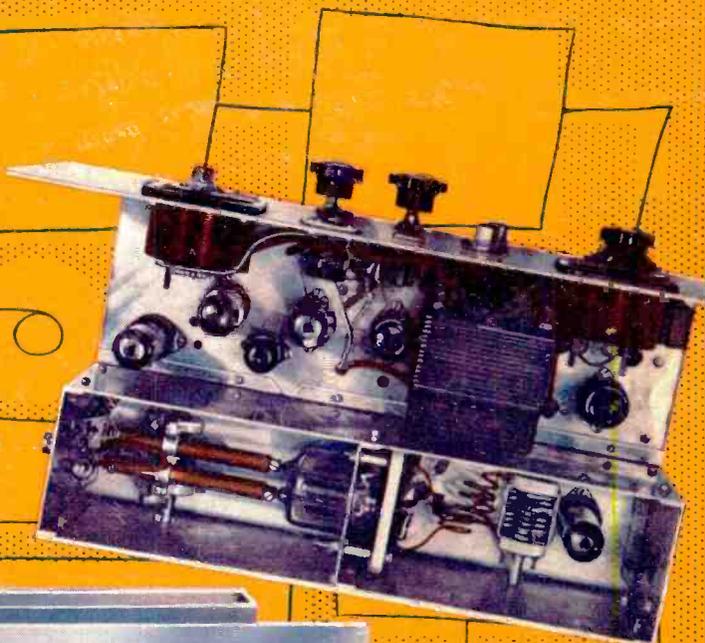
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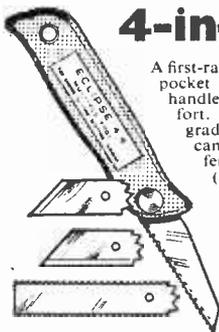
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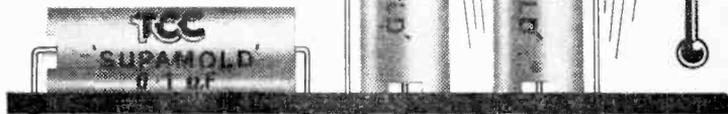
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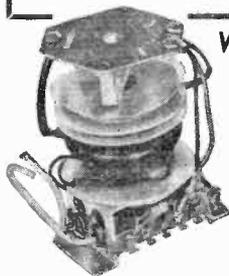
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Practical Television

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VOL. 14, No. 162, MARCH, 1964

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The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Television". Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for the manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to The Editor, "Practical Television", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2.

Owing to the rapid progress in the design of radio and television apparatus and to our efforts to keep our readers in touch with the latest developments we give no warranty that apparatus described in our columns is not the subject of letters patent.

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For Good or Evil?

HOW long is a line of sight? Not all that many miles, really, and although certain of our readers disdain anything not propagated via tropospheric refraction or Sporadic E reflection, for the multitude of ordinary viewers it is the limitations of v.h.f. signals to the line-of-sight range that for years have imposed a strict local-station-only aspect on television viewing. The much-maligned "steam radio" has always been much more versatile in this direction, even in its infancy, for obvious technical reasons.

However, so far as TV viewing is concerned, the prospect is broadening. The *Eurovision* and *Intervision* networks of the E.B.U. and O.I.R.T. have, by a combination of microwave links and land lines, made it possible to link up much of Europe. Even more interesting are the opportunities presented by the American communications satellites.

Telstar 1 was launched on July 10th, 1962, and 13 days later came the first TV link between Europe and North America. By the time its power supply was exhausted nine months later, 600 experiments had been made, including 50 Transatlantic programme exchanges, five of them in colour. Later that year *Relay 1* was launched, followed in May 1963 by *Telstar 2*.

Last year, these three communications satellites enabled millions of viewers in Europe and North America to watch intercontinental programmes. In fact, 130 Transatlantic exchanges took place.

These are, however, low altitude satellites, with the inherent restriction on optimum operation times. But *Syncom* also launched last year orbits at 22,300 miles above the earth. At this altitude, its velocity is equal to that of the earth and thus it appears to be almost stationary.

A satellite of this type permits almost continuous "visibility" between the chosen terminal points. At the moment, weight limitations preclude its use for TV, but this is a problem capable of resolution. A group of such satellites opens up interesting prospects.

Clearly, the dream of world-wide TV is within the realms of reality. Will this, when it comes, really lead to a better understanding between nations? We incline towards the optimistic viewpoint, despite the degeneration of the radio bands (most particularly the short waves) into a bedlam of high pressure propaganda, incitement and jamming.

In favour, paradoxically, is our old bogey line-of-sight, which may well be a blessing in disguise. Also the vexed problem of differing transmission standards between countries. For whereas anyone with a short wave receiver can tune into high power stations almost anywhere in the world, inter-continental TV programmes still require control at both ends by the broadcasting organisations concerned, the viewer using only his local TV station.

The day could come, of course, when a determined power could overcome these obstacles of control. We can only hope that in the years ahead, international TV does not go the same way as international radio.

Our next issue dated April will be published on March 20th.

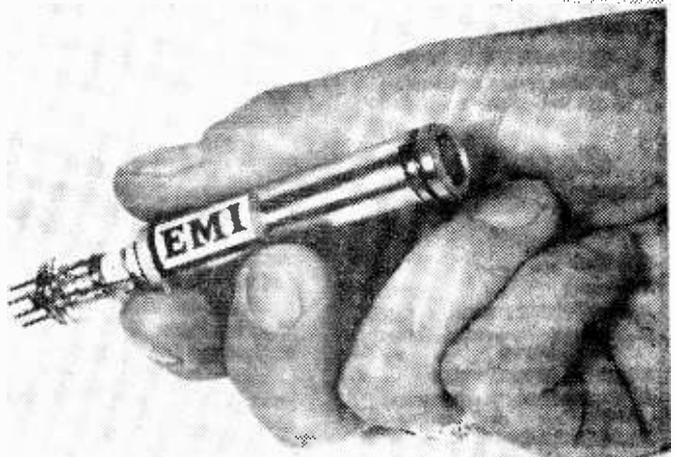
TELETOPICS

New $\frac{1}{2}$ in. Vidicon Camera Tube Under Development

CURRENTLY under development at EMI Electronics Limited is a $\frac{1}{2}$ in. diameter vidicon camera tube. This new tube is said to have resolution capabilities in excess of those which can be obtained from the older 1in. vidicons. The increased resolution is obtained by operating a separate mesh electrode positive with respect to the wall anode.

The tube's small diameter is matched by its length of only $3\frac{1}{2}$ in.— $2\frac{1}{2}$ in. less than the 1in. tube. These dimensions and its reduced weight will make it very acceptable in the many applications requiring these specialised properties. Television equipment manufacturers, for example, will find uses for such a tube in small, lightweight cameras and in the chrominance channels of colour cameras.

The new tube has been designated type 9697.



E.M.I.'s new $\frac{1}{2}$ in. diameter vidicon camera tube now under development.

RECEPTION SURVEY VEHICLE FOR BBC-2 AREAS

WITH the beginning of the BBC-2 test transmissions from the London station comes also the start of a new period of survey work for the Corporation's Engineering Information Department.

Whenever a new station commences its service the Department vehicles will tour the service area to check reception and investigate any problem areas and subsequently advise dealers

and viewers about reception conditions.

The forthcoming network of u.h.f. stations which will follow the opening of the London station, will make necessary intensified surveys of each area as the transmitters begin service and for this the Department has obtained a new estate car specially equipped for survey duties. Included in its equipment is a retractable mast which can be extended to about 30ft and which carries either u.h.f. or v.h.f. aerials. Test gear, measuring equipment and receivers are fed by a transistorised power unit which provides a standard a.c. voltage supply.

U.H.F. AERIALS FOR TRANSMITTERS

WHEN the BBC-2 programmes are first transmitted in Wales it will be from the Corporation's station at Wenvoe. U.H.F. aerials have already been ordered for this transmitter—and also for the Sutton Coldfield station—from the Marconi Co. Ltd., and these will be mounted atop the existing 750ft. television masts which are at present in use at both sites for BBC-1 programmes.

The aerials will consist of a number of fibre-glass cylinders with the dipoles mounted on panels inside. The design of the aerials allows for their use as radiators of as many as four programmes simultaneously, although initially they will only be used for BBC-2.

EUROPE'S TALLEST TV MASTS

DETAILS have been announced of three new television transmitting masts which are to be erected at Emley Moor (Yorkshire), Winter Hill (Lancashire) and Belmont (Lincolnshire). Two of these masts (Emley Moor and Winter Hill) will carry aerials for both future BBC u.h.f. and existing ITA v.h.f. transmissions. It is expected that the new ITA aerials will come into service during 1965 and take over programme transmissions from the present towers at these two stations. The u.h.f. aerials will be used to transmit the BBC-2 programmes and, eventually, the BBC-1 programmes. When the third mast at Belmont is ready to begin transmitting later in 1965 from the new station being built on this site, it will extend the ITA service to much of East Lincolnshire.

All these masts will be for the use of both Authorities under the system which has been decided upon to provide shared-site stations in the future 625-line u.h.f. network. However it was necessary to provide for the existing 405-line services and for this, the masts will each have 350ft. of aerial space to carry a variety of aerials including one for f.m. radio.

The structures at Emley Moor and Belmont will both be 1,250ft. high, making them the tallest in Europe (the Winter Hill mast is to be 1,000ft. high). But their size will not be their only notable feature as, for the first time, the conventional open lattice type of mast construction will not be used for the television towers. Instead the masts will be cylindrical steel columns, 9ft. in diameter. This form of construction adds considerably to the strength of the masts as well as giving all-weather access to the telephone and feeder cables inside the columns. The aerials, which are to be mounted on the top-most sections of the masts, will be enclosed in translucent cylinders of glass-fibre-reinforced plastics.

TELEVISION FACTORY FOR SOUTH SHIELDS

THE television and radio receiver manufacturing firm of Rank-Bush Murphy Limited, has announced its plans for a factory in South Shields to be built on a nine-and-a-half acre site in the centre of the city. When complete this plant will be able to employ some 1,200 people, but this figure should eventually rise to 2,000.

The new factory will make a total of six throughout the country producing receivers with the Bush and Murphy brand names and will bring the labour force to nearly 10,000.

The ITA aerials at the Emley Moor and Winter Hill stations will transmit on the same channels as the present aerials (channels 10 and 9 respectively) and the new station at Belmont will use channel 7.

Details which have so far been released concerning the BBC's u.h.f. aerials at these sites, give the effected radiated power of the Emley Moor array as 1,000kW on channels 44 and 51 and that for the Winter Hill array as 500kW on channels 55 and 62.

EMI Electronics Limited are to supply the aerials and feeder systems for the masts which will be erected by the British Insulated Callender's Construction Company Limited.

Wideband Link Equipment for O.B.'s

PORTABLE wideband link equipment for operation in the 11Gc/s (11x10⁹c/s) band has been supplied by Mullard Limited, to the BBC for television outside broadcast links. The two equipments bought by the Corporation will help to relieve overcrowding in the 7Gc/s band which is at present used for o.b. links. A control unit, an s.h.f. head and a parabolic aerial comprise the units which allow for either single or double-way links.

In use with a 4ft. parabolic aerial, the equipment covers a range of 20 miles at a signal-to-noise ratio of 58dB. Its 8Mc/s bandwidth enables it to accommodate 625-line monochrome or colour TV signals as well as radar signals and telephone channels (as many as 120 of the latter may be accommodated).

RELAY STATION IN S.W. WALES

FOLLOWING a series of trade test transmissions begun on the 3rd February, transmissions of the BBC Welsh television service from the new relay station near Haverfordwest, Pembrokeshire, commenced on the 15th of the same month. In common with other BBC television relay stations, the three v.h.f. sound programmes are also transmitted from this site. Improved reception in many parts of Pembrokeshire of both the sound and TV services will result from the opening of the new station and in some parts will introduce these BBC services for the first time.

The television broadcasts will be on channel 4 (vision 61.75Mc/s and sound 58.25Mc/s) with horizontal polarisation.

Outside Broadcast Unit is Gift to Yugoslavia

IN response to a request made to the European Broadcasting Union for equipment for the television station of Yugoslavia's earthquake disaster city, Skopje, it was decided that the ITV companies, Associated Rediffusion and Associated Television, should provide a complete outside broadcast vehicle as a gift to the

Yugoslav Radio and Television Service.

During January the unit arrived in Belgrade ready for operation on the Yugoslav CCIR standard. An engineer from Television Transmission and Recording Services, a subsidiary of Pye Limited, also travelled to Belgrade to familiarise Yugoslav

technicians with the operation of the unit.

Included in the equipment of the unit were three cameras, vision mixer, sound equipment, etc., with such ancillaries as lenses, cables, microphones, etc., to make the vehicle complete.

In all the vehicle weighed eight tons and was over 20ft in length.

for 70cm ham band

A Switchable

SOUND/VISION TRANSMITTER

CAUTION

Before r.f. transmission of pictures can be contemplated, the operator will require an Amateur Television Licence. This licence can be obtained by a British subject who has passed the Radio Amateur's Examination. No Morse test is required. For further particulars on this subject write to the Radio Services Dept., General Post Office, Headquarters Building, St. Martins-le-Grand, London, E.C.1.

By B. W. Smith, G3LGJ/T

This is a low power transmitter suitable for the newly licensed TV ham. The input to the final stage is 25W.

The G.P.O. licensing conditions require amateur TV stations to transmit their call signs by c.w. or phone as well as by the video signal, although not necessarily simultaneously. Therefore the equipment to be described in this present series has been designed for sound or vision operation. The mode of operation is selected by a sound/vision switch.

THE transmitter described in this article was first designed as a low-power sound transmitter for the 70cm band to accompany an existing high-power vision transmitter providing simultaneous sound-with-vision transmissions. The circuitry was simplified as much as possible to reduce power consumption without sacrificing efficiency, since portable operation working from accumulators was anticipated as well as the normal mains power supply operation.

A video modulator was designed for the transmitter at a later date when the writer was required to supply a portable video transmitter for a particular outdoor function. (The main high-power vision transmitter could not be used since it was hardly portable, weighing about 1½cwt.) The results obtained from the transmitter operating under video conditions were remarkably good and provided a pleasant surprise.

The transmitter has three distinct sections, the r.f. power section, the sound modulator and the vision modulator. The construction as described in this article follows the sequence in which the circuitry was developed. The r.f. generator and sound modulator are on the main chassis, while the vision modulator is contained on a separate chassis; however, there is no reason why the sections should not be rearranged. For example, the r.f. section and vision modulator could be combined on one chassis with a sound modulator on a separate chassis, this being a vision transmitter with sound facilities instead of vice versa.

THE R.F. CIRCUIT

The circuit diagram for the r.f. and sound modulation sections is given in Fig. 1. The r.f. generation portion of the transmitter will be considered first.

Self-excited oscillator transmitters are still used

on the 70cm band but they are falling out of favour now because the signals cannot be easily received on a selective narrow band converter.

Because of the poor frequency stability of self-excited oscillators it is highly desirable to have a crystal-controlled transmitter with good frequency stability.

The amateur television band on 70cm is 425Mc/s to 445Mc/s. wide, giving plenty of room without interference to other band users. The 70cm sound only amateurs have the same band as the TV amateurs but they usually occupy the range 432Mc/s to 438Mc/s, which is in direct harmonic relationship with the two-metre band 144Mc/s to 146Mc/s (three times the frequency). In fact the band plan which has been adopted on the two-metre 2Mc/s wide band is now also used between 432Mc/s and 434Mc/s. This means that the TV operator has practically the whole of the band without interference with the exception of the occasional professional user.

TRITET CRYSTAL OSCILLATOR

Valve VIA, the pentode section of a PCL83, is a tritet crystal oscillator which will allow the crystal to oscillate on its third overtone, the crystal frequency being 8Mc/s approximately. (For choice of frequency see later.)

At this stage the writer would like to point out the reason for using an 8Mc/s crystal requiring a frequency multiplication of 54 times to obtain the 70cm signal when quartz crystals of up to 100Mc/s can be obtained, obviously requiring a much lower frequency multiplication. The explanation is that there is a large selection of cheap ex-Government crystals available with frequencies around 8Mc/s, and when a set of crystals is required for a selection of frequencies throughout the band the saving in cost is well worth while. These crystals can be dismantled and reground to adjust their frequencies

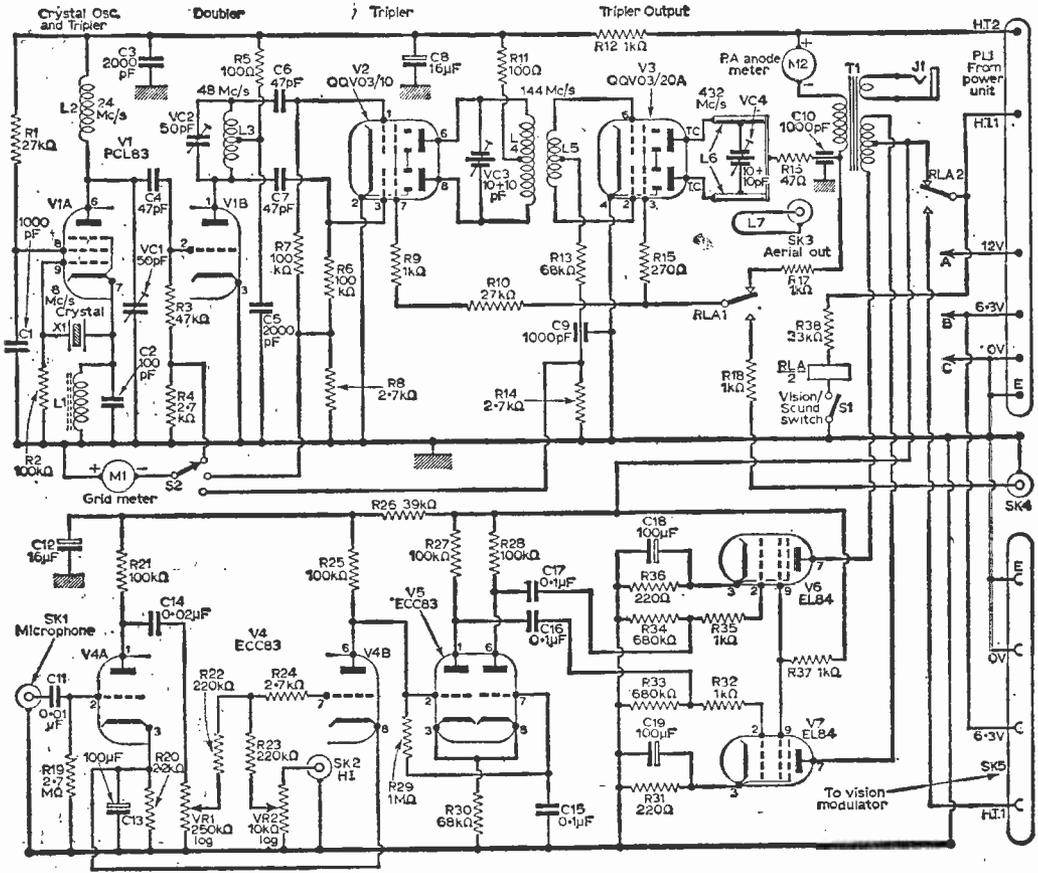


Fig. 1(a)—The r.f. and sound modulator circuits.

if required.

The tripler circuit was chosen because it is a very stable overtone oscillator requiring little initial tuning to make it go and it provides a good r.f. output. Overtone circuits make the crystal oscillate on an odd multiple of its fundamental frequency—three times is the most that is normally used, although special overtone crystals will work well on fifth and seventh harmonics.

In this circuit V1A anode is tuned to 24Mc/s (3 x f crystal) and delivers plenty of r.f. drive to V1B grid. Grid leak biasing is used on V1B grid and throughout the r.f. section of the transmitter. The appropriate grid bias for the valve is obtained by allowing grid/cathode current to flow when the valve is driven hard with r.f.

This method of biasing is very simple but provides no valve overload protection if the drive fails at any multiplier stage. In the case of V1B this grid current flows through R3 to earth and provides the correct negative bias to operate the valve.

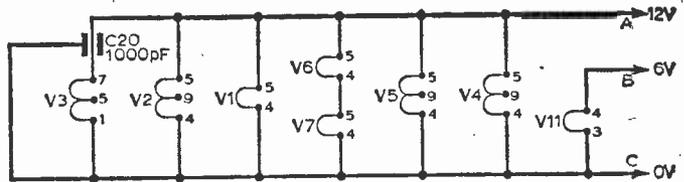


Fig. 1(b)—The heater circuit for the main unit.

S2 switches a 0.5mA meter into the grid circuit of V1B, V2 and V3 in turn so that the tuning of individual multiplier stages is easily accomplished and correct transmitter operation can also be checked. R4, R8 and R14 provide a continuous d.c. path to earth when the meter is switched to another grid but do not unduly affect the meter reading.

Frequency multipliers work under class C bias conditions: the valve is biased beyond cut-off and only conducts for a small part of a complete cycle and consequently the anode current flow has a high harmonic content. Using an anode circuit tuned to one of these harmonics will allow a power output to be obtained at a particular harmonic frequency.

