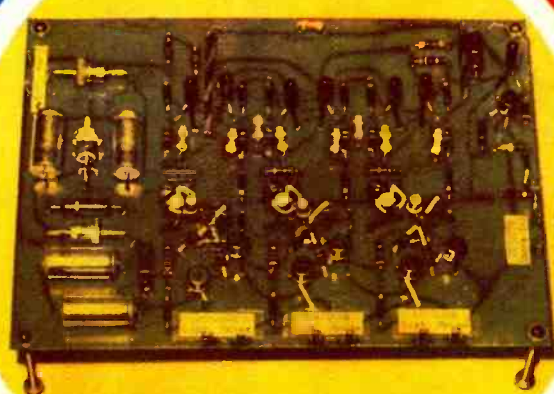
Practical TELEVISION

FEBRUARY 1969

2/6

EXPERIMENTS IN COLOUR TV



ALSO INSIDE: POWER SUPPLY TESTING

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, LONDON, N.W.1 Tel. Primrose 9090

Nearest tube Chalk Farm

SPECIALISTS IN NEW VALVES AND TRANSISTORS

OA2	5/9	6V6G	3/6	30L17	13/-	DY87	5/9	ECL83	9/-	EM71	14/-	PC88	9/6	PY33	9/6	UBL21	9/-	2N3866	20/-	BC108	3/6	OC25	5/-
OB2	6/-	6X5GT	5/-	30P4	12/-	E80CC	33/-	ECL84	12/-	EM80	5/9	PC95	8/3	PY80	5/3	UC92	5/3	2N3121	50/-	BC109	4/3	OC26	5/-
OZ4GT	4/3	7B6	10/9	30P4MR		E80F	24/-	ECL85	11/-	EM81	6/9	PC97	7/9	PY81	5/3	UCC84	8/-	AA120	3/-	BC113	5/-	OC28	5/-
1R5	5/6	7R7	12/-		17/6	E83F	24/-	ECL86	8/-	EM84	6/-	PC900	8/3	PY82	5/-	UCC85	6/6	AC107	3/-	BC115	3/-	OC30	5/-
1S5	3/9	7S7	20/-	30P12	13/-	E88CC	12/-	ECLL800		EM85	11/-	PCC84	6/-	PY83	5/6	UCF80	8/3	AC113	5/-	BC116	5/-	OC35	5/-
1T4	2/9	10C1	12/6	30P19	12/-	E180F	17/6		30/-	EM87	7/3	PCC85	6/6	PY88	6/3	UCH21	9/-	AC126	2/-	BC118	4/6	OC36	7/6
2D21	5/6	10C2	10/-	30PL1	15/-	EABC80	6/-	EF22	12/6	EY51	6/9	PCC88	9/9	PY800	6/6	UCH42	9/3	AC127	2/-	BCY10	5/-	OC38	11/6
2X2	4/9	10F1	15/-	30PL13	15/-	EAF42	8/3	EF36	3/6	EY81	7/-	PCC89	9/6	PY801	6/6	UCH81	6/6	AC128	2/-	BCY12	5/-	OC41	10/-
3A5	10/-	10F18	7/6	30PL14	15/-	EB34	7/6	EF37A	7/-	EY83	8/3	PCC189	9/6	PZ30	9/6	UCL82	7/-	AC154	5/-	BCY33	5/-	OC44	2/-
3Q5GT	6/-	10LD11	10/-	30PL15	15/-	EB41	4/6	EF39	5/-	EY84	7/6	PCF80	6/6	R10	15/-	UCL83	9/3	AC156	4/-	BCY34	4/6	OC45	1/9
3S4	4/9	10P13	12/-	35L6GT	5/9	EB91	2/3	EF40	8/9	EY86	6/-	PCF82	6/-	R17	17/6	UF41	9/6	AC157	5/-	BCY38	5/-	OC46	3/-
3V4	5/6	10P14	12/6	35W4	4/6	EBC41	8/6	EF41	9/-	EY87	6/-	PCF84	8/-	R18	9/6	UF42	9/-	AC165	5/-	BCY39	4/6	OC70	2/3
5R4GY	8/9	12AC6	7/-	35Z3	10/-	EBC81	5/9	EF42	3/6	EY88	7/6	PCF86	8/6	R19	6/6	UF80	6/9	AC166	5/-	BD119	9/-	OC