COMPONENTS LIST

Resistors:

R1	27k Ω $\frac{1}{2}$ W	R32	1k Ω $\frac{1}{2}$ W
R2	100k Ω $\frac{1}{2}$ W	R33	680k Ω $\frac{1}{2}$ W
R3	47k Ω $\frac{1}{2}$ W	R34	680k Ω $\frac{1}{2}$ W
R4	2.7k Ω $\frac{1}{2}$ W	R35	1k Ω $\frac{1}{2}$ W
R5	100 Ω $\frac{1}{2}$ W	R36	220 Ω $\frac{1}{2}$ W
R6	100k Ω $\frac{1}{2}$ W	R37	1k Ω $\frac{1}{2}$ W
R7	100k Ω $\frac{1}{2}$ W	R38	33k Ω 3W w.w.
R8	2.7k Ω $\frac{1}{2}$ W	R39	Not used
R9	1k Ω $\frac{1}{2}$ W	R40	1M Ω $\frac{1}{2}$ W
R10	27k Ω $\frac{1}{2}$ W	R41	10k Ω $\frac{1}{2}$ W
R11	100 Ω $\frac{1}{2}$ W	R42	3.9k Ω $\frac{1}{2}$ W
R12	1k Ω $\frac{1}{2}$ W	R43	270 Ω $\frac{1}{2}$ W
R13	68k Ω $\frac{1}{2}$ W	R44	100k Ω $\frac{1}{2}$ W
R14	2.7k Ω $\frac{1}{2}$ W	R45	100 Ω $\frac{1}{2}$ W
R15	270 Ω $\frac{1}{2}$ W	R46	100 Ω $\frac{1}{2}$ W
R16	47 Ω $\frac{1}{2}$ W	R47	15k Ω 3W w.w.
R17	1k Ω $\frac{1}{2}$ W	R48	10k Ω 6W w.w.
R18	1k Ω $\frac{1}{2}$ W	R49	470 Ω $\frac{1}{2}$ W
R19	2.7k Ω $\frac{1}{2}$ W	R50	10M Ω $\frac{1}{2}$ W
R20	2.2k Ω $\frac{1}{2}$ W	R51	100 Ω $\frac{1}{2}$ W
R21	100k Ω $\frac{1}{2}$ W	R52	100 Ω $\frac{1}{2}$ W
R22	220k Ω $\frac{1}{2}$ W	R53	100 Ω $\frac{1}{2}$ W
R23	220k Ω $\frac{1}{2}$ W	R54	10k Ω 3W w.w.
R24	2.7k Ω $\frac{1}{2}$ W	R55	100 Ω $\frac{1}{2}$ W
R25	100k Ω $\frac{1}{2}$ W	R56	10k Ω $\frac{1}{2}$ W
R26	39k Ω $\frac{1}{2}$ W	R57	6.8k Ω $\frac{1}{2}$ W
R27	100k Ω $\frac{1}{2}$ W	R58	1M Ω $\frac{1}{2}$ W
R28	100k Ω $\frac{1}{2}$ W	R59	680 Ω $\frac{1}{2}$ W
R29	1M Ω $\frac{1}{2}$ W	R60	100 Ω $\frac{1}{2}$ W
R30	68k Ω $\frac{1}{2}$ W	R61	47k Ω 3W
R31	220 Ω $\frac{1}{2}$ W		

All $\pm 10\%$, carbon, unless otherwise stated

Potentiometers:

VR1	250k Ω log	VR3	1k Ω log, if possible
VR2	250k Ω log	VR4	5k Ω linear

Capacitors:

C1	0.001 μ F disc ceramic
C2	100pF mica
C3	2,000 μ F disc ceramic
C4	47pF mica
C5	2,000pF disc ceramic
C6	47pF mica
C7	47pF mica
C8	16 μ F electrolytic 450V
C9	1,000pF ceramic feedthrough
C10	1,000pF ceramic feedthrough
C11	0.01 μ F paper 350V
C12	16 μ F electrolytic 450V
C13	100 μ F electrolytic 25V
C14	0.02 μ F paper 350V
C15	0.1 μ F paper 350V
C16	0.1 μ F paper 350V
C17	0.1 μ F paper 350V
C18	100 μ F electrolytic 25V
C19	100 μ F electrolytic 25V
C20	1,000pF ceramic feedthrough
C21	0.1 μ F paper 350V
C22	16 μ F electrolytic 450V
C23	1,000 μ F electrolytic 15V
C24	1 μ F paper 350V
C25	250 μ F electrolytic 25V
C26	16 μ F electrolytic 450V
C27	0.1 μ F paper 350V
C28	680pF mica
C29	10pF mica
C30	0.1 μ F paper 350V

C31	16 μ F	} electrolytic 450V
C32	16 μ F	
VC1	50pF air spaced variable	
VC2	50pF air spaced variable	
VC3	10 + 10pF split stator	} (Jackson type C808)
VC4	10 + 10pF split stator	

Diodes:

D1	OA86
D2	OA86
D3	Silicon 400V p.i.v., 125V r.m.s. (Radio-spares)
D4	GEX65

Valves:

V1	PCL83	V7	EL84
V2	QQV03/10	V8	EF80
V3	QQV03/20A	V9	6CH6
V4	ECC83	V10	E88CC or ECC88
V5	ECC83	V11	Z77
V6	EL84	V12	5U4G

Sockets:

SK1	Coaxial	SK6	Coaxial
SK2	Coaxial	SK7	Coaxial
SK3	Coaxial	SK8	Coaxial
SK4	6-pin	SK9	Coaxial
SK5	4 pin (or more)		

Plugs:

PL1	6 pin (or more)	PL2	4 pin (or more)
J1	Jack socket		

Switches:

S1	Toggle switch s.p.d.t.
S2	Rotary switch, 1 pole, 3 way
S3	Toggle switch on/off

Inductors:

L1	12 turns 30s.w.g. enamelled copper close wound on a $\frac{3}{8}$ in. diameter Aladdin former.
L2	12 turns 18s.w.g. enamelled copper $\frac{1}{2}$ in. inside diameter, $\frac{3}{8}$ in. long.
L3	7 turns 18s.w.g. enamelled copper $\frac{1}{2}$ in. inside diameter $\frac{3}{4}$ in. long, centre tapped.
L4	4 turns 18s.w.g. enamelled copper $\frac{3}{8}$ in. inside diameter 1in. long, centre tapped.
L5	4 turns 20s.w.g. enamelled copper $\frac{3}{8}$ in. diameter $\frac{1}{2}$ in. long, centre tapped, with two $\frac{3}{8}$ in. long end leads.
L6	See text.
L7	3in. length of poly vinyl chloride covered 22s.w.g. formed into a loop.
L8	Smoothing choke 10H 150mA (see text)

Transformers:

T1	Modulation transformer 4000 + 4000 Ω to 4000 Ω , handling power 15 watts. Woden type UMO modulation transformer.
T2	Mains transformer. Secondaries: 300-0-300V 150mA; 5V 3A; 6.3V 2A; 12.6V 2.5A (see text)

Meters:

M1	0-5mA moving coil meter.
M2	0-100mA moving coil meter.

Crystal:

X1	Approx. 8Mc/s quartz crystal, type FT243 (see text)
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Relay:

RLA	High impedance relay 6,800 Ω relay coil, operating on 8mA.
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FREQUENCY DOUBLER

V1B r.f. drive is about 24Mc/s and its anode is tuned to 48Mc/s and thus this stage is a frequency doubler. The anode coil of V1B has a centre tap which is returned to h.t. and this makes the coil work in a balanced mode even though being driven by V1B anode at one end only. Two push-pull r.f. outputs are available from the ends of the coil L3 and are capacity coupled to the respective grids of a double tetrode V2 which operates as a push-pull frequency tripler.

V2 is a QQV03/10 and was chosen because it is a small valve on a B9A base, although having a high anode dissipation. It is a very efficient tripler to 144Mc/s, providing about 5W output for only 1W of drive on 48Mc/s. The valve grid biasing arrangement is similar to V1B doubler stage, each grid has its own grid resistor and the combined grid drive current is measured at the junction of R6, R7 and R8. As is usual with this method of biasing the valve cathode is returned directly to earth.

A balanced circuit is connected between V2 anodes, tuning being accomplished by VC3, which is a split stator capacitor. This type of capacitor is designed for balanced circuits and, due to its construction, the moving parts have no d.c. on them and are at earth potential in the r.f. sense. The output of V2 anode coil L4 is inductively coupled to V3 grid coil L5.

The screen of V2 is connected to the screen of V3 through R9 and R10. R9 serves to prevent any r.f. present on V2 screen from being coupled to other parts of the circuit and is connected close to the valve screen pin, similar to grid stopper resistors.

OUTPUT STAGE

V3 is the output r.f. valve of the transmitter and is a push-pull tripler similar to V2, multiplying from 144Mc/s to 432Mc/s. The valve used is the QQV03/20A, which is extremely efficient up to 600Mc/s either as a straight amplifier or tripler, requiring quite low drive power. The "3/20" is a double tetrode like the "3/10" but it is a much larger valve, mounted on a B7A base, and has a maximum total anode dissipation of 20W.

The grid coil of V3 (L5) is resonated to 144Mc/s by the grid capacity of V3. Inductive coupling is used between L4 and L5 to suppress as far as possible all multiplier chain harmonics present at V2 anode. Capacitive coupling between V2 and V3 would have been less efficient and, because V3 is the stage feeding the aerial, this harmonic suppression is very necessary to avoid out-of-band interference to other h.f. signals. The grid coil is centre tapped; R13 is the grid bias resistor of V3.

The anode circuit of V3 is a little unusual (compared with lower frequency techniques) and quarter-wave resonant lines are used, and these are tuned to 432Mc/s by VC4, which is a split stator capacitor tapped down the lines L6. The capacitor is not necessary to a line circuit but provides the simplest method of tuning adjustment. Lines have been used for two reasons—the Q of a line circuit at 70cm is superior to that of a lumped constant circuit, also the QQV03/20A will run very cool with good heat sinks on its anode pins and the lines

perform this function admirably.

The r.f. output of V3, which will be about 8W at 432Mc/s, is coupled to the aerial by a simple coupling loop L7. Aerial coupling units at 70cm tend to become a little complex, but these are not really essential unless the aerial matching is poor. This simple loop has proved very effective and can be adjusted easily to heavily load the r.f. output stage, which is necessary for good TV modulation.

MODULATION OF THE R.F. POWER

The mode of modulation is selected by S1, which operates the relay RLA for vision transmission and de-energises RLA for sound transmission. This relay is used to switch the modulator outputs to avoid the capacitive effects of long leads.

Extra stray capacitance on the vision modulator output will only have a detrimental effect on the transmitted bandwidth. The relay is mounted under the chassis near V3 base.

The modulation transformer T1 modulates the anode and screen of V3 and also the screen of V2 driver stage to provide the sound modulation.

Anode and screen modulation is the normal high-level modulation used universally. However, at 70cm, and also due to a tripler output stage, the output stage drive also requires a small depth of modulation. This is provided by the screen modulation of V2 and gives a full 100% upward modulation of the r.f. output, which is so important for intelligibility over poor signal paths.

Vision modulation is applied to the screen of V3 and also to the screen of V2. When modulated with vision, using the British standards of peak white corresponding to maximum r.f. output, it is essential to completely reduce the transmitter r.f. output to zero at sync pulse bottoms. R.F. power still present at sync pulse bottoms represents unmodulated r.f. signal and will be seriously detrimental to the signal-to-noise ratio at the receiving end, producing the all-too-familiar report of weak, wishy-washy pictures. This stray r.f. if excessive will also cause synchronising troubles at the receiving end.

SOUND MODULATOR

The sound modulator circuit is quite conventional. V4A is the microphone amplifier and is designed to work with a crystal microphone. The output of V4A anode is coupled to VR1, the microphone gain control.

The output from VR1 slider is resistively mixed with the output of VR2 slider and amplified further by V4B. VR2 is the gain control of a high-level input which can be used for a second audio input to the transmitter; the use of this facility will be discussed later.

V5 is a phase splitter and produces a balanced output to drive V6 and V7, the push-pull output stage. V6 and V7 are EL84s run in AB1 biasing conditions to provide about 15W of audio, which is sufficient to modulate fully the QQV03/20A tripler.

The audio power is matched to the tripler by the modulation transformer T1—note the third winding on the transformer which is connected to an output jack socket J1. The transformer used by the writer was a spare mains transformer 240V to

150-0-150V. The 150-0-150V winding was used on the EL84 anodes, the output was obtained from the 240V side and the headphone monitor output was obtained from a 6.3V winding. It is recommended, however, that a proper modulation transformer should be used. The impedance match required is $8,000\Omega$ (centre tapped) to about $4,000\Omega$ matching the EL84s to the QQV03/20A.

VISION MODULATOR

The circuit of the vision modulator appears in Fig. 2.

The vision modulator is designed to accept a standard 1V positive composite signal. Two vision sockets are fitted and strapped in parallel, allowing the vision signal to "bridge" the transmitter. If the vision requires terminating a 75Ω termination

and anode bottoming.

The vision output of V9 has sync pulse bottoms d.c. restored to earth potential by D2 and D3 in series. A silicon and a germanium diode are used in series to obtain the low leakage current properties of the silicon diode together with the good high frequency response of the germanium diode. Two relatively cheap diodes produce the equivalent results of one rather expensive silicon diode. The resistor R50 sets the response time of the d.c. restorer, without this resistor the response of the restorer circuit will be too sluggish.

The restored vision signal is now coupled to a cathode follower V10, which provides a low driving impedance vision output to the transmitter r.f. valves.

Correct modulation depth is automatically

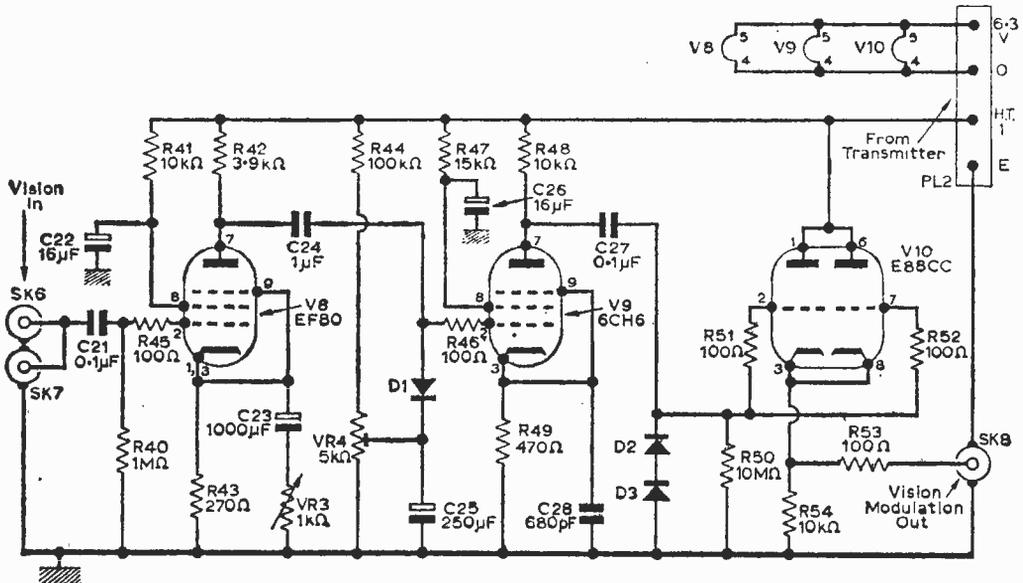


Fig. 2—The vision modulator circuit.

can be plugged into the second socket.

V8 is a straightforward vision amplifier. The stage gain, and thus the depth of modulation on the transmitter, is controlled by VR3, which varies the amount of negative feedback from V8 cathode.

The vision output at V8 anode, which is now negative going, is d.c. restored to a voltage set by VR4 and drives the grid of the high voltage amplifier V9. This second stage provides a positive vision output of about 250V peak to peak. High voltage running is achieved by using a 6CH6 valve which has a high gm, and also has a low anode bottoming voltage.

The anode load resistor R48 has rather a high value for a vision circuit, but is necessarily large to reduce valve power dissipation and also provides the required output voltage swing. The frequency response of the modulator is converted by the cathode h.f. boost provided by R49 and C28 combination.

Adjustment of the d.c. grid restoring potential set by VR4 allows the valve anode output to be adjusted to swing evenly between anode cut-off

ensured if the d.c. restorer is working correctly, since sync pulse bottoms start at earth potential and the r.f. output of the transmitter is practically zero with V2 and V3 screens at earth potential. The power output is almost a linear with modulator voltage up to about 250V on the screens. This operation can be checked by using a sawtooth test signal to the transmitter and a remote receiver.

Vision or telephony transmitter operation is selected by the relay RLA. RLA2 contact switches the h.t. from the sound modulator to the vision modulator, while RLA1 contact switches V2 and V3 screens to the appropriate modulator output.

The modulation transformer T1, of course, is inoperative when transmitting vision, since the sound modulator has its h.t. disconnected. The r.f. carrier frequency will remain unaltered by changing the type of modulation, i.e. sound or vision; however, the transmission bandwidth will be completely different, about 20kc/s on sound and 6Mc/s on vision.

CONTINUED NEXT MONTH

Starting A RADIO And TELEVISION Repair Business

By A. Ford

ESSENTIAL REQUIREMENTS FOR ANY-ONE CONTEMPLATING ESTABLISHING HIMSELF AS A FULL-TIME SERVICEMAN

MANY enthusiasts, through study in the pages of PRACTICAL TELEVISION and elsewhere and through experiments and construction, have attained a standard of theoretical knowledge and practical ability which could well be extended from an enjoyable hobby to a profitable sideline and subsequently a full-time business.

Doubtless many of the readers of this journal are employed as radio or TV engineers and may already repair sets for neighbours in their spare time. This article sets out to suggest principles on which a very profitable small business may be set up.

First Essential

Firstly, and most important, it is obviously quite useless setting up a TV repair business unless you have a really sound knowledge of TV engineering, preferably backed up with plenty of experience actually tracing faults. While it takes little more than common-sense to replace a valve or solder in a fresh component, it is the *locating* of the fault which calls on the engineer's skill.

A profitable living cannot possibly be made unless you understand the techniques of fault tracing, and even more important, unless you have at least started to develop that sixth sense which comes from experience and often leads the engineer to the fault in a fraction of the time it would take to trace logically. In this respect, television repairs require a high standard of theoretical knowledge as well as considerable practical experience—also a wide range of test equipment.

It is a good idea, therefore, unless you have had previous experience in this field, to start by repairing sound radio equipment only, either progressing to television equipment at a later date or else employing a television specialist if business should warrant it.

Capital

As is true of any business, a reasonable capital will be required to make a reasonable start. If starting as a part-time venture this will need to cover: premises, tools, instruments and service sheets, a basic stock of spares, lighting and heating, stationery and printing, postage and telephone, advertising, buying and/or running a vehicle for collection and delivery of sets, plus a reserve in case of difficulties.

If you are taking the plunge full-time you should also allow yourself a weekly wage equal to that you have been earning, to cover say, three or four months, during which time your business will show itself either to be succeeding or else definitely not!

Premises

There is no need to go to great expense to acquire premises. A wooden building at the rear of the engineer's home would be admirable. But don't try to convert an old potting shed. Invest in a garage sized workshop with good windows, which can be kept warm and dry. Remember that in your locality there may be restrictions regarding the running of a business in a residential area, and it is as well to enquire about this at the start.

Most local authorities are satisfied that radio and TV repairs are not likely to annoy residents, but they may wish to increase the rateable value of the property. It is as well to be sure about this at the outset.

Flooring

A concrete floor in the workshop will be found to be cold, damp, and dangerous electrically. In this case treat it with a sealer, and lay a good thick lino or other rubber covering. A wooden floor raised above the ground is better. A "garage-sized" workshop will be at least large enough for one long bench, a desk, racks for spares and floor space for sets awaiting repair or delivery. Anything smaller than this will prove a great nuisance if business becomes brisk.

Accommodation

A bench along one wall would be ideal, with a shelf about a foot above it to carry test gear. Another bench about a foot high would be very convenient for work on radiograms and console receivers. A covering of lino enables you to keep your benches clean.

Apart from shelf-space for instruments, you will also need to accommodate components, service manuals and technical data, and stationery. There are nests of small metal drawers on the surplus market which are admirable for storing resistors, capacitors, etc. Valves are best stored in some sort of small cupboard.

Bureau type desks are easy and cheap to obtain

secondhand, and one of these would accommodate all technical literature as well as stationery and account books. A telephone is, of course, essential, and would be best positioned on the bureau.

Mains Supply

A main cable to carry at least 30A should be run from the house main supply to the workshop. This will have to be inspected and passed by the local electricity authority. This cable can terminate just inside the workshop door at an isolating switch and fuses. From here a stout cable should be run to a distribution board along the back of the workbench, fitted with at least one of every kind of socket.

This will save needless changing of customers' plugs. 13A switched points at other positions round the workshop will serve for power tools and test gear, and an electric kettle, an important psychological servicing aid!

Lighting

Good lighting is probably best provided by fluorescent fittings, plus an Anglepoise or similar lamp over the workbench. In the writer's locality, mains voltage fluctuations are so bad in the winter that meter readings and servicing in general is disrupted, so a mains voltmeter is permanently in circuit on the distribution board. It is also worth while installing a meter to record power used. This will be most helpful when preparing accounts.

Heating

For heating, some sort of oil convector is probably the cheapest way of starting. Later, if finances allow, tubular thermostatic heaters attached to the wall are economical and convenient.

Safety

A word or two on the subject of safety. The main switch by the workshop door should cut off the supply to every point. It should be in a place which every member of the family knows and can reach.

Every adult in the house should be able to apply artificial respiration and should understand that speed is essential, and that in the case of electrocution waiting for a doctor or ambulance to arrive would be useless.

An insulated floor has already been mentioned. In addition to this, when working with high voltage equipment, the engineer should remember to work with one hand behind his back or in his pocket, or else wear rubber gloves. In this way, a shock across the body will be avoided.

Special precautions should be taken with a.c./d.c. chassis, cathode ray tubes, and electrolytic capacitors. Familiarity often breeds contempt, and it is all too easy to be careless, particularly if one has by luck come unscathed through a number of minor shocks. A placard in the writer's workshop says "Remember—Death is permanent!"

Test Gear

It is possible to spend anything from £5 to £500 on test equipment, and here the would-be serviceman often makes his most expensive mistakes. For

radio work, the first essential is the best multimeter you can afford. Do not try to save money here—a good sensitive and accurate instrument will pay for itself over and over again. A signal generator is also necessary from the start. Later a CR bridge and an oscilloscope will be useful.

A valve tester often saves time but is unfortunately very expensive. Faults can usually be narrowed down to a valve using the multimeter, and then a trial substitution can be made. A transistor tester, not nearly so expensive, will be very useful.

For television work the field of choice and expense is very much greater, and here individual engineers have widely differing and emphatic views about particular pieces of testgear. However, standard requirements will be an oscilloscope, tube tester, pattern generator, and valve-voltmeter.

Although in general it is not wise to try to save money in the choice of test gear, the writer does recommend the Heathkit range. In slack moments additions to the engineer's equipment may be constructed very economically.

Tools

Regarding tools, complete kits in upholstered carrying cases are available at rather high prices; alternatively a kit can gradually be built up starting with the obvious essentials of soldering iron or gun, spanners, screwdrivers, trimming tools, wire strippers, side cutters, and pliers. A heat shunt and several varieties of tweezers will be needed for work with transistors. The workbench should be fitted with a good vice, and some metalwork tools such as a hacksaw and twistdrills will be needed from time to time.

Spares

Building up a stock of spares is quite tricky if needless capital is not to be tied up. Resistors and capacitors are sufficiently cheap to enable a large stock to be held, but in the case of valves the best plan is to stock a small number of the most common types (your wholesaler will tell you which he sells most) and order others as they are required. Larger components like transformers and loudspeakers fortunately fail only rarely.

Wholesaler

You will, of course, need to open an account with your local wholesaler, although he will probably require cash settlement to begin with. It seems obvious to say this, but it is surprising the number of part-time servicemen who buy their components retail, thus cutting down on their profits. If your wholesaler runs a daily delivery, ordering parts as they are required will prove satisfactory, though in other cases it would lead to wasted time.

Advertising

The success of your business will first depend on the number of sets you can bring into your workshop, and subsequently on the reputation these earn for your skill. Advertisements in the local press should start the ball rolling, though these

should be display advertisements and not in the classified columns as this gives a cheap effect.

If well printed, showcards in the newsagents' windows will also be effective. It is best to advertise under a business name. This you can choose for yourself within limits, and the necessary form can be obtained from the Registrar of Business Names. The fee for registration as a business is 5s.

It is sometimes a good plan to write to the local retailers suggesting that they may like to farm out some of their work. It is often the case that a dealer employs a highly skilled television engineer who can ill afford the time working on sound radio, and then is very happy to farm out this section of his trade, adding a handling charge of his own. There are also a number of shops in rural areas whose custom would not justify a permanent engineer, but who would like to be able to accept what work there might be, if only for the goodwill that a good repair creates.

Stationery

Some printed stationery will be needed. Here it is well worth while investing in a really attractive result. Good printing is an art and creates an excellent impression; cut-price printing will save nothing in the long run. Business cards are the first essential. Also needed will be headed notepaper and a duplicate invoice book. It is a good idea to glue your business card neatly to the back of each set you handle, though you will not be able to do this with farmed-out work.

Technical Data

Amongst the technical data you will require are a comprehensive valve characteristic manual, and service sheets. An excellent and economical way of holding a large store of service sheets is to subscribe to Newnes Radio and Television Servicing Manuals. These list data for nearly every set made since 1955, besides some earlier models, and each year a fresh volume appears to keep the series up to date. It is foolish to attempt reliable servicing without the correct data and this is certainly a convenient form in which it may be purchased.

Transport

Some sort of transport will naturally be required. A smart new van, whilst ideal, would be rather extravagant. However, whatever kind of vehicle is used, new or secondhand, keep it clean and well maintained. A dirty vehicle creates a bad impression—so does a breakdown in the customer's driveway!

Accounts

Lastly, accounts. Here is where many self-employed men panic and worry needlessly. Keeping reasonable accounts is quite straightforward and need cause no headaches. If you have been put off by the sight of ledgers, filing cabinets, and strings of reference numbers, forget it. In many cases these are unnecessarily complicated.

You already have a duplicate invoice book—no separate receipt book is required. The whole system requires merely two ledgers. In one, as each set

comes in, you write in the date, name and address of customer, the make and number of the instrument, and the complaint. As you work on the set, note the parts used and adjustments made, and finally the price you have calculated.

This book, which is really a day-book, is merely for your own convenience. You have it as a record of all work done, and it will show you what kind of spares you use most, which faults occur most frequently in given makes, and so on. Also, if a set comes back under guarantee you can refer back to see what work was carried out.

The other ledger is the account book proper. The left-hand page can show all the outgoing, and the right-hand page the income and balance columns. All you have to do is record every item of expense as it occurs, with the date. On the right-hand page you record each payment by a customer. At the end of each week or month you only have to subtract expenses from income to show profit in a separate column.

Keep all invoices and receipts as these will be required by the accountant. To avoid complicated numbering systems, as each set comes in allot a job number. Enter this in the day book, and on the invoice you give to the customer, also in the account book. With only one series of numbers it is then a simple matter to refer from one book to another.

Don't forget to show all your expenses, including petrol, postage, and other daily items. If you are working full-time in your business you will also be buying weekly National Insurance stamps at the special weekly rate for self-employed persons. This is also a deductible expense. When the time comes for you to make a tax return it is worth while employing the services of a reputable accountant who will ensure that you receive the full allowances due to you.

Regarding the charging of jobs, a good general principle is to explain to the customers that if the charge is to be under say three pounds you will go ahead at once, but will, in other cases, submit an estimate. Free estimates are valuable goodwill, though in the case of smaller jobs they simply waste time.

Parts used should be charged retail price and a labour charge of 15s. per hour is reasonable. Remember to count time collecting and delivering, also collecting spares. Add a small charge when you use certain instruments which make the job quicker, such as the oscilloscope, thus helping to offset their outlay.

After a period, a careful look at your accounts will tell you whether an adjustment either way to your charges is necessary.

Reputation

Once you have made a start, your success in business will depend more on the reputation you acquire than on any advertising. The need for courtesy at all times is obvious. You must be reliable, call when you promise, and so on. If you have faith in your work you will guarantee it for at least six months.

Despite common opinions to the contrary, the writer has always believed that business and ethics can be mixed. The small trader is quickly recognised as conscientious, to his ultimate benefit. ■

Increasing METER Sensitivity

for TV testing

By T. L. May

WHEN an ordinary voltmeter is applied to a television receiver circuit to make a test, power is extracted from the test circuit to deflect the pointer of the instrument. This is all very well provided the test circuit is endowed with sufficient power to produce movement; but even though there may be quite a high voltage the power in the circuit may be totally inadequate to cause pointer deflection.

In this case, as soon as the voltmeter is applied, the voltage across the test circuit will drop either to zero or to a low value depending upon (a) how much power there is in the circuit and (b) how much power is required to deflect the pointer of the voltmeter.

High power can only be obtained in a low impedance television circuit. For example, there is a lot of power available at the output of the mains rectifier because this is a low impedance circuit. Thus, if we connected a voltmeter between the h.t. line and chassis we would read fairly accurately the voltage present at that point. The small power required to deflect the pointer on the meter is insignificant compared with the large power required to operate the set, so the meter would be accommodated without any fall in voltage.

Now, suppose we connected a $10M\Omega$ resistor to the h.t. line (Fig. 1). Without anything connected to the end of the resistor the full h.t. line voltage would exist at that point, relative to chassis. By connecting a voltmeter to that point, however, we should read nothing like the full h.t. line voltage. This is because the voltmeter wants power and to produce power current must flow in the $10M\Omega$ resistor, and because of the current flow there is a voltage drop across the resistor.

The amount of voltage drop depends upon the value of current—the smaller the current the smaller the volts drop—ordinary Ohm's law, $E=I \times R$, where E is the voltage dropped, I the current and R the resistance.

Sensitivity

The current required to deflect the pointer of the meter depends upon the sensitivity of the movement. The greater the sensitivity, the smaller the current required to give full-scale deflection (f.s.d.). It follows, therefore, that the higher the meter sensitivity, the less the voltage dropped across the $10M\Omega$ resistor and the more accurate the voltage reading. If the impossible condition of the meter

not taking any current at all could be achieved, then the reading would be exactly equal to the h.t. line voltage.

Many general-purpose voltmeters require 1mA of current (0.001A) for f.s.d. This means that for every f.s.d. volt that we require to measure on such a meter we must connect $1,000\Omega$ in series with the movement. Suppose it is required to measure 1V f.s.d., then a resistance must be selected that will pass exactly 1mA and 1V (taking into account the resistance of the meter winding itself). By Ohm's

law $\left(R = \frac{E}{I}\right)$ we find that this works out to $1,000\Omega$

—which proves the point! For 10V f.s.d. we must add $10,000\Omega$ of series resistance; $100,000\Omega$ for 100V f.s.d. and so on.

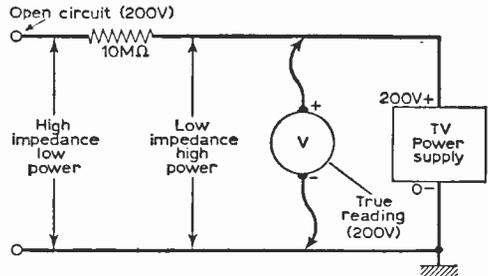


Fig. 1—Owing to the low impedance of the TV power supply, adequate power is available to deflect the pointer of the voltmeter without a fall in voltage.

With a meter of smaller sensitivity the series resistance per volt of f.s.d. is smaller, and larger for a meter of greater sensitivity. The resistance added per volt of f.s.d. is termed the Ω/V value of the voltmeter. This signifies the sensitivity of the voltmeter. Thus a movement of 1mA would make a voltmeter of $1,000\Omega/V$, a 10mA movement $100\Omega/V$ and a 0.1mA ($100\mu A$) movement $10,000\Omega/V$. A popular value for a TV voltmeter these days is $20,000\Omega/V$, having a movement with a nominal value of $50\mu A$.

Now to get back to our problem. Suppose that we connected a $1,000\Omega/V$ meter set to 200V f.s.d. to measure the voltage at the end of the $10M\Omega$ resistance, we would, in effect, be connecting a resistance of $200,000\Omega$ across the test point, as

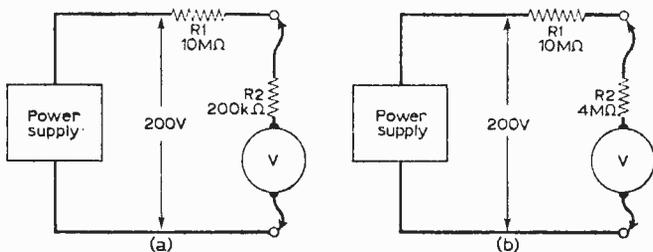


Fig. 2—Current flows in the 10MΩ resistor R1 by connecting a voltmeter, and the amount of error in voltage reading depends upon (i) the value of R1 and (ii) the sensitivity of the meter (see text).

shown in Fig. 2(a). We produce a potential-divider, and if we mark the 10MΩ resistor R1 and the meter series resistance R2, the voltage across R2—that is, the voltage indicated by the voltmeter—is equal to:

$$R2 \times E$$

$$R1 + R2$$

where E is the h.t. line voltage. Putting figures to these things, we get

$$0.2 \times 200$$

$$10 + 0.2$$

which works out to a little under 4V! Thus, the actual voltage is 200 and the indicated voltage 4, an error of 98%. By using a 20,000Ω/V meter, we would read on the 200V range

$$4 \times 200$$

$$10 + 4$$

which works out to about 56V, an error of 72%—still very high.

A meter of 100,000Ω/V would read about 133V (Fig. 2(b)), which still represents an error of about 34% and 100,000Ω/V meters are not usually possessed by the average enthusiast, though some service technicians may be lucky enough to have one. The best way of measuring voltage in such a high impedance circuit is by use of a volt voltmeter, in which the power to deflect the pointer is derived from a mains or battery operated valve circuit.

There is another way, however, which is by the use of a transistor, and this will now be described, as it may well represent an inexpensive solution to the problems outlined to many television enthusiasts and readers of this magazine.

Current Amplifier

A transistor is essentially a current amplifier, so it is a "natural" for increasing (or amplifying) the sensitivity of a meter movement. With such a current amplifier a relatively inexpensive and insensitive meter movement can be made as sensitive as an expensive microammeter.

A transistor has a current gain (often called "beta"), whereby the current in the collector circuit is proportional to the forward current in the emitter/base junction times the current gain. A transistor with a current gain of, say, 100 would give almost 1mA of collector current when a forward current of 10μA is flowing in the emitter/base junction. A full 1mA is not given (as may be expected for a current gain of 100; e.g., 1mA/10μA = 100) owing to various losses and the way that

the transistor is run in current amplifiers.

This does not matter, as we can always arrange for adjustments in the amplifier circuit and employ a transistor with a current gain in excess of the current step-up required. For example, it would be best to use a transistor with a current gain of, say, 100 to give a current step-up of 50; this leaves some gain in hand which can be varied as required by circuit adjustments to suit the meter employed.

The basic circuit of the current amplifier is given in

Fig. 3. The transistor is connected as an emitter-follower and the current in the emitter resistor R1 is almost equal to the collector current. The emitter-follower configuration makes it easy to connect the external meter. Actually, the meter is connected to a bridge circuit with the transistor and R1 as one arm and R2 and R3 (the set zero control) as the other arm.

With the amplifier switched on by S1, the bridge is balanced by R3, balance being indicated by zero

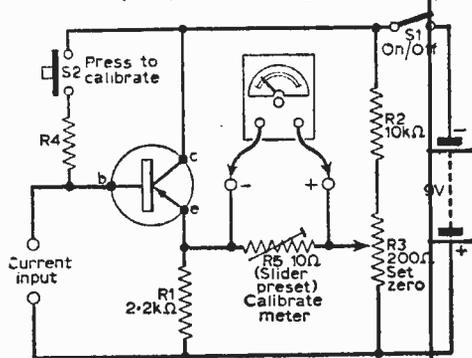


Fig. 3—Basic circuit of current amplifier. The procedure for setting up is as follows: first switch on S1, adjust R3 to zero the external meter adjusted to its lowest current range (e.g., 1mA f.s.d.), depress S2 and then adjust R5 to give f.s.d. on the external meter. See text for method of computing the value for the calibrate resistor R4.

reading on the meter. Note that the meter should be switched to its lowest current range (d.c., of course). The next move is to determine the current gain required. Say, for instance, the transistor has a beta of 100, then we can set the circuit to provide a gain of 50 without being too far on the edge.

If the lowest current f.s.d. given by the external meter is 1mA, the current gain of the amplifier will reduce this by a factor of 50 (e.g., 1mA/50 = 20μA). We want to get f.s.d. with a current of 20μA applied to the base circuit of the amplifier, and in order to do that we need to calibrate. This is not difficult, and is achieved by switching in the calibration resistor R4 by the "press to calibrate" switch S2.

Calibration Resistor

When S2 is depressed, 20μA must be applied to the base circuit, so we require to select the value for

R4 accordingly. The volts drop across R1 in the emitter is nominally 0.3V, so when S2 is depressed a voltage of 9V (the battery voltage) minus 0.3V, or 8.7V will appear across R4.

The resistance required to produce 20μA from 8.7V in megohms is equal to $\frac{8.7}{20}$, which is 0.435MΩ, or 435k. The nearest preferred value is 430k, and one which is slightly high could be

selected.

The next thing is to adjust the meter itself for f.s.d. when S2 is depressed, and this is done by adjusting the "calibrate meter" preset.

The foregoing, then, has revealed how a basic 1mA meter movement can be increased in sensitivity to 20μA f.s.d. by the use of a transistor adjusted to give an effective current gain relative to the meter of 50. As will now be clear, the beta of the transistor must be above 50, and one with a beta of 100 would suit admirably.

As Voltmeter

Set up in this way, the circuit would give a voltmeter sensitivity of 50,000Ω/V, meaning that for every volt f.s.d. 50,000Ω of series resistance is required. Incidentally, this series resistance, as with direct connection to a movement, is called multiplication resistance, and the components used multiplication resistors.

Fig. 4 shows how a seven-position rotary switch can be used to give f.s.d. voltage ranges of 1V, 2.5V, 10V, 25V, 100V, 250V and 1,000V and the required values for the multiplication resistors. The final accuracy of the instrument will, of course, depend upon (a) the accuracy of the calibrate resistor R4 and (b) the accuracy of the multiplication resistors.

While we have seen that the basic 1mA meter (1,000Ω/V) reads only about 4V of the 200V in Fig. 2(a), the "amplified" meter would read 100V, reducing the error from 98% to 50%—with the same movement.

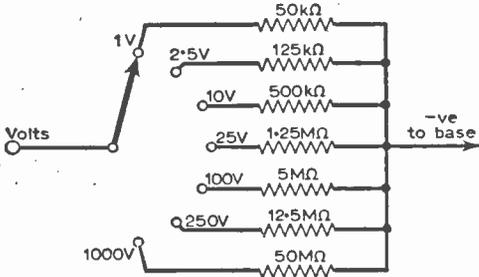


Fig. 4—With a transistor beta of approximately 100 (greater than 50) the sensitivity of a 1mA f.s.d. meter can be increased to 20μA f.s.d. and by using switched multiplier resistors as this illustration shows, a useful range of voltages can be measured. An eighth position can be used on the rotary switch if required for the "calibrate" position, thereby eliminating S2 in Fig. 3.

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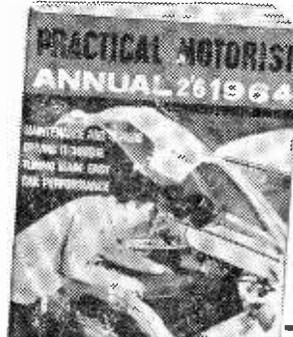
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**THE VIDEO
AMPLIFIER,
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IT can be shown mathematically that the picture information in a 405-line television transmission occupies a band of frequencies from 0 to 4Mc/s for commercially satisfactory picture definition. In order to amplify this information faithfully the amplifier must have a bandwidth of at least this figure (4Mc/s). This means that all frequencies within this range must be amplified by the same amount. However, it can be further shown that most of the picture information is contained in the band 0 to 2Mc/s and this is the bandwidth aimed for here.

The design of wideband amplifiers differs radically from that of the familiar audio frequency amplifier in that at high frequencies the valve capacitance and the inductance and capacitance of the associated circuits have a profound effect on the gain. Thus the limiting factor on the design is the high frequency performance of the valve used and it can be shown that for maximum gain the anode load of the valve must be made equal to the reactance of the output capacitance of the valve at the highest frequency to be used. Now the reactance of a capacitance is given by the formula:

$$X_c = \frac{1}{2\pi fC}$$

where X_c = reactance in ohms
 f = highest frequency in c/s
 C = capacitance in farads.

If we consider a valve such as the 6AC7 the output capacitance is about 15pF (including the strays in the coupling circuits) and if we aim for an upper frequency limit of 3.5Mc/s then by substitution we find that $X_c = 3.3k\Omega$ approximately. (This value is, in fact, the nearest preferred value of resistance to the actual calculated value.)

So for a 3.5Mc/s bandwidth we need an anode load of 3.3k Ω for maximum gain. It is obvious, then that as we increase the bandwidth we have to reduce the anode load and conversely an increase in anode load reduces the bandwidth. Another difficulty is that if we have two or more valves connected in cascade there is a further loss of bandwidth, and this reduction is proportional to the square root of the number of stages used. Thus if we use

three valves the bandwidth is reduced by $\frac{1}{\sqrt{3}}$ or

$\frac{1}{1.732}$ and this must be borne in mind when designing the amplifier.

The gain of a valve is given by:

$$\text{Amplification (A)} = \frac{\mu \times R_a}{R_a + r_a}$$

R_a = anode load
 r_a = anode impedance
 μ = amplification factor

for the r.f. pentode used $r_a = 1M\Omega$ so that $R_a + r_a \approx r_a$ since R_a is insignificant compared to

r_a , so that the gain is $\frac{\mu}{r_a} \times R_a$

now $\frac{\mu}{r_a} = g_m$ (mutual conductance) so that $A = R_a \times g_m$

for the 6AC7 $g_m = 9mA/V$, so that

$$A = \frac{9}{1.000} \times 3,000 = 27.$$

The gain required of the video amplifier is about 20,000 since the output required from the final stage is roughly 5V and the input derived from the photocell network will be 0.25mV.

How Many Valves?

The method of deciding how many valves are going to be used to achieve this gain is really a matter of trial and error since as we add more valves the bandwidth is reduced, which means that we have to reduce the anode loads to increase the bandwidth again. This causes the gain to be reduced so that a further valve must be added and the spiral starts again!

For the purpose of calculation the triode phase reversing stage built around V12A can be ignored because it is something of a special case. Looking at the theoretical circuit we see that three valves are used and are designed to have a level response from 0 to 3.5Mc/s. The overall bandwidth is therefore:

$$\frac{3.5}{\sqrt{3}} \approx 2 \text{ Mc/s which is what we require.}$$

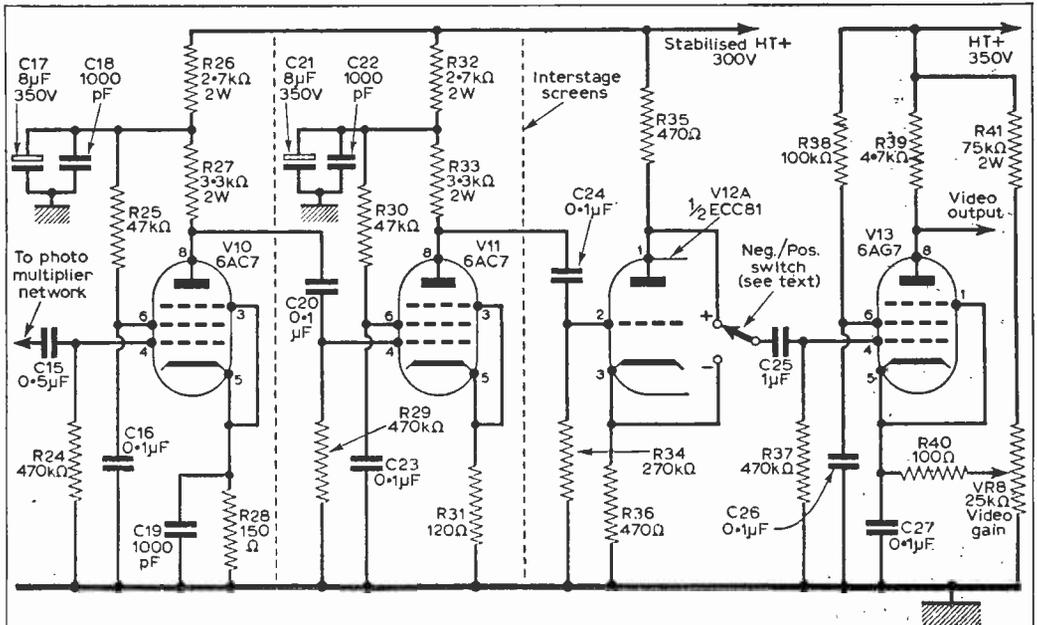


Fig. 16—The video amplifier circuit.

COMPONENTS LIST VIDEO AMPLIFIER (Fig. 16)

Resistors: $\pm 10\%$, $\frac{1}{4}$ W except where stated.

R24 470k Ω	R33 3.3k Ω 2W
R25 47k Ω	R34 270k Ω
R26 2.7k Ω 2W	R35 470 Ω
R27 3.3k Ω 2W	R36 470 Ω
R28 150 Ω	R37 470k Ω
R29 470k Ω	R38 100k Ω
R30 47k Ω	R39 4.7k Ω
R31 120 Ω	R40 100 Ω
R32 2.7k Ω 2W	R41 75k Ω 2W
VR8 25k Ω wire-wound	

Valves:

V10 6AC7	V11 6AC7
V12 ECC81	V13 6AG7

Capacitors:

C15 0.5 μ F paper
C16 0.1 μ F paper
C17 8 μ F electrolytic 350V
C18 1,000pF mica or ceramic
C19 1,000pF mica or ceramic
C20 0.1 μ F paper
C21 8 μ F electrolytic 350V
C22 1,000pF mica or ceramic
C23 0.1 μ F paper
C24 0.1 μ F paper
C25 1 μ F paper
C26 0.1 μ F paper
C27 0.1 μ F paper

Using the formula outlined above, the gain of V10 and V11 is 27 for each valve and V13 has a gain of 50 which means that the overall gain is

$$27 \times 27 \times 50 = 36,000 \text{ approx.}$$

This is more than our minimum requirement and is thus quite satisfactory. This extra gain is useful in that we have little in hand to compensate for losses, etc., unforeseen in the design. In order to obtain maximum gain in video stages we tend to find that we have low anode loads on the valves with comparatively high values of screen resistance. This, coupled with the fact that a high final gain is obtained and that the amplifier operates at low frequencies, means that the completed amplifier has a tendency to oscillate spontaneously at a low frequency. These low frequency oscillations are known as "motor boating".

To counteract this effect we decouple V10 and V11 anodes and run the valves from a stabilised h.t. line. Also, since the amplifier operates well into

the broadcast band we have to take every precaution against breakthrough at r.f. and one of the methods used is to decouple the h.t. line from the anode loads by means of a low capacitance. The low frequency decoupling circuits may be thought to be adequate for r.f. decoupling, but unfortunately the electrolytic capacitors used have a high inductance which defeats their high capacitance for this purpose. These, then, are the considerations underlying the design of the video circuit shown in Fig. 16.

Circuit Description

Considering V10 we see that it satisfies the design requirement in that a low value anode load is used. This load is decoupled by means of the 2.7k Ω resistor R26 and the 8 μ F capacitor C17 for low frequencies, and by this same resistor and the

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0Z4GT	4/3	9A9	10/9	10C1	9/3	30P14	12/3	D9F86	15/-	ECC88	10/-	EL41	7/3	KT41	7/6	PEN46	4/3	U16	15/-	UF41	6/9	0.81	3/-	
1C3	9/6	9C116	18/-	10C2	12/3	30P12	7/6	D9F88	5/9	ECC91	9/-	EL42	7/6	KT44	5/6	PEN39B	U19	48/6	UF42	4/9	0.19	25/-		
1D4	9/6	9C116	5/-	10F1	10/-	30P10	12/3	D9F87	10/-	90P9	9/9	EL43	6/3	KT46	6/9	10/3	D92	5/9	UF80	6/3	0.22	23/-		
1H5	4/-	9C14	24/-	10LD11	9/6	30P11	8/6	DH101	25/-	ECC90	6/-	EL43	6/9	KT68	3/9	PL33	9/-	C24	12/6	UF85	6/9	0.26	25/-	
1B5	3/6	9D3	9/6	10P13	8/3	30P13	9/6	DH107	16/11	ECC82	6/3	EL84	4/9	KT68	12/3	PL36	8/-	C25	8/6	UF86	9/-	0.28	12/6	
174	2/3	9E1	9/6	10P14	11/6	30P14	12/6	DK92	6/9	ECC86	11/6	EL85	7/6	KT88	28/-	PL38	18/-	C26	7/3	UF89	9/-	0.29	25/6	
2D21	6/6	9E13	4/9	12AC6	8/6	30C5	8/3	DK96	6/3	ECC82	9/9	EL86	7/6	KTW3	4/9	PL81	6/9	C31	6/9	UL1	6/6	0.35	15/-	
3A5	6/9	9F23	14/9	12A16	8/6	33L8GT	6/9	D989	15/-	ECC86	6/3	EL86	9/6	KTW3	8/6	PL82	5/3	C39	13/9	UL44	23/3	0.36	21/6	
3Q50T	7/-	9J7G	4/9	12A17	5/-	35Z3	16/4	D996	5/9	ECC81	5/9	EL360	27/-	MDL106	12/6	PL84	5/6	C37	29/-	UL84	8/6	0.44	8/3	
3B4	4/6	9K7G	7/3	12A18	9/-	35Z40T	4/6	DM70	5/-	ECC83	6/6	EL320	16/4	MT44	17/6	PL90	15/9	U45	15/6	UM4	15/2	0.45	8/6	
3V4	5/3	9K9G	3/3	12A16	4/6	35Z6GT	5/9	DM71	9/6	ECC184	9/6	EL322	18/6	PM84	9/3	PT82	9/3	U72	4/6	UM84	16/10	0.65	22/6	
5H4GY	8/6	9K35	24/-	12A19	5/9	30B3	6/6	DY86	7/6	EL386	6/-	EL380	20/5	PT84	9/-	U91	9/9	UM80	8/3	0.68	25/-			
5C4G	4/9	9L11	10/-	12A14	6/9	30C3	8/6	E90F	24/-	ECL82	3/-	EM4	17/9	N37	23/3	PY31	6/6	U251	9/-	U6	9/-	0.70	6/6	
5V4G	7/6	9L6G	6/6	12BA6	5/9	30L6GT	6/3	E93F	24/-	ECL83	9/6	EM34	11/6	N18	38/-	PY32	8/6	U282	12/3	U8	11/6	0.71	8/6	
5V30T	4/3	9L7GT	4/6	12B16	4/9	38K14	14/6	E98CC	10/-	ECL86	9/9	EM71	13/6	PT2	10/-	PY33	8/9	U301	11/8	UV1N	10/3	0.72	8/6	
5Z3	7/-	9L18	10/-	12B17	6/9	72	8/6	E180F	19/6	EP26	8/3	EM80	8/3	PC80	6/9	PY80	5/3	U404	6/-	UV21	8/-	0.73	16/-	
5Z4G	7/-	9L20	3/6	12C3	10/-	55A2	8/6	EAS9	1/6	EP37A	3/9	EM81	6/9	PC80	6/9	PY81	5/3	U401	16/3	UV41	4/6	0.74	8/6	
6A7	8/9	9P28	11/6	18A65	7/3	90A6	8/6	EABCO80	5/6	EP86	6/9	EM84	6/9	PC86	10/3	PY82	4/9	U420	6/6	U85	6/-	0.75	8/6	
6A8	5/9	9Q7G	4/6	19H1	6/-	90AV	8/6	EAF42	7/-	EP40	8/9	EM85	8/9	PC88	14/7	PY88	5/9	U4BC80	5/-	VP4	14/6	0.76	8/6	
6AC7	3/-	9R7G	5/9	20D1	10/-	90C1	16/-	EB34	1/-	EF41	6/9	EM87	15/2	PC86	11/8	PY88	7/9	U4F42	7/-	VR165	6/6	0.77	12/-	
6AG7	5/9	9C4GT	8/6	20F2	11/6	90F2	42/-	EB41	4/9	EF42	4/9	EV31	5/9	PC94	5/9	PY80	6/6	U4F41	10/6	VR150	4/8	0.78	8/6	
6AQ5	5/9	9V99	3/9	30L1	12/6	90V9	42/-	EB91	2/3	EF73	5/-	EV81	7/3	PC93	6/9	PY81	7/-	UR41	6/9	W107	10/6	0.81	4/-	
6AT6	3/9	9X3	3/9	30P1	12/6	130Z2	18/6	ED32	8/6	EF82	9/9	EV82	9/9	PC93	6/9	U10	20/6	UR81	6/3	W29	17/6	0.81D	4/6	
6AU6	5/3	9X3	4/6	30P3	12/-	185BT	34/11	ED44	6/6	EF83	9/6	EV84	9/6	PC98	10/6	U17	17/6	URF80	5/9	X41	15/-	0.82	10/-	
6AV6	6/6	9J91Z	3/3	30P4	13/6	96B4	12/6	EB61	6/-	EF85	4/9	EV86	5/9	PC99	7/9	U18	9/6	URF89	5/9	X65	7/3	0.83	6/-	
6BA6	4/6	9B6	12/6	20P3	12/3	57B3	7/6	EBF80	5/6	EF86	6/-	EV88	8/6	PC189	10/6	U19	6/6	UR121	9/9	X78	20/6	0.84	8/6	
6B98	4/6	9B7	7/-	32Z4G	6/6	7473	2/9	EBF83	7/3	EP89	4/-	EZ40	5/3	PC98	5/6	EP41	2/-	UC92	6/3	X79	20/6	0.84	8/6	
6B98A1	13/6	7C3	7/3	25V30	7/9	AC9PEN	4/9	EBF89	6/3	EP91	5/-	EZ41	6/-	PC98	6/9	EP41	2/-	UC94	5/9	Y63	5/-	0.81T	9/6	
6BR6	6/3	9C4	6/9	278C	23/3	14Z1	6/6	EL121	8/-	EP92	2/6	EZ40	4/-	PC94	8/6	EP45	27/2	UC95	6/3	Z66	7/3	0.81T	17/6	
6B16	6/6	9H7	5/9	30C13	9/-	AZ41	6/6	ELC70	4/9	EP95	4/9	EZ81	4/-	EP36	7/9	TA1	9/-	UCF80	8/9	Transistors	IM	T100	7/9	
6BQ7A	7/6	9R7	12/6	30A18	10/6	E39	4/9	E881	27/6	EP97	11/8	EZ33	17/6	PL82	6/6	TH41	13/-	UCB21	8/3	and diodes	IM	T101	8/6	
6BR7	8/6	9R7	14/6	30F5	5/9	ELC13	11/6	E932	6/6	EP98	7/6	EZ34	10/-	PL83	7/9	TH33A	6/9	UCH42	7/-	AT17	8/6	M	T20	7/9
6BR8	8/-	9Y4	14/6	30FL1	9/3	CV31	5/9	E934	7/6	EP184	27/9	H4HC90	9/3	PL84	7/-	TH9F	11/6	UCB81	6/6	OA70	9/-	M	T21	8/6

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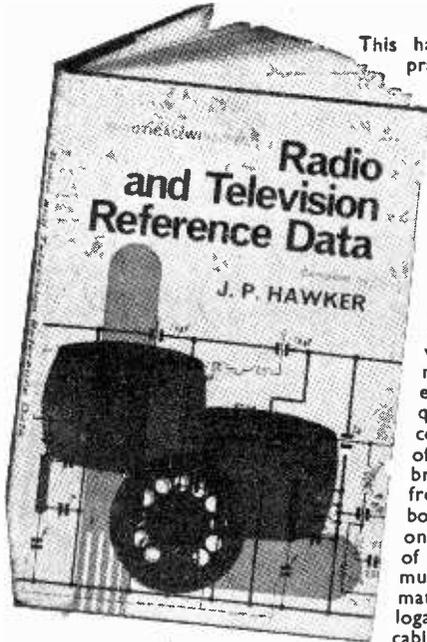
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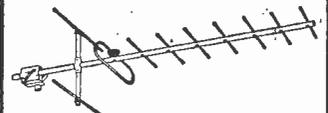
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1,000pF capacitor C18 at radio frequencies. The cathode bias resistor R28 is by-passed by a 0.001μF capacitor C19 which has the effect of slightly increasing the h.f. response of the amplifier which otherwise tends to fall off in the other stages.

The input signal from the photocell network is presented to the grid of V10 by way of the 0.5μF capacitor C15, is amplified and passed on to V11 which has circuitry similar to that for V10 save for the capacitor in the cathode circuit.

The output from V11 is fed to the phase reversing stage which is constructed around one triode section of an ECC81 (V12A). This stage enables us to select a positive or negative going wave form and this means that a positive picture can be obtained from a photographic negative, or alternatively a positive picture can be obtained from a positive transparency (such as a cellophane wrapper) depending on the switch position.

direct as possible. Especially sensitive in this respect are the resistors in the control grid circuits and the r.f. decoupling capacitor in the anode networks. Heater wires must be twisted together to reduce hum. The interstage coupling capacitors should be mounted a little way from the chassis to reduce their inductance and capacitance to earth and should be of a high quality. If metal clad capacitors are to be used they should not be clamped to the chassis.

The metal screen between stages is useful in reducing r.f. pick-up and in helping to prevent instability. As the anode and screen resistors tend to get a little warm it is advisable to mount these components as far away as possible from waxed capacitors and from the electrolytics—but remembering that short connections are still vital.

If these points are noted the construction of the video amplifier—one of the more critical parts of

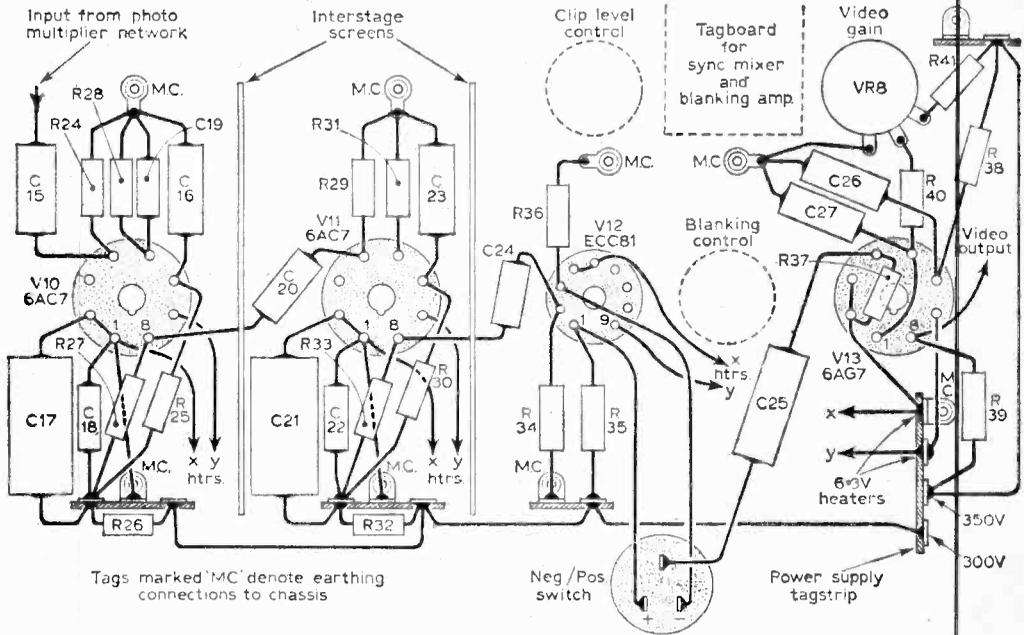


Fig. 17—Wiring for the video strip.

The output from this V12A is coupled to the output stage V13 by means of the capacitor C25 which must be a good quality paper type. The cathode of V13, the video output stage, is biased from the h.t. line by way of the wirewound potentiometer VR8 and the resistor R41, and has the effect of varying the gain of V13 and thus of the whole amplifier. VR8 is therefore the video gain control.

Construction

The wiring diagram of the video amplifier is shown in Fig. 17. This diagram has been expanded to show the circuit effectively, but in the actual construction all connections should be as short and

the entire circuit as far as component tolerances are concerned, should be a fairly simple procedure.

Testing

If the video output at the anode of V13 is connected to a pair of headphones via a 0.5μF 500V working capacitor (see Fig. 18) and the unit switched on, then on touching the grid connection to V10 with the finger or the blade of a screwdriver a loud buzz possibly accompanied by the sound of the local broadcasting station should be heard in the headphones. The gain of the amplifier will be controlled by varying VR8, maximum gain being obtained when the slider of the control is at the earthy end of its track.

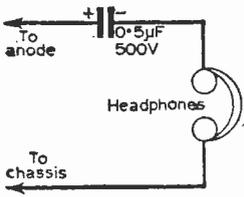


Fig. 18—Test circuit for video amplifier.

With the input to V10 shorted to earth and full gain on the amplifier nothing should be heard at the output other than white noise which is noticeable as a general hiss. Should radio breakthrough occur the decoupling circuits should be examined and if excessive hum is present attention should be paid to the heater wiring to minimise hum pick-up

Fig. 20—The sync pulse clipping action.

in the early stages. If no output is obtained with the "finger test", each stage should be checked individually to find the faulty section starting with V10, and progressing through the circuit. When all is correct the final check is to connect a length of wire to the input at V10 when the local broadcast stations will be heard at V13 anode.

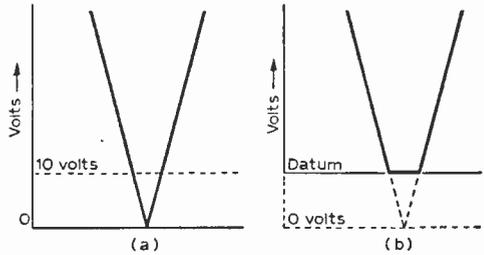
Test Voltages for Video Amplifier				
	H.T. 300V		H.T. 350V	
Anode voltage	250	250	300	350
Anode current (mA)	10	10	10	0
Screen voltage	160	160	—	80
Cathode voltage	1.5	1.2	0.5	300

measured with 20,000Ω/V meter.
* Depends on setting of VR1

THE SYNC MIXER AND BLANKING AMPLIFIER

This section of the circuit is considered now since it is constructed around the second triode section of the ECC81 (V12B) used in the video amplifier.

The purpose of this circuit (see Fig. 19) is to form the pulses received from the screens of the timebase generators into a suitable shape to feed into the modulator and thence to the monitor for synchronisation. Unfortunately, just "any-old-pulse" will not do for synchronisation purposes and we have to make the wave form look correct before passing it on to the monitor timebases.



The correct shape for synchronising pulses for feeding into a domestic television receiver is a square wave and as can be seen from Fig. 13 the pulses obtained at the screen grids are a sharp V shape. For the line sync pulse this shape is almost satisfactory and all we need to do is to clip off the lower section of the pulse and this may be done in the following way.

Consider the pulse shown in Fig. 20(a). If we regard the pulse from the zero volts datum line, then the pulse will have a V shape, but if we regard the same pulse from the 10V datum and take any-

COMPONENTS LIST SYNC MIXER AND BLANKING AMPLIFIER (Fig. 19)

Resistors:

- R42 100kΩ
- R43 2.2kΩ
- R44 47kΩ
- R45 100kΩ
- VR9 500kΩ potentiometer
- VR10 25kΩ potentiometer
- R46 47kΩ
- R47 47kΩ
- R48 470kΩ
- R49 100kΩ

Capacitors:

- C28 0.1µF paper
- C29 0.1µF paper
- C30 100pF mica or ceramic
- C31 5,000pF mica or ceramic
- C32 5,000pF mica or ceramic
- C33 25µF electrolytic 25V

Valves:

- V12B ECC81 (see Fig. 16)
- D1 OA71
- D2 OA71
- D3 OA71

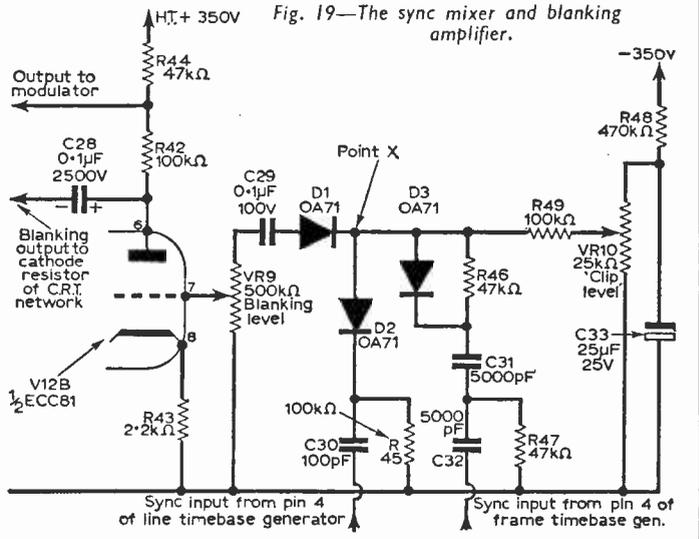
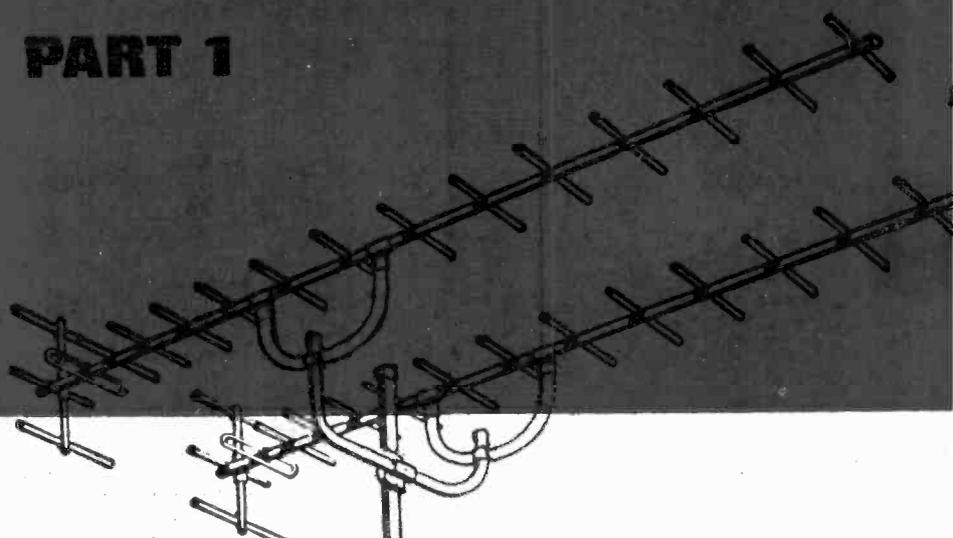


Fig. 19—The sync mixer and blanking amplifier.

PART 1



By K. Royal

THE new u.h.f. BBC-2 aeri- als which are now beginning to adorn chimney stacks in the London region are nothing more than scaled-down versions of the v.h.f. BBC-1 and ITV aeri- als. Television aeri- als are tuned devices made up of inductance and capacitance just like any electrical tuned circuit. With an ordinary tuned circuit made up of a coil of inductance L and capacitance C an increase in tuned frequency is accomplished either by taking turns from the coil (to decrease the value of L) or by reducing the value of C (or both).

When the tuned frequency is decreased, of course, L or C (or both) is made larger.

FREQUENCY AND WAVELENGTH

The frequency is the number of times that a complete cycle of waveform occurs in one second. The wavelength of the signal is the distance taken by one complete cycle (see Fig. 1).

Radio waves, in common with the other types of so-called electro-magnetic waves such as light rays, X-rays and cosmic rays, travel (in free space) at the speed of 186,000 miles per second. The metric system is usually adopted here and the equivalent of 186,000 miles is 300,000,000 metres. We can thus say that radio waves travel at a speed of 300,000,000 metres per second.

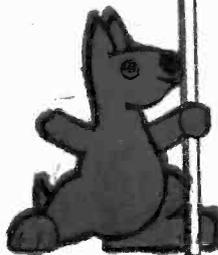
The wavelength then is equal to the distance that the wave travels in one second divided by the number of times that the wave occurs in one second.

This can be put in a little formula like this:

$$\text{Wavelength } (\lambda) = \frac{300,000,000}{\text{frequency } (c/s)} \text{ or}$$

$$\text{Wavelength } (\lambda) = \frac{300}{\text{frequency } (Mc/s)}$$

The wavelength is measured in metres or centimetres and is usually signified by the Greek letter lambda (λ).



As a practical example the wavelength corresponding to a frequency of 50Mc/s (in Band I) is equal to 300/50, that is six metres. At 200Mc/s in Band III the wavelength is 1.5 metres, at 500Mc/s in Band IV it is 0.6 metre, at the very top of Band V it is 30 centimetres.

To complete this little exercise the frequency of a signal of a given wavelength can be found by using the formula:

$$\text{Frequency } (Mc/s) = \frac{300}{\lambda \text{ (metres)}}$$

Now if we have a rod that is equal in length to the wavelength of the signal we wish to receive we obtain very good conditions for inducing into the rod almost the maximum possible signal strength. The effect is that a "standing wave" would appear across the rod from one end to the other as shown in Fig. 2.

This wave can represent the change of signal current in the rod and it will be seen that the current starts at zero, rises to a maximum positive value and then drops to zero again. This scheme is repeated but this time the current rises to a maximum negative value. We thus have two half-waves which, apart from polarity, are identical from the current change aspect.

HALF-WAVE DIPOLE

From a practical point of view this means that if we have a rod which is only a half of a full wavelength long the signal pick-up efficiency is about the same as that of a rod a full wavelength long.

This is just as well as otherwise there would be twice as much ironmongery adorning the roofs of houses all over the world as there is today! As a practical example the rods of, say, a Channel 1 aerial would all approximate 21ft 4in. in length instead of the typical 10ft 7in. for that channel.

AERIAL DESIGN FOR

B B C 2

We have seen, therefore, that to increase frequency (reduce wavelength) on an aerial we have to reduce its length. This action effectively reduces the L and C elements which are possessed by aerials as by conventional tuned circuits.

It follows that if we have an aerial tuned to, say, 50Mc/s an aerial tuned to 25Mc/s would be double the length and one tuned to 100Mc/s would be half the length. 50Mc/s is in Band I and 200Mc/s is in Band III, which means that a Band III aerial is approximately a quarter of the length (depending upon the exact channel) of a Band I aerial. 800Mc/s is in Band V, which means that a Band V aerial is approximately a quarter of the length (again depending upon the exact channel) of a Band III aerial.

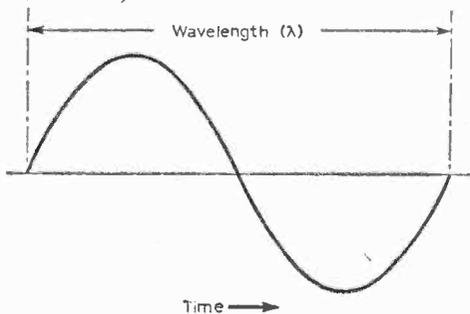


Fig. 1—The wavelength of an electromagnetic wave is the distance between one whole waveform as shown. The frequency is the number of times that the wave repeats in one second.

Very approximately, therefore, we can say that the new u.h.f. aerials for BBC-2 have rods which are about an eighth of the length of those on the BBC-1 aerials and about a quarter of the length of those on the ITV-1 aerial. To give very rough figures a Band I aerial may be 8ft long, a Band III aerial 2ft long and a Band V aerial 1ft long. These lengths should not be used for constructing aerials as they are given simply to illustrate the approximate ratios of rod lengths over the three bands.

VELOCITY FACTORS

When the wave of a radio signal comes up against a tuned aerial the wave tends to slow down a little from its free-space velocity of 300,000,000 metres per second. This also happens when the signal from an aerial is directed along a feeder cable

for application to the receiver. The aerial and cable are said to have a "velocity factor" which is less than unity which corresponds to the unrestrictured free-air propagation.

We need not bother too much about velocity factors and the like, suffice to say that the reduction in wave velocity means that the length of the aerial rod does not quite correspond to the length of the wave for optimum tuning. The aerial rod is, in fact, generally made about 95% of the length of the signal wave.

Other factors are involved here. For example the aerial insulator, the manner in which the aerial rod is connected to the feeder and the proximity of the aerial to objects such as other aerials, the

roof, metal pipes and so forth. All these things tend to have some influence on the ideal length of the aerial rod and hence the tuning of the aerial. The length of any aerial then is based on some sort of compromise!

A signal wave induces into a rod whose length approximates that of half the length of the wave, both voltage and current waveforms as shown in Fig. 3. This diagram represents a typical half-wave aerial from which it will be seen that the voltage is at a maximum at each end of the rod while the current is at a maximum at the centre of the rod. Should the length of the rod differ substantially from the signal half-wavelength then these conditions will no longer hold. This is rather an important point to keep in mind.

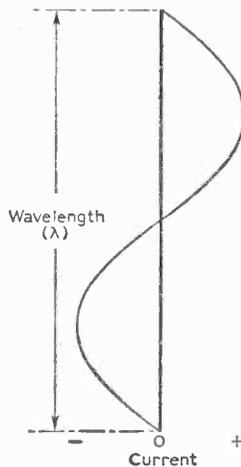


Fig. 2—A standing wave of signal induced into a rod approximately equal in length to that of the wave.

CENTRE

The most popular arrangement for extracting signal from such an aerial is to sever the rod in the middle, at the minimum voltage maximum current point, and connect the break across a suitable feeder cable that will convey the aerial signal to the set without too much being lost on the way.

We thus have two rods each approximately a quarter of a wavelength long which are supported mechanically at the centre by an insulator. The insulator holds the ends of the two rods about a quarter of an inch apart and is made of a material that does not short-circuit the signal. The arrangement is usually referred to as a half-wave "dipole".

IMPEDANCE

Since a dipole is concerned with both current and voltage it possesses impedance the value of which is equal to the voltage-to-current ratio. At the centre of the dipole the impedance must be low, since the current is high and the voltage low. If the voltage were zero then the impedance would be zero. In practice, however, there is always a little voltage, even at the centre, and this, in conjunction with the current at the centre, gives an impedance around 72Ω . The impedance rises, of course, up the rods and at the end it is high—several thousand ohms.

While some aerials are fed from the ends (end fed), most of the u.h.f. aerials for BBC-2 are fed from the centre (Fig. 4). This applies also to many BBC-1 and ITV-1 v.h.f. aerials.

With this in mind, coaxial cable (and twin feeder) is made to suit the 72Ω centre impedance of a dipole, that is the cable itself has a characteristic impedance of 72Ω . A cable of impedance to match that of the aerial is essential to avoid signal losses and reflections which could impair the reception, especially of BBC-2.

If the impedance of the dipole at the feeder connecting point differs substantially from that of the feeder cable then a transformer must be connected between the dipole and the feeder to restore the matching or else some other impedance matching artifice must be adopted, as we shall see.

BBC-2 DIPOLE

We now have sufficient information from which we can make our own BBC-2 dipole. In the London area BBC-2 has a vision frequency of 567.25Mc/s and a sound frequency of 573.25Mc/s , corresponding to Channel 33. This represents a mean frequency, between the sound and vision carriers, of 570.25Mc/s .

It is often desirable to design an aerial for mid-channel working, particularly in service areas. In fringe areas it may be best to design more towards the vision carrier frequency. However, it should be remembered that a u.h.f. aerial is often designed to work over a number of channels. This will be considered later.

Let us suppose that we want a dipole tuned to the mean of Channel 33. The wavelength in metres is equal to $300/570.25$, that is 0.526 metres or 5.26 centimetres. To convert 0.526 metres to feet we divide by 0.3048 . This works out to 1.6ft or $1\text{ft } 7\frac{1}{4}\text{in}$. For half-wavelength we divide this by two, which gives $9\frac{1}{2}\text{in}$. As a practical aerial is 95% of this length we multiply by 0.95 , which gives an overall dipole length of $9\frac{1}{4}\text{in}$.

Actually there are one or two approximations in the above working but at least it serves clearly to reveal the basic principles involved in the calculation.

The whole process can be simplified and the length in feet for the dipole calculated from the

formula:

$$\text{Length (ft)} = \frac{468}{f (\text{Mc/s})}$$

Since one works in inches rather than in feet so far as the design of u.h.f. aerials is concerned the following formula will be useful:

$$\text{Overall dipole length (in.)} = \frac{5616}{f (\text{Mc/s})}$$

WIDEBAND WORKING

Although an aerial is designed towards a specific frequency the tuned circuit is heavily damped and the effective Q is low. This gives the aerial wide-band characteristics so that signals using frequencies removed from the design frequency are also embraced. It is because of this that a single aerial serves for both the vision and the sound signals. If an aerial was a high Q circuit and damping was not possible two aerials would be needed for each television channel—one for sound and one for vision!

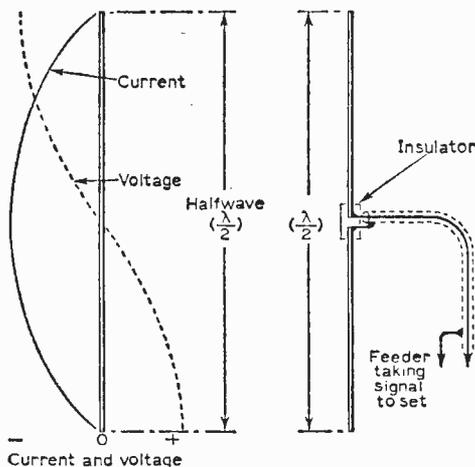


Fig. 3 (left)—A signal wave induces into a rod whose length approximates that of half the length of the wave both current and voltage waveforms, as this diagram shows.

Fig. 4 (right)—A half-wave dipole comprises two quarter-wave rods separated at the centre by about a quarter of an inch.

Aerials designed for the higher frequency channels have a greater bandwidth than aerials designed for the lower frequency channels. For example a Band I aerial needs to be cut fairly accurately to the required channel, since its response falls off relatively sharply either side of the tuned channel.

A Band III aerial has a wider passband and such an aerial would probably respond to the adjacent channels either side of the tuned channel, thereby rendering it suitable for use over three adjacent channels.

On the u.h.f. bands the bandwidth of an aerial is automatically greater and most commercial BBC-2 aerials are designed for working over a spectrum of 88Mc/s . In the London u.h.f. region Channels

23, 26, 30 and 33 are allocated. Channel 33 is the first to start, carrying BBC-2.

Each u.h.f. channel is 8Mc/s wide with guard channels between. Thus a u.h.f. aerial for the London region should be designed to embrace 11 8Mc/s channels from about 486Mc/s to 574Mc/s. The same will apply to aerials for certain other regions (Suffolk, for instance). However, this 88Mc/s spectrum will not apply in all parts of the country. Hampshire, for instance, is allocated Channels 39, 42, 45 and 68, representing 232Mc/s.

For the very best results, especially in deep fringe areas, an aerial should be optimised for one particular channel. This also applies to DX television activities.

Nevertheless, for most general u.h.f. reception an aerial designed for broadband working over 88Mc/s is perfectly adequate.

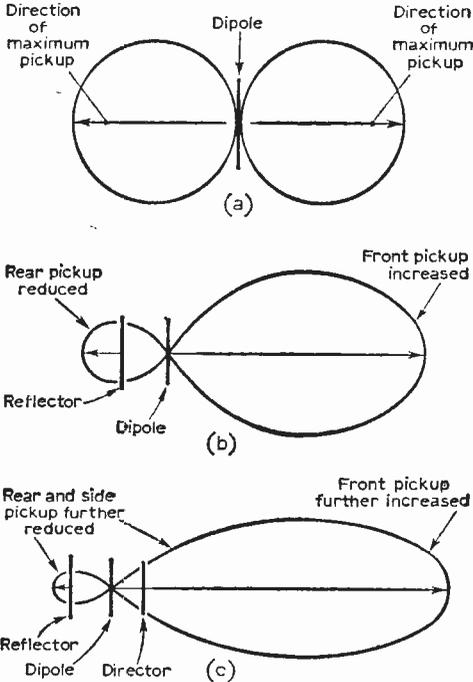


Fig. 5—A single horizontally-mounted u.h.f. dipole has a polar diagram as shown at (a), where the pick-up is equal at either broadside and minimum along the length of the dipole. The pickup pattern at (b) and (c) are altered by the addition of a reflector and reflector plus director respectively.

The mean of the London region channels is 530Mc/s, so a London dipole should be cut towards that frequency. The overall length of the dipole is then 5,616/530in. (from the above formula), which is 10.595in. This is just a little longer than a dipole designed specifically for Channel 33.

A single dipole of only about 10½in. in length does not represent very much metal with which to "grip" the signal and only in very strong signal locations, free from multipath interference (ghosting), would such a simple aerial work.

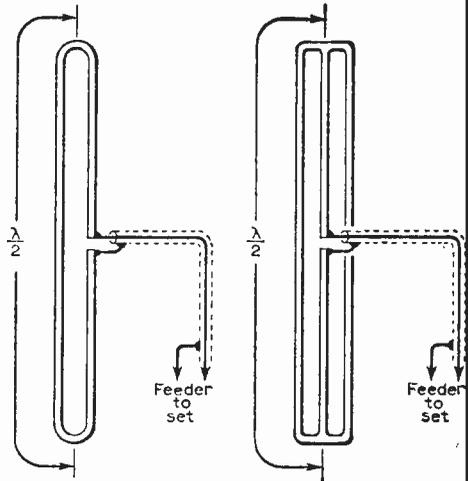


Fig. 6 (left)—A simple folded dipole. This increases the impedance four times.
Fig. 7 (right)—A triple fold dipole.

REFLECTORS AND DIRECTORS

The dipole cannot be increased in length because it is tuned, so the only thing that can be done to make the aerial more "powerful" is to add a reflector and a number of directors.

A rod placed behind the dipole is called a reflector and a rod placed in front of the dipole is called a director. A reflector considerably reduces the pick-up at the rear of the aerial and adds to the pick-up efficiency at the front, while a director further adds to the front pick-up efficiency and tends to cut down the response at the side. Reflector and director rods are known as parasitic elements.

PARASITIC ELEMENT LENGTHS

The u.h.f. signals are horizontally polarised. This means that the aerial must be positioned so that its rods are horizontal. A single horizontally mounted dipole has a signal pick-up pattern (polar diagram) in the form of a figure eight as shown at (a) in Fig. 5. Diagrams (b) and (c) show how the pick-up pattern is altered by the addition of a reflector and reflector plus director respectively.

For the best results a reflector should be about 5% longer than the dipole and the director about 5% shorter than the dipole. The following formulae are useful in calculating the length of these elements:

$$\text{Length of reflector (in.)} = \frac{5976}{f \text{ (Mc/s)}}$$

$$\text{Length of director (in.)} = \frac{5400}{f \text{ (Mc/s)}}$$

For the London region stations, therefore, the reflector would be 11.275in. and the director 10.188in.

SPACING OF ELEMENTS

For the best gain the reflector should be spaced

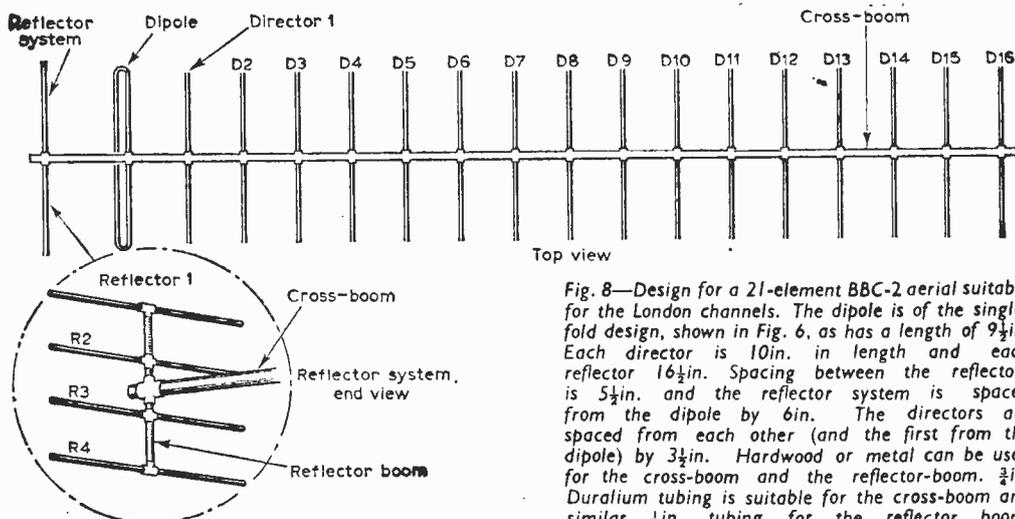


Fig. 8—Design for a 21-element BBC-2 aerial suitable for the London channels. The dipole is of the single-fold design, shown in Fig. 6, as has a length of $9\frac{1}{2}$ in. Each director is 10 in. in length and each reflector $16\frac{1}{2}$ in. Spacing between the reflectors is $5\frac{1}{2}$ in. and the reflector system is spaced from the dipole by 6 in. The directors are spaced from each other (and the first from the dipole) by $3\frac{1}{2}$ in. Hardwood or metal can be used for the cross-boom and the reflector-boom. $\frac{3}{8}$ in. Duralium tubing is suitable for the cross-boom and similar $\frac{1}{2}$ in. tubing for the reflector boom. Duralium rod of $\frac{3}{8}$ in. in diameter is suitable for the elements themselves, since they are very short. Electrical connection may be maintained between all elements (though this is not essential if wood is used) apart, of course, from across the open end of the folded dipole, across which an insulator must be fitted.

about 0.15 wavelength from the dipole and the director about 0.1 wavelength from the dipole.

The wavelength of the London region stations (that is the mean wavelength) is 300/530 metres, which works out to 0.565 metres. 0.15 of this value (0.565×0.15) works out to 0.08475 metre or 8.475 centimetres. To convert centimetres to inches we divide by 2.54, which gives the dipole/reflector spacing of 3.33 in.

0.1 of 0.565 (0.565×0.1) works out to 0.0565 metre or 5.65 centimetres, which converts to 2.22 in. and gives the dipole/director spacing.

It is in the element spacings that we may find the greatest difference between aerials of different design, even though they may all be designed for the London region channels.

Reflector-dipole and director-dipole spacings of 0.15 wavelength and 0.1 wavelength respectively, whilst giving the greatest gain, do tend to be somewhat critical and vibration of the elements due to wind or other causes could cause picture flutter effects. For this reason arbitrary spacings, somewhat in excess of those for maximum gain, are often employed in practice. Typical dipole-reflector and dipole-director spacings are 5 in. and $3\frac{1}{2}$ in. respectively.

Now when parasitic elements are added to a dipole aerial the impedance at the centre of the dipole (see Fig. 4) tends to fall well below the dipole-only impedance of 72Ω . Indeed the impedance may drop to around 18Ω and a very poor match then exists between the dipole and the feeder cable.

THE FOLDED DIPOLE

Something must be done to step up the dipole impedance again so that it approximates that of the cable. One simple and effective way of accomplishing this is by folding a full-wave rod dipole as shown in Fig. 6; this results in a folded (half-wave) dipole. One simple fold like this increases the centre impedance by four times, so if the impedance is down to 18Ω due to the addition of parasitic elements, a simple fold steps it up again to 72Ω . Very convenient, to say the least!

The array is best supported at the point of balance along the cross-boom and it should be connected to the u.h.f. socket on the set through special low-loss coaxial cable.

The array has very high directivity and care is necessary to orientate it for the maximum signal pickup.

This technique is adopted on the majority of BBC-2 aerials and in some very complicated designs there may be a triple fold (Fig. 7) and tapering of the dipole metal to secure to optimum conditions over a wide frequency spectrum. A triple fold incidentally increases the impedance nine times. The length of a folded dipole is measured from the middle of the bend at one end, round one of the sides to the middle of the opposite bend, as shown in Fig. 6.

TYPICAL ARRAYS

We now have the basic ingredients necessary to make up our own BBC-2 arrays. As the elements and element spacings are so small, arrays of up to 21 elements are relatively compact. There is not much point in adding any more than about 16 directors (the director-director spacing should equal the director-dipole spacing originally computed), but with four reflectors, plus the dipole, these give an array of 21 elements as shown in Fig. 8.

Instead of reflector rods, the reflector can comprise a sheet of expanded metal (alloy for light weight) about a full wavelength square ($22\frac{1}{2}$ in. square for the London region channels). Spacing should then be approximately a quarter wavelength from the dipole ($5\frac{1}{2}$ in. for the London channels).

NEXT MONTH PRACTICAL AND CONSTRUCTIONAL DETAILS OF U.H.F. AERIALS



SERVICING TELEVISION RECEIVERS

No. 99: PHILIPS 17TG1000
and 21TG1000

By L. Lawry-Johns

CONTINUED FROM PAGE 227 OF THE FEBRUARY ISSUE

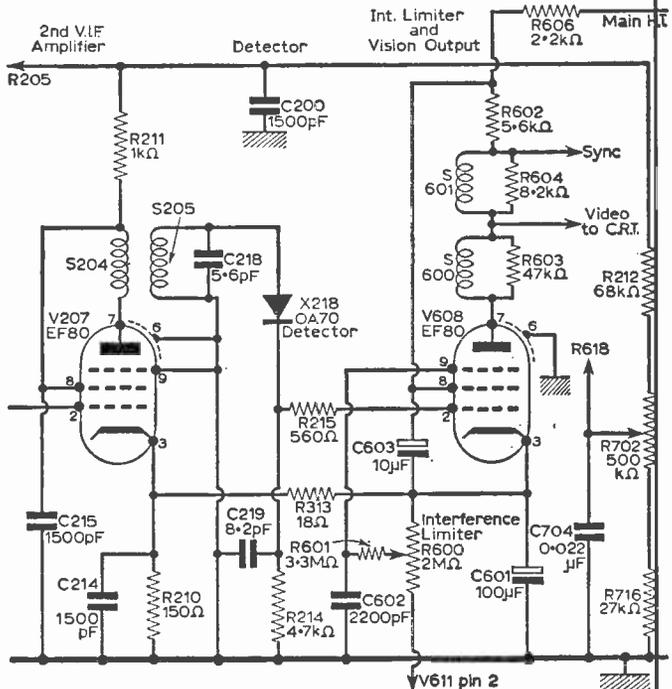
WHEN it appears that there is no current flowing through the set and there is no sign of life at all from the set the first action must be, of course, to ensure that mains voltage is being applied to it.

A small neon screwdriver is all that is needed for this type of test. The live mains input is taken first to the main fuse (Z721) and should be present at least on one side of the holder if mains voltage is being applied. If the neon does not light, touch it to chassis as the mains plug could be wrongly wired (live to chassis) or wrongly inserted. Remedy this immediately if necessary.

Assuming the neon lights one side of the fuse but not the other, check for obvious shorts before replacing. If there are no obvious shorts replace the fuse and observe the valves carefully. If there is a delay of a minute or

the mains dropper sections, pin 9 of each PY82, the thermistor R710 and thence to pins 4 and 5 of each PY82, following along to the PY81 heater pins, PL81, ECL80 and so on until the neon is found to light at one heater pin but not the other, say at pin 4 but not pin 5.

This procedure rapidly reveals where the break in the circuit is occurring. The c.r.t. heater is the final link in the heater chain (pins 1 and 8) before the return to chassis, but the condition may be met



where the neon lights at all points, including chassis, even though the mains leads are intact and are wired correctly. This directs attention to the on/off switch, which completes the return to the mains, or the mains lead itself, which could be fractured.

Hum Bars on Picture and Sound Rippled

Check both tuner valves for heater-cathode leaks and if neither is at fault check the h.t. electrolytics C708 and C709. If C708 is open-circuited the h.t. voltage will fall, causing the picture to be small, but this may not be as severe as one might expect.

For example, if R211 is found burned out check C215, 1,500pF, which may have shorted to chassis.

If the OA70 is at fault some very faint modulation will usually still be seen on the screen, but no hard and fast rules can be laid down here. It is best to check the diode with a meter which should show a fairly high resistance reading in one direction and a fairly low reading when the leads are reversed. Also check S206 if severe hum bars are evident, since this choke also completes the video amplifier control grids' return to chassis, and if it is open circuit the grid is left floating, giving rise to the screen being divided into distinct black

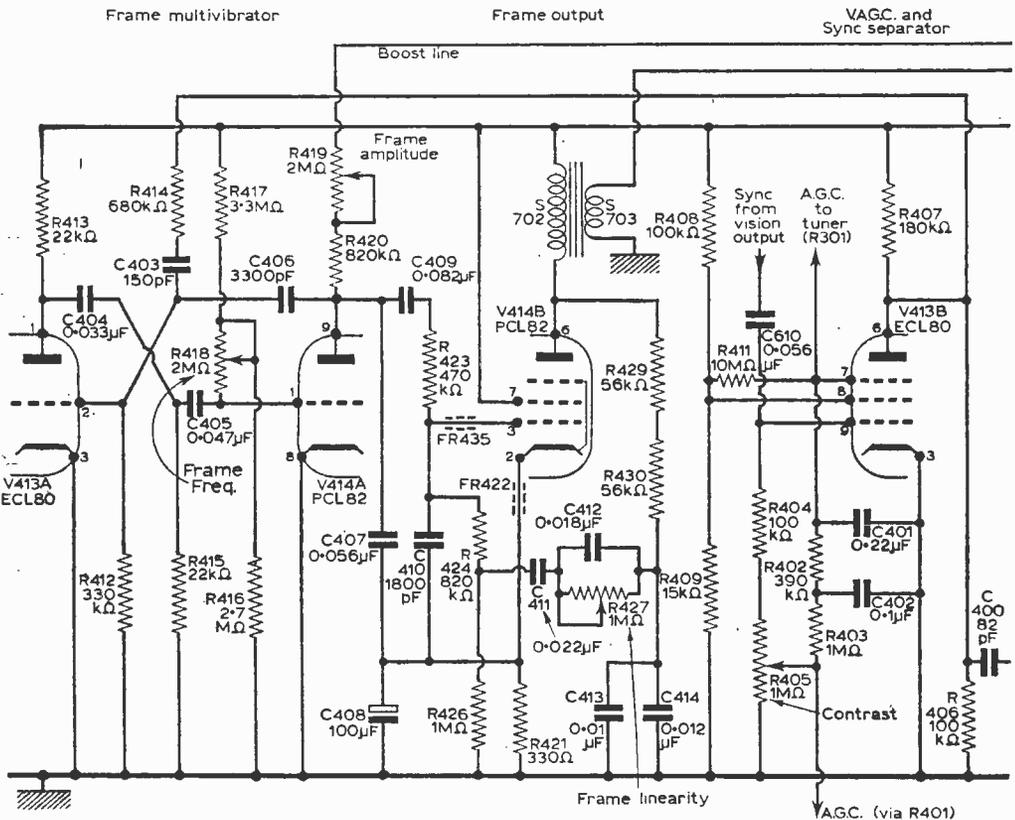


Fig. 5—Frame timebase and sync separator circuits.

Vision Buzz on Sound

If this is not due to incorrect tuning or to excessive signal input check C703 (10 μ F), which is probably open-circuit.

No Vision Signal; Sound in Order

If the raster is normal and the brilliance functions normally check V207, V207, X218 (OA70) and the voltage supplies to V206 and V207 at pins 7 and 8. If the supply resistor is found damaged check the associated decoupling capacitor.

and white sections, i.e. the top may be white, the lower half black.

Valve and Component Numbering

At first sight the method of numbering may appear confusing but is adopted immediately to identify the section or part of the circuit in which the valve or component is used. Components are numbered in blocks of 100 for each section of the receiver. 100 is used for the sound i.f. section, e.g. R103 is the supply resistor to pin 8 of V103; 200 is used for the vision i.f., i.e. V206; 300 is reserved

for the tuner unit, 400 frame timebase, 500 line transformer, 600 line timebase, 700 mounting plate, power supply, etc.

Valve Voltages

Whilst it is most convenient to be able to pinpoint a particular fault with no involved testing there is always a time when it is necessary to employ routine voltage checks in order to trace a

defective component. There are few faults which cannot be traced by intelligent interpretation of voltage readings if the correct readings are known. Therefore we quote the following voltage figures which will obtain under normal conditions:

C.R. TUBE—Cathode 145V, grid 100V, first anode 465V, focus anode 440V, final anode (e.h.t.) 15kV approximately.
 H.T. LINES—H.T. at C708, 214V; C709, 204V; H.T.2, 200V; tuner h.t., 185V; boost line, 465V

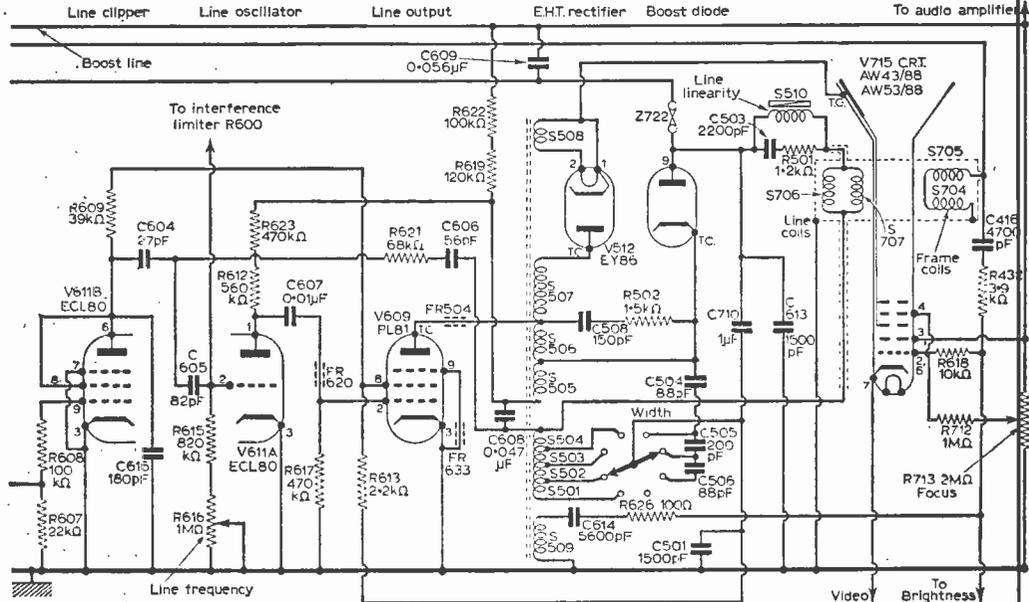


Fig. 6—The line timebase and c.r.t. sections of the circuit.

TOWARDS 625

We wish to bring to the notice of our readers an error concerning the heater connections of the ECC82 valve on page 540 of the September, 1963, issue of PRACTICAL TELEVISION. This valve has two heater sections each rated at 6.3V 0.15A. With the two sections connected in series the rating is thus 12.6V at 0.15A and not 12.6V at 0.3A as stated in the text. For 0.3A heater chains, therefore, the two sections should be connected in parallel which is achieved by connecting pins 4 and 5 and using pin 9. The correct connections for 0.3A chains are in fact, given in Fig. 11 (page 539), only the text being in error and conflicting with the circuit. For sets with 0.15A chains, of course, the two heater sections are connected in series.

Using an 0.15A heater in an 0.3A heater chain will result in over-running the heater, but this will be revealed by the heater glowing brighter than it should. We are sorry for this error, and wish to thank the reader who brought it to our attention.

ADVERTISEMENT CORRECTION

Owing to a misprint on Page 191 of the January issue, the price of the Double 5 TV Aerial advertised by Electronic Installations was incorrectly given as 10s. This should have read 70s., and we regret the inconvenience caused by this error.

In the next issue of "Practical Wireless"

A STEREO AMPLIFIER DESIGN USING THE NEW ECLL800 AUDIO VALVE

Also in the same issue:

- An All Band Aerial Tuner; A Pocket Signal Tracer; A Metronome; A Stabilised Power Pack and many more informative articles.

The March PRACTICAL WIRELESS, on sale February 7th—2/-

A MONTHLY FEATURE
FOR DX ENTHUSIASTS

by Charles Rafarel

DX TV

A PART from the clues mentioned last month, another method of narrowing down the origin of an unidentified DX station is to note whether the transmissions contain "commercials".

Continental services are very similar in form to ITA and this may help as the number of continental TV services which carry commercials is limited. The principal ones are TVE Spain, RTP Portugal, RAI Italy, Telefis Eirean (more local) some of the West German networks, Austria, Tele Luxembourg, Tele Monte Carlo, (an unlikely one for reception here, Yugoslavia (30 minutes per week) and, curiously enough DDR East Germany. Switzerland too is scheduled to go "commercial" later this year.

If we are fortunate enough to see a weather forecast chart, this can also be invaluable. For example, RTF France always shows firstly a general weather map for the whole of Europe, and secondly a detailed map of France alone. NTS Holland shows maps of the Low Countries. DDR East Germany, after its general European map, shows the local map together with a kind gentleman with a stick who points out the places of interest! (For example, my own positive identification of Brocken (E6) was done from this map.)

Certain caption words will help as well and, if we are prepared to note them as they arise in a previously identified programme, they will be of use when we see them again. This is the sort of thing:—"Fin"=end in French, "Konec"=end in Polish, "Einde"= Dutch, "Intervallo"=Interval in Italian, it is "Szünet" in Hungarian. Spanish stations frequently show a caption "Ha Visto Vds" =you have seen etc.

Propagation and Polarisation

While most DX reception is according to the book, i.e. vertically polarised signals are better received on vertical aerials and horizontal ones on horizontal arrays, this is by no means always the case.

Due to atmospheric and local site conditions, we can get a "twist" in the angle of polarisation at times.

In January 1964, the BBC were testing a new Band III transmitter at Wenvoe on channel 13. This is a vertically polarised transmission, but here in Poole the signal is far better on a horizontal

array, while colleague Roy Allen some 12 miles away at Highcliffe has better results on a "correct" vertical aerial.

ITA Caradon Hill (channel 12) also vertically polarised is usually better on a horizontal array here but it can, at times, revert to vertical polarisation. Sporadic "E" reception is notorious for this "twisting" and quite often better DX reception can be had on a vertical aerial although the majority of receivable stations are horizontally polarised.

The point is that although we should first use orthodox methods, remember that it may be possible to get better reception with an "incorrect" aerial at times!

Local DX

We can get some interesting DX within the confines of the British Isles, particularly amongst the Band III ITA transmitters, by picking times when powerful "locals" are off the air and the distant ones are transmitting (particularly late evenings).

The TV weeklies and the daily press is largely regionalised and does not give programmes for all ITA regions, but *The Times* gives full coverage of programmes in all areas.

DX News

RTF have already got a second u.h.f. transmitter under test on channel 31, it is at present relaying the first RTF programme and it is most probably located at Lille-Bouvigny.

A New Year Card from the RTF MT Pinçon transmitter at Caen says that they will be operational on u.h.f. with the second programme in September 1964. So there should be some new "pickings" on u.h.f. for DXers in the South of England.

Further news from the Continent indicates that RAI Italy are now adopting a helpful technique with their standard Test Card "N". The small top left hand corner circle will now carry a number which will identify the station of origin and although this number is rather small it can be deciphered on a reasonable picture. I hope shortly to give a full list of these numbers for stations receivable over here, together with the station names.

One item of bad (but not unexpected) news. EBU Brussels tell me that the price of the TV station list (quoted as 50 francs Belgian) in our February issue will have to be increased to 100

—continued on page 274

The PULSE and BAR Test Signal

The purpose of this transmitted waveform and the method of removing the pattern it causes from the screen of a receiver.

By H. Peters

A NUMBER of readers have written recently asking for advice on how to cure an intermittent frame flyback fault which has developed on their receivers. In endeavour to clear this trouble some of them indeed have almost rebuilt their frame scan generator stage, but all to no avail.

The symptoms are, in fact, caused by a test line signal inserted into the broadcast waveform by both

the BBC and the ITA, and although the nature of this test signal can vary, the general effect on a receiver with slow flyback is that seen in Fig. 1. Receivers of recent manufacture are less likely to display this signal on the screen, as their designers have allowed for it, with the result that the signal sits on top of the picture (usually above the mask and out of sight) as seen in Fig. 2.

Purpose of the Test Signal

Three factors have brought about the need for inserting such a waveform into the transmitted signal, the main one being the increase in programme hours, which have now spilled over

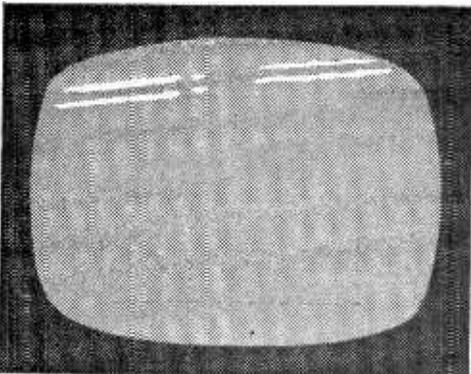


Fig. 1—The test signal superimposed on the picture area of a set with slow flyback.

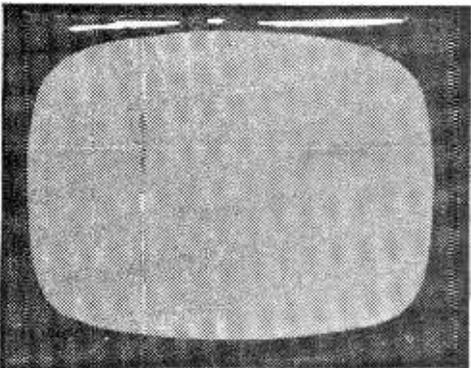


Fig. 2—The normal position of the signal—above the picture area and out of sight.

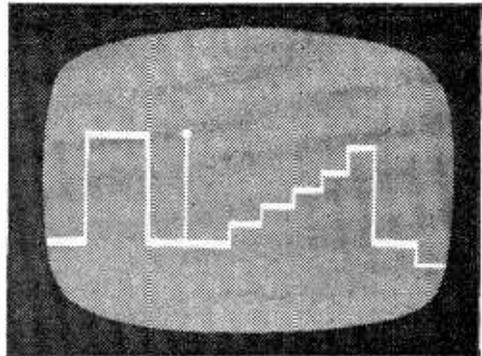


Fig. 3—The signal as it appears on the screen of a monitoring oscilloscope.

into what has been regarded for a long time as a testing period.

The other two factors are the use of unattended translator and satellite transmitters, and a number of unattended links. It can be seen that if the output of an unattended transmitter or link is monitored, and if the test signal lines are gated out of the combined vision waveform and displayed on an oscilloscope, it is possible to make a direct comparison between this output and the original test signal, and consequently to apply any correction needed to overcome distortion.

Many Different Waveforms

As already stated, the nature of the test line

signal can vary, as things are still in an experimental stage, and no standard has yet been decided upon. The avid "pulse and bar spotter" can, in fact, log up to as many as five different waveforms in a 24 hour period. They all, however, have one thing in common, which is that they are inserted in the frame blanking period as late as possible, usually on lines 12 and 214, and the majority begin with a white bar of about 10 microseconds duration, followed by a 1 microsecond pulse, and, after an interval, by a "staircase" waveform consisting of five level increments of voltage from black level to peak white.

On the monitoring oscilloscope this would appear roughly as seen in Fig. 3, but readers must realise that a special 'scope is needed, and that on an ordinary display taken from the video stage on the

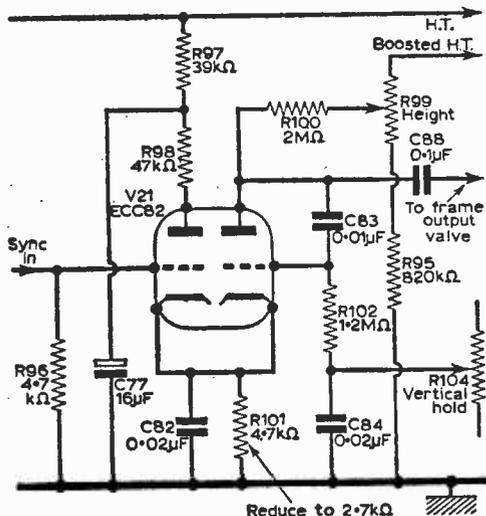


Fig. 4—A typical frame generator circuit in which C82/R101 governs the flyback time.

workshop oscilloscope, the two test lines would be completely masked out by the picture and sync details on the other 403.

Times of Transmission

The BBC insert the signal at their London switching centre at the commencement of programmes in the morning, and it is usually left up until 7 p.m., after which time it is usually removed except from the Crystal Palace and Dover transmitters, which radiate the 10 microsecond bar only. This is used primarily for checking the performance of the automatic monitoring equipment at the Dover station.

On the ITA network, the waveform is inserted usually by the Programme Contractor at the studio from which the programme originates. It follows from this that it will not appear on test transmissions, as these originate from the local transmitter itself.

Neither the BBC nor the ITA have a fixed timetable or specification for the signal, but it is hoped that standardisation will ultimately be reached.

Removing the Pattern

A viewer's main concern is naturally the removal of this pattern from the picture area of the screen. To do this it is necessary to speed up the frame flyback.

On blocking oscillators the speed is determined by the efficiency of the frame oscillator transformer, and to some degree by the quality and biasing of the valve. The writer finds that provided the valve has been eliminated as being above suspicion, the most satisfactory way to effect a cure is to substitute a larger and more efficient frame oscillator transformer.

Multivibrator or Frame Generators

On multivibrator frame generators, which are the most likely to give trouble, the flyback is determined mainly by the grid leak and coupler combination which has the smaller time constant, and in the cathode coupled type, this is invariably due to the value of the C and R of the common cathode circuit.

A typical example is shown in Fig. 4. This is the circuit of the Pye "Continental" CTM17 frame generator, but it is also to be found in a number of other models produced about the same time by the Pye Group. An official modification has been issued for this model comprising the reduction in value of R101 from 4.7kΩ to 2.7kΩ. In practice this can be quickly accomplished by soldering another 4.7kΩ resistor between the valve-holder tag and spigot.

Thyratron Timebases

Increasing the flyback speed of thyratron timebases is not so easy, as it depends on the goodness of the gas triode itself. Fortunately only a few receivers with this type of frame generator are still in service.

DX-TV

—continued from page 272

francs, 15s. for No. 9 due out in March, 1964.

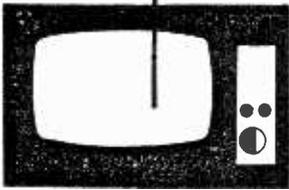
A correction: R. G. Fowler of Acton points out that the West German Test Card photo in the December issue was in fact upside down! Sorry! Incidentally, it may be of interest to established DX viewers to note the very close similarity between this DBP card and that of Tele Luxembourg, the only difference being that the West German has seven white and six black small rectangles in the inner circle, whereas that of Tele Luxembourg has six white and five black, so I suggest you look closely at any card of this type seen on channel E7. Mr Fowler goes on to say that he has received a test card and a "Saar Brucken" caption on channel 27 or near it.

The second programme from Saar Brucken is channel 31 according to the lists, so this may well be a new first programme relay on channel 27. It all goes to prove even further that u.h.f. will give DX results.

Finally, remember spring sporadic "E" openings will soon be here so be ready for them. We should be very busy!

A MONTHLY COMMENTARY

Underneath the Dipole



BY ICONOS

AS the year 1964 gets into its stride, so the shape of things to come in television techniques can be discerned. Policies proposed by the Television Advisory Committee and endorsed by the Postmaster General as regards line standards and colour, posed many problems for BBC and ITA engineers, and not all of them have been solved. Towards the end of 1963, however, many of the details had been thrashed out by the Technical Committees of the BBC, the Independent Television Authority, the programme companies and the receiver manufacturers—all working in liaison, with European broadcasting authorities. Faced with the complications of multi-standard set design for 405 and 625 line transmissions, British receiver manufacturers have had so many problems to face up to, that they have been unable to give much attention to the widespread complaints of the absence of d.c. restoration circuits from domestic receivers. The wide range of signal strengths to be coped with in the varying domestic locations has necessitated the employment of mean level automatic gain control. This facility reduces the fading effects of reflections from passing aircraft. It also tends to distort the reproduction of the various tonal shades of the greyscale so that, with low key (dark) scenes, blacks become a kind of foggy

grey. In fact, it has been pointed out that the term "a.g.c." has become synonymous with "always grey control"!

G.B.C.

The problems have been complicated not only by the change of line standards, but also by the change of video modulation from positive (peak white) to negative modulation on 625 lines. However, at one of the last meetings of the Television Society in 1963, Mr. P. L. Mothersole of the Mullard Research Laboratories, disclosed a new black level correction circuit which he had invented, which was put forward as an intermediate solution. A demonstration of two production line receivers, one fitted with the new additional circuit, which was impressive in the improvement in quality attained in low key "mood" scenes, with the black parts of the picture really *black* in comparison with the grey tones of the conventional set. It seems at last there is a possibility of achieving "G.B.C." (genuine black control) on commercial receivers, in spite of all the special difficulties I mentioned earlier. The complication may add a little to the cost of receivers, but I feel certain that there is always a market for a quality article. The growing popularity of hi-fi and stereo sound proves this. But it will be many months before this development can be integrated into production line domestic receivers.

1925 and all that

One of the best Christmas presents that the BBC gave viewers was the opportunity of seeing Charles Chaplin's silent film classic, "*The Gold Rush*". Made in 1925, this film was photographed even before panchromatic negative film was in general use in film studios, and

cameras were hand-turned at a speed of sixteen to eighteen frames per second. In 1942, Chaplin re-issued the picture with a commentary and music sound track and must at that time have had many scenes optically "stretched" to cope with the sound film speed of 24 frames per second. Nevertheless, one would expect that reproduction on TV from telecine operating at 25 frames per second would re-introduce in many of the scenes the jerky movements which usually afflict the old silent films. In the case of "*The Gold Rush*" this did not happen, and the photographic qualities of the thirty-nine year old film masterpiece were outstandingly good. I wondered, at first, whether the BBC had run the picture at a lower-than-normal speed telecine, but enquiries of the engineering department revealed that it was reproduced on a normal Rank-Cintel twin lens flying spot equipment.

As for the entertainment value of "*The Gold Rush*"—they remain unique. I have heard a few people say that they would have liked to see it in its original silent form, with a tinkling period piano accompaniment. But I doubt if one could tolerate an hour of such music. Besides, Chaplin's own commentary added a great deal to the charm of the picture. The popularity of Charles Chaplin also remains unique, as may be judged by the fact that about 70% of viewers switched to the BBC for this programme on Christmas Day—and stayed with it! There must be something to be learned from the fact that, in this age of smart-alec and satirical comedy, the elemental values of the laughter-and-tears style of entertainment of our grandfather's days still appeals so. It is the genius of Chaplin which does not date. Car

we hope for more vintage Chaplin from the BBC?

Plautus—and all that

The Beagle craze, now on its inevitable ebb, is symptomatic of the trends of show business generally — and this includes sound and television broadcasting. Fashions come and go, often repeating themselves from time to time. The humorous plays of the Roman playwright, Plautus (254 to 184 B.C.) have reappeared in various forms and versions periodically ever since those far-off days, when they served as an admirable intellectual comedy relief from the sterner entertainments of gladiatorial joustings and the throwing of prisoners to the lions. Shakespeare borrowed plots from Plautus, and, in the course of time, so have the film producers of super-colossal films. Lately, "The Boys from Syracuse", with Bob Monkhouse, "A Funny Thing Happened on the Way to the Forum", with Frankie Howerd, and the Royal Shakespeare Company's "Comedy of Errors", have been simultaneously presented respectively on the stages of Drury Lane, Strand and Aldwych Theatres, all within a hundred yards of one another.

It was the Aldwych production which was put on television by the BBC, and viewers were able to see a version played in period costume but on a stage which comprised a series of rostrums, with side and back entrances for the actors. In a sense, this was reverting to the fittings and fixtures of the original theatre where Shakespeare's plays were first produced. At the Aldwych Theatre, characters rushed on and said their lines with the dash of Douglas Fairbanks Snr., and the witch doctor's agility belied his long beard. It takes a little time for a viewer to become accustomed to such unorthodox (yet classic) theatre mechanics. But viewers who left the production switched on were rewarded with a riotously funny show that was almost ruined by unnecessary cut-in shots of the audience in the theatre. The theatre of the future—and that includes the new National Theatre about to be built near the Festival Hall—should take into account future requirements, including built-in

facilities for filming, taping, putting out on live TV. This implies provision for camera positions, special lighting and multiple microphones.

Head Hunting

Low Grade's idea of audience research into the likes and dislikes of television viewers as supplementary information to be considered in addition to the TAM-rating counting of heads, is a good one. The principles of the National Productivity Year stress the importance of relating supply to demand for improved efficiency in any manufacturing process, and there is no logical argument against using the same principles in the creative and arty-crafty fields. After all, it is useless stamping out L.P. or E.P. discs of pop numbers by the thousands at a time when the demand for those particular discs is beginning to fall. What is even more necessary is to anticipate possible falling sales by "audience" market research. Television programmes are presented to large audiences on a "one off" basis, excepting for series or serial items. It is therefore all the more important to assess the changing tastes of viewers as far in advance as possible. Letters from viewers are a valuable guide, and I have seen a number which deplore the present pre-occupation with kitchen sink plays by authors too weary to think up endings and leave them to viewers to figure out for themselves. The assertion that everybody wants reality these days, is not true. They don't want it. They've got it—and they hate it! Even more voluble are those who wish for a nice restful evening's viewing, free from the constant popping up and down like a jack-in-the-box to adjust sound volume controls, particularly when loud background music comes on. This fault is usually due to a sound balancer paying more attention to his volume meter than to the subjective appreciation of the level on his monitor loud speaker. When it comes to the real appreciation of sound levels, the ear is the best meter.

"Steptoe" Again

One of the most welcome reappearances on television has

been the return of "Steptoe and Son", in which Harry H. Corbett and Wilfred Brambell continue their bickering in a new series.

The situation in the first one, "Homes Fit For Heroes", were on the same lines as before and equally amusing. The script by Simpson and Galton, the production by Duncan Wood, and the sets by Lionel Radford were well up to the high standard of the first series. Yet I have uneasy reservations about the basic subject matter. The idea of Harold attempting to put his Dad into an old folk's home was not completely palatable, notwithstanding the fact that one knew in advance that Harold's plans would be frustrated. However, long live the Steptoes! But the script-writers will have to step more carefully themselves, now that their brain-children have become TV idols.

Three Years On

Though all the major and regional Independent Television Companies were individually confident that their applications for a renewal of their contracts with the Independent Television Authority would be granted, they were not absolutely certain. All kinds of artistic, administrative and technical developments were held up, pending the publication of the terms of the renewal of the licences, quite apart from the fact that no new contracts were awarded. Of course, every single contractor was aware of any particular things he had done that he ought not to have done, which he hoped would be overshadowed by the good things he had contributed. These have ranged from the fine production of plays and current affair programmes to the more solid bricks-and-mortar new studio buildings; from improved vision-and-sound techniques. When the dust settles and everyone really knows what is going to happen with colour television, it will be found that T. C. Macnamara, Technical Councillor of A.T.V., Howard Steele, Chief Engineer of A.B.C.-TV and Denis Packham, Technical Controller of Tyne Tees, played most significant and important parts in the difficult international negotiations, as did Pat Bevan, Chief Engineer of the Independent Television Authority.

PRINCIPLES AND PRACTICE OF COLOUR TELEVISION

PART 9

CONTINUED FROM PAGE 231 OF THE FEBRUARY ISSUE

BY G. J. KING

THE 1963 colour television system controversy has a parallel in the early forties. At that time the question was whether to start up again after the war on 405 or 625 lines. We, in this country, started up on 405 lines, as we well know, but are now changing to 625 lines. It can only be concluded from this, therefore, that the decision was wrong at the end of the war.

Colour television is shortly to start, but before it does we must make sure that this time we make the correct decision in terms of system, for it can prove expensive to make a change in mid-stream. At the time of writing there are three systems under debate, the NTSC, the SECAM and the PAL systems which have all been considered in past articles in this series.

All Systems Compatible

Apart, really, from matters of detail all these systems are rather similar. They are all compatible; they all use a fairly standard receiver system and they all use a tricolour display device of contemporary design.

It has been suggested, therefore, that an immediate start should be made with colour broadcasting using the well tried NTSC system, for even if subsequent practice proved that a change was desirable this would not be unduly difficult to accommodate, having in mind the similarity between the systems.

Several more systems could be added to the main three, but again, these differ only in detail. The big difference would be between a system designed for colour only (e.g. incompatible), using separate luminance and chroma channels, and systems of contemporary design.

Eventually, it is probable that all television will go out in colour, meaning that whatever system of compatible colour television is adopted today, it will have to be changed, anyway, sometime in the future!

Better colour rendering, with fewer complications, is possible by the use of a colour-only system, than by use of a mono/chroma compatible system. There are, of course, many economic reasons inhibiting the launching of a colour-only service.

Perhaps, after all, then, today's colour system decision may not have a deep influence on the future of television, for we are by no means near the top of the television ladder. An entirely different and complete system of television could be unfolded at any time. This could be in full colour, stereo and less expensive than the present or contemplated systems. We must always remember that television today is barely out of its embryo state. The future holds great hopes and interests.

Colour Purity

But now to get back to reality. From the users point of view colour television should be considered as an ordinary black-and-white set that is able to give colour pictures as well. Looking upon it in this way facilitates adjustment.

To start with, most programmes will be in black and white and just a few in colour. Nevertheless, colour sets will be purchased and these will be used on mono transmissions. Now, it normally follows that when a colour set is adjusted to give satisfactory black-and-white pictures, good colour pictures will also be obtained by switching to a channel giving a colour programme.

This technique for adjusting colour sets has been found to be the most satisfactory in colour television countries (mainly America). Far better in the majority of cases than endeavouring to secure the best colour picture by virtue of a colour transmission! This is probably the biggest advantage of a compatible system. If there is colour fringing or edging to the mono picture then the tube is not pure (see Part 4) and adjustments are needed.

When receiving a mono transmission the tricolour tube usually receives the luminance or "Y" information at its cathodes. The grids normally receive the chroma information but when there is no chroma signal these grids are effectively devoid of signal and the three colour displays are balanced in a correctly adjusted set, thereby giving the display in monochrome (see Part 1).

Colour Killer Control

Colour sets, however, feature a rather special kind of control called the "colour killer" control. This is to switch the colour circuits off when the set is used on a mono transmission. This control

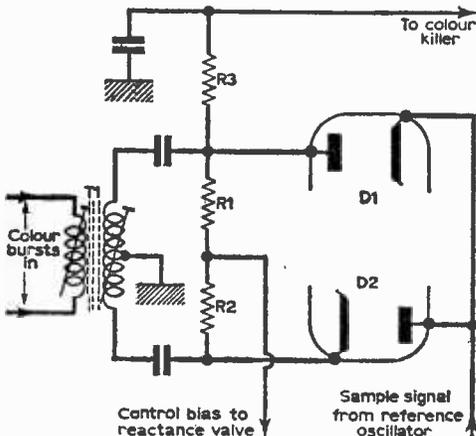


Fig. 33—Basic phase detector circuit.

is desirable because, although a mono picture is obtained when the set is correctly adjusted for colour, interference can disturb the three-colour balance and result in random colouring, the interference spots appearing in 'colour'!

The colour killer is worked from the phase detector circuit which is employed to lock the phase of the reference sub-carrier signal produced by the set to that of the original sub-carrier which was suppressed at the transmitter on the NTSC system. The basic features of the reference oscillator and the phase detector or discriminator, as it is sometimes called, are revealed in Part 7. It will be recalled that colour burst signals are sent out by the transmitter on the porches of the line sync pulses to phase the reference oscillator.

The basic circuit of a phase detector is shown in Fig. 33. It consists essentially of a pair of diodes, D1 and D2, and a tapped transformer, T1. The detector is in receipt of two signals, that of the colour bursts and a sample from the reference oscillator which is producing a signal to replace the sub-carrier suppressed at the transmitter.

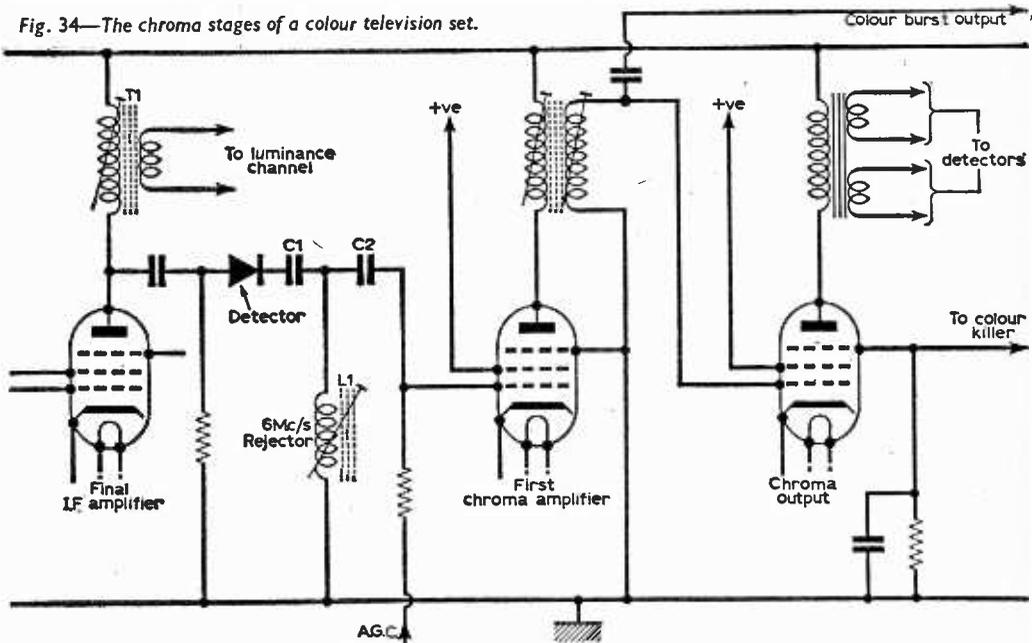
junction. The magnitude of this voltage depends upon the phase error while, as we have seen, the polarity depends upon phase lead or lag.

Reactance Valve

This voltage is applied to the grid of a reactance valve, the effective capacitive or inductive value of which depends upon the grid voltage. The reactance valve is connected across the tuned circuit of the reference oscillator so that the reference frequency (and hence phase) is caused to alter, to lead or lag on the colour bursts, by the phase detector derived control voltage. The reference generator is thus pulled back into phase automatically should it tend to wander for some reason or other.

Note that when colour burst signals are applied the anode of D1 is fairly highly negative, while the cathode of D2 is of equal positive value when the phases of the signals coincide. We shall be referring back to the negative voltage at D1 anode shortly.

Fig. 34—The chroma stages of a colour television set.



Basically the two diodes conduct equally when the relative phases of the two signals are the same. This means that currents of equal value flow through the load resistors R1 and R2 and, since their resistance values are the same, each has developed across it the same voltage. However, the voltages are of opposite polarity, since the diodes are connected cathode-to-anode, which means that the voltage at the junction of R1—R2 is zero.

Now should the phase of the reference oscillator deviate from that of the colour burst signal the diode balance would be destroyed. A voltage, positive or negative, depending upon the sense of the phase deviation, thus occurs at R1—R2

Signal from the vision detector is channelled off to a chroma amplifier via a chroma take-off coil. This is something like the sound take-off coil in any television set. The chroma amplifier has high-pass characteristics—that is, it accepts the 4.43Mc/s sub-carrier frequency and the higher video signals up to about 5.5Mc/s, bearing in mind that the colour information occupies the spectrum from about 3.5Mc/s to 5.5Mc/s.

This means then that the chroma amplifier rejects the lower video frequencies of the luminance channel but it does pass the higher frequency luminance signals. This latter function is undesirable, since it does cause some degree of colour interference. Nevertheless it is not easily possible

to delete all the luminance signal from the chroma amplifier in a compatible colour system. Fortunately the interference so produced is small.

Cross Colour

The effect gives rise to a symptom called "cross colour" which is usually noticeable only when a part of the picture consists of fine black and white vertical lines the corresponding frequency of which matches that of the sub-carrier: the display is spurious colour on the picture.

Fig. 34 shows a basic chroma amplifier section. The final vision i.f. valve feeds the detector and the luminance signal is developed in a bandpass chroma amplifier section consisting of two pentode valves. Rejection at 6Mc/s is given by L1 and C1, C2.

The colour burst signal is extracted after the first chroma stage and is usually further amplified before being applied to the phase detector (Fig. 33). The anode of the chroma output stage is loaded to a pair of synchronous detectors. These, it will be recalled, operate after receiving the reference signal to make up for the suppressed sub-carrier. The detectors then demodulate either R'-Y' or B'-Y' signals and the third signal, G'-Y' is obtained from the matrix, which receives B'-Y' and R'-Y' to give G'-Y', remembering that the colour picture tube or display device requires three colour signals to work it.

The luminance signal, occupied within the spectrum d.c. (almost) to 5.5Mc/s, is extracted from transformer T1 in the anode of the final i.f. amplifier valve. This signal is fed to a luminance detector and thence to a luminance amplifier (equal to an ordinary video modulator) as per mono practice.

Now when the contrast of the set is adjusted both the luminance and the chroma signals are altered in level together. This means that the colour saturation of the picture remains constant. And normal a.g.c. holds the overall contrast stable as in any set.

Saturation Control

However, the colour saturation can be altered by adjusting the gain of the chroma channel. A "saturation control" is, therefore, incorporated in this channel either in the form of a potentiometer or tied to the chroma a.g.c. system. In the latter case it is worked like an ordinary contrast control circuit.

Chroma a.g.c., though, is obtained by measuring the amplitude of the colour burst signals, the same as ordinary a.g.c. is obtained by measuring the amplitude of the sync pulses. A d.c. bias is derived in both cases. In the latter it is picked up from the grid of the sync separator and applied to the controlled stages, while in the former a rectifier is used and the bias is applied to one (or both) of the chroma amplifiers.

Chroma a.g.c. is desirable so that the colour saturation remains constant when switching from one colour channel to another. Without this feature saturation control adjustment would be needed on programme change, the same as contrast control adjustment is required on ordinary sets without vision a.g.c. when changing channel.

The saturation control simply varies the amount

of colour in a picture. With the gain of the chroma channel at zero no colour signal is passed and a picture in black and white is obtained, even though the transmission is in colour.

This brings us back to our colour killer again. Note that in Fig. 34 the suppressor grid of the chroma output valve goes to the colour killer circuit. Normally this electrode is held at chassis potential and the valve works in the usual manner, but when the colour killer is in action a high-value negative voltage is applied to the suppressor from the killer circuits. This effectively mutes the chroma stages and stops the passage of chroma signals. The set then runs in black and white, provided the adjustments are correct, as already detailed.

The colour killer circuit in basic form is shown in Fig. 35. The grid of the triode valve is connected to the phase detector circuit as shown in Fig. 33. Now when the set is receiving a colour

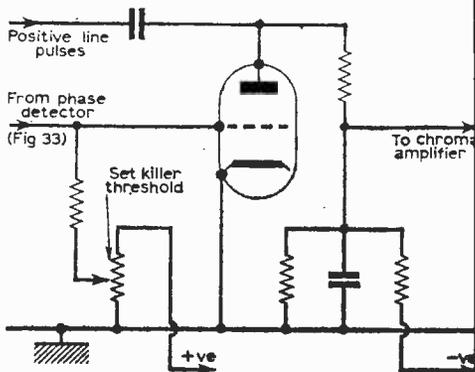


Fig. 35—Basic colour killer circuit.

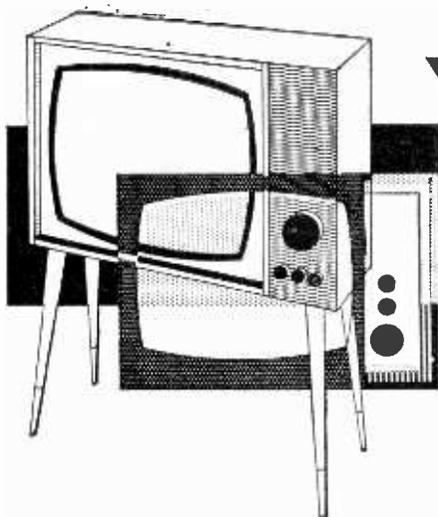
signal it will be remembered that the anode of D1 is highly negative. This negative potential is reflected, through R3 (Fig. 33), to the triode grid (Fig. 35). The triode is thus biased heavily negative and is cut off, so the circuit is inactive.

However, when a mono transmission is being received the lack of chroma information (e.g. colour burst signal) means that the phase detector is inactive. D1 anode does not go negative. The circuit in Fig. 35 thus comes to life.

The positive pulses applied to the anode of the triode from the line output stage cause the valve to conduct and the coupling capacitor charges. The anode goes negative and this negative potential, after having its pulses removed by the RC network, is fed to the suppressor of the chroma output valve in Fig. 34. The chroma channel is then automatically muted!

The sensitivity of this automatic muting or colour killing is adjustable by the "set killer threshold" control. This simply adjusts the bias on the triode to determine its operating point.

The circuits described are some of the most important in a colour receiver. There are many others, of course, and one could write a book about them as they are so extensive and diverse. Nevertheless it is hoped that this article and the previous articles in this series have at least shed a little light on various aspects of colour television.



Your Problems Solved

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. **WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE.** The coupon from p. 284 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

PYE V4

The picture rolls up and down the screen continuously unless the vertical hold control is set at its maximum position. Then the picture will only lock with the bottom half at the top of the screen and the top at the bottom.

I have checked V22 and V23 by substitution and have found them to be in order.—E. H. Houlsden (Girton, Cambridge).

Suspect an open circuit interference limited control. This is in parallel with the frame hold control h.t. feed.

G.E.C. BT2155

After working perfectly for a few minutes after being switched on, the screen goes dark so that only the highlights of the picture can be seen. A few seconds after this an audible "plop" is heard and the picture returns to normal. The sound remains normal throughout this series of events.

I have replaced the valves in the tuner and have checked all the other valves in the receiver i.f. stages by substitution. Also I have changed C121 (0.1 μ F) in the cathode lead of the c.r.t. and tested the 120k Ω resistor in the same lead.—P. W. Ellis (Alconbury, Huntingdonshire).

You should check the tube base voltages. The pin 11 voltage should be about 120-150V normally: note whether this varies.

The voltage on pin 2 should be about 100V at the control of the brilliance; again check for variation. The pin 10 voltage is via a 2.2M Ω resistor and may appear low, but if the voltage necessary to check for variation, and if the voltage is noticed to fall, check the 0.5 μ F (C120) decoupling capacitor.

REGENTONE TEN 4

Recently this set went completely dead. An examination showed that the fuse had blown and that the cathode resistor of V11b (R76) had burnt out.

The PY32 was tested and replaced, as was R76 and the fuse. On switching on once more, the fuse blew and R76 burned out. A further examination revealed a burnt out ballast resistor which I replaced.

This has cured the fuse-blowing but R76 still burns out when the set is switched on.—R. J. Southwell (Basingstoke, Hampshire).

Replace V11 (PCL82) which apparently has an internal short. Check C61 if necessary.

BUSH TV 105

After working normally the previous evening, I switched this receiver on recently to find no sound, vision, raster or line whistle. The heaters of all the valves and c.r.t. light, and the fuses are intact.—B. R. Noble (Langley, Buckinghamshire).

This condition is caused by a faulty resistor in series with the metal rectifier. This can be checked, normally by bridging the 16 Ω and 20 Ω resistors in turn, replacing whichever ever is open circuited.

DEFIANT 410X

To obtain and control the picture on this set, it is necessary to advance either the brilliance or contrast controls slowly until the correct picture quality is obtained. If either control is moved past the correct setting both picture and raster will disappear.

I have recently fitted a new tube, line output



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998T, 999T	1 at 52/6
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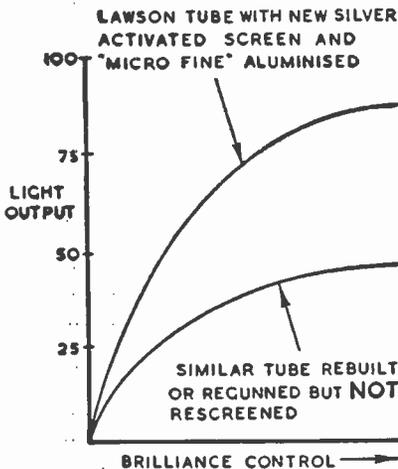
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valve (PL36), video amplifier valve and a U191. The e.h.t. appears to be low.—S. R. Humble (Morpeth, Northumberland).

Replace the U25 e.h.t. rectifier which is soldered to the line output transformer. Check V7 (ECL80) if width is also lacking and the PY32 h.t. rectifier, if the h.t. voltage is low.

G.E.C. BT1743

For the first thirty minutes after switching on the picture on this set fills the screen correctly. After this period of time however, a dark margin, about $\frac{1}{2}$ in. wide, develops down each side of the picture. I have checked the frame output valve by substitution but without improving the situation.—H. V. Powell (Lydbrook, Gloucestershire).

Since the width of the picture decreases, the trouble lies either in the line or h.t. circuits, and not in the frame section. First check the line time-base valves for emission, including the booster diode, and replace if less than 75% good.

If the valves are in order, check the h.t. rectifier and replace if the d.c. output voltage is less than a.c. input voltage.

EKCO TC267

The left-hand side of the picture is permanently obscure and slightly distorted. I recently changed the tube in this set and although the picture quality is greatly improved, this fault remains.—R. Hunt (London, S.E.14).

Replace the 0.001 μ F frame flyback suppression capacitor which is beneath the chassis near the main smoothing capacitor.

DECCA D.M.4C

When switched to the ITA channel the sound and vision are perfect. On BBC however, a loud buzzing noise is always present. The fine tuner is turned fully clockwise to reduce this noise as much as possible; with the fine tuner fully anti-clockwise, the noise becomes almost unbearable.—J. W. Gibson (Pudsey, Yorkshire).

With the fine tuning control at range centre, adjust the core of the BBC oscillator coil for maximum sound consistent with minimum sound-on-vision. This core is accessible through a hole in the front of the cabinet, directly beneath the channel selector knob. A thin, plastic, knitting needle with a suitable shaped point can be used to adjust the coil core.

R.G.D. L2351T

This fairly old receiver was functioning well until recently when the height of the picture suddenly reduced to a $\frac{1}{2}$ in. band across the screen. I changed the frame oscillator (T41) and amplifier (EL33) valves without curing the fault.—L. Taylor (Edinburgh 13).

The trouble may be a faulty frame output transformer, but we suggest you check the whole frame output stage by applying 6.3V a.c. from the heater system to the EL33 grid. This will give a picture 3 in. to 4 in. tall if the output stage is satisfactory.

PAM 600S

On this receiver, no setting of the vertical hold control will lock the picture steady.—A. Reid (Dungannon, Co. Tyrone).

We advise you to check the ECC82 (V16) vertical oscillator valve, and the small M3 metal diode (V15) on the right-hand side printed panel.

MURPHY V3100

The picture on this receiver disappeared after having been perfect for some time. I noticed that the line whistle was not present and so I replaced the 30P4 which was found to have an anode to grid short. This cured the fault for two days. Now the picture has disappeared again and I would like your advice before replacing the 30P4 once more.—E. Whitehead (London, S.W.19).

The line output stage in this model is somewhat critical and should have a 30P4 coded "MR" fitted. You may have a faulty new valve, or else the 6/30L2 line oscillator valve (if fitted) or U191 efficiency diode may be at fault.

FERGUSON 306T

A fault on this set produces a picture which is greatly extended in the bottom half of the screen. This situation results in some of the picture content being lost.

No adjustment of controls affects the picture.—G. H. Yeomans (Birmingham).

You should check the 0.05 μ F linearity capacitor wired from pin 6 of the top centre PCL83 to both present linearity controls. Check these controls and the 120k Ω resistor and 0.01 μ F capacitor.

G.E.C. BT302

After being switched on for three to five minutes, the picture disappears completely leaving a bright raster. It remains possible to vary the screen brightness by the brightness control after the picture has left the screen.

I suspect a grid to cathode short in the tuner, or a similar fault in one of the Z329 valves.—L. C. Langrish (St. Albans, Hertfordshire).

Since the brightness is controllable, the tube biasing is probably in order, meaning that the tube and associated valves are free from inter-electrode shorts.

The most likely causes are sudden vision i.f. channel instability due to a faulty i.f. valve or decoupling, or, more probably, intermittent open-circuit in the feed from the vision detector stage to the video amplifier stage. Check the associated chokes and components.

K.B. NF70

Periodically the height of the picture reduces leaving a gap top and bottom. After a while the set corrects itself leaving a normal picture.

Any adjustment to the height control to correct this fault results in the picture collapsing to a line across the screen or to expand and stretch the

picture images. I have replaced the frame output valve and checked the resistor in series with the height control, but the fault remains.

Another fault, which appears when the set is switched to the ITA channel, takes the form of a vertical column of flashes down the centre of the screen. This interference can be reduced by adjusting the vision limiter or removed by turning the linearity control fully anticlockwise. This latter adjustment upsets the linearity of the picture, of course.—F. Dicken (Alfrick, Worcester).

Change the ECL82 valve and the height control ($1M\Omega$) also the series resistor ($240k\Omega$).

The centre line of flashes may be due to a faulty 6CD6G line output valve or a brushing associated with the top cap or line output transformer.

PAM 754

Recently, due to a decreasing signal/noise ratio, I replaced the PCC84 in this set. This restored the signal-noise ratio but also produced patterning on the screen on Band I (channel 2) on top of an otherwise perfect picture.

This patterning is affected by alteration of the fine tuner but if this control is used to tune out

the patterning, the sound is de-tuned as well. I have found that by reducing the sensitivity of the tuner unit, the patterning can be cleared entirely, which leads me to suspect instability in the tuner.—J. Mebray (Wilmslow, Cheshire).

Instability can often be traced to an open circuited decoupling capacitor associated with the input to the tuner (of the ceramic type). Bridge each suspect in turn with a known good capacitor. We would point out, however, that this type of tuner is subject to patterning at the optimum fine tuner setting.

EKCO T217

I cannot obtain a picture on this receiver. There is no e.h.t. at the c.r.t. anode, nor at the e.h.t. rectifier. Also there is no line timebase whistle.

I have tried replacing several valves but I have been unable to trace the line oscillator valve to check its performance.—H. S. Hurn (Guisborough, Yorkshire).

We suggest you check the 20P1 line output valve, the U282 efficiency diode and the 20L1 line oscillator valve which is situated just outside the e.h.t. unit.

TEST CASE -16

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions, but are based on actual practical faults.

? A receiver had been working correctly on both channels, but after switching on one winter's evening it was discovered that the Band III picture was barely discernible with the Band I picture "ringed" badly and having the symptoms of "black-after-white" and slight instability. The sound on both channels was present but it was below normal and rather noisy.

The set was left switched on and turned round so as to remove the rear cover. This caused the Band I picture to disappear altogether, with just the raster showing. It was later discovered that the picture on either channel could be cut right out or brought up to a reasonable quality simply by altering the position of the aerial downlead at the rear of the set.

Why was this; and what would be the most likely cause of these effects?

See next month's PRACTICAL TELEVISION for the solution to this problem and for a further article in the Test Case series.

SOLUTION TO TEST CASE 15 (Page 236, last month)

The sudden occurrence of reduced picture width, as given last month, usually indicates that a component has suddenly failed, and this is not likely to be the mains rectifier as deterioration,

resulting in low h.t. voltage and reduced width, takes place over a period of time.

There are three main causes of the symptom, having in mind the manner in which it occurred. These are (i) failure of one or more of the surge limiting resistors connected to the multiple anodes in the rectifier valve (failure would give low h.t. voltage—which should have been checked by the experimenter); (ii) increase in value of the screen grid feed resistor on the line output valve (if fitted)—note that this trouble could reduce the e.h.t. voltage and impair the e.h.t. regulation, but not always, (iii) fracture in the core of the line output transformer.

The latter possibility can be detected by carefully examining the line output transformer core. Unfortunately, such trouble usually demands the replacement of the whole transformer, but it is as well to know the cause of the symptom, and a fractured core can greatly reduce the line amplifier efficiency, though is rarely considered by the experimenter.

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TU628, M69, TU669, Rewind or Exchange Unit at 128/-	All spares available. Prices on request, S.A.E.
TV50 at 103/9	PAM—908, 909, 932, 953, 959 at 57/9
TV55 at 103/9	734, 954, 701 at 63/9
TV55 Rewind Only	501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	521F, 560F
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	With INVICTA, PAM or PVE spares please state serial number and maker's part number.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	PETO SCOTT—148A, TR16, 178A, TV1416, T1419, T1419, at 33/6
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	TV1716, TV1719, TV1720. These are supplied as inserts only at
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	PHILCO—1000, 1010 at 91/5
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	1019 at 92/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	1021, 1023 at 91/5
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	1800, 1810 at 72/3
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	1960, 1961, 1968, 2160, 2161 at 47/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	1962M, 1967, 1967M at 65/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	All Philco spares available, some being exchange units, some are rewind (older models). Please send S.A.E. for quota- tion on any not listed.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	PILOT—CV76, TV76, CV77, CV84, TV84, CV84/12, TV82/12, at 44/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	DDC87, CV87, TV87, DDC87/12, CV87/12, TV87/12. These at 44/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	are supplied as inserts only
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	110F, 111, 117, TV197 at 63/11
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	All other types available, prices on request.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	PORTADYNE—All types are rewind only at 70/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	PYE—V14, V140, V4, V74, V7, V77 at 52/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	Luxury 17 series at 86/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	17C10L, CS17, CS17C, CS17E, CS17CF, CTM17E, CTM17S, at 86/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	CTM17E, CW17, CW17C, CW17CF, CW17F at 86/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	CTM17S, CW17S, CW17SF at 87/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	CTM218, CW218, CW218F at 87/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	CTM21, CTM217D, CTM21E, VT21, VT21CD at 72/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V200, V200LB at 57/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V110, PV110, V300S, V300F, V310S, V310F, V210, V210LB, at 72/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V220, V230, V410, V430, V510, V720, V600A at 42/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V700 P/No. 792740 at 81/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V700 P/No. 716374 or V700 P/No. 792643 at 42/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V700A P/No. 792740 at 59/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V700LBA P/No. 716374 at 59/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V820A, V830LBA, V710A at 42/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V71 at 59/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V620A, V700D, 710D, 830D, Model 1, Model 2, Model 11, at 59/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	Model 15
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	Other Pye spares quotation on request, S.A.E. please. When
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	ordering Pye spares please state model No. and serial No.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	also state if printed or wired circuit.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	RAYMOND—All 8coils and line outputs are rewind only.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	REGENTONE—All early models rewind or exchange unit.
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	T14 10-6 (or rewind at 70/-)
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	10-4 and 1017 supplied as insert at 114/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	R.G.D.—DEEPI/TIME, 17TME21 rewind only at 38/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	719, 611, 910 at 81/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	SOBELL—TS47, T347 at 87/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	T21, T21C, T21L, T22 at 87/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	TP8147, T178 at 81/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	T171, T171C, T172 at 66/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	T181, SC34, SC24, SC270, SC370
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	ULTRA—V814, V815, V817, V915, V917. These are exchange at 97/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	units
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V4-53, V414-53, V15-60, V1750, V1752, V1753, V1760, at 63/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V1752 at 80/9
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	W1752, V1753, V1754, V21-50, V21-52, V21-60 at 60/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V17-70, V17-71, V17-72, V17-73, V17-74, V17-75 at 72/8
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V17-80, V17-81, V17-82, V17-83 at 81/3
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V19-80, V19-84, V19-85 at 70/-
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	V23-80, V23-84
501, 501A, 501F, 517, 517A, 517C, 517E, 521, 531CA, 521CF, at 67/8	All 8coils can be supplied on the above Ultra range.

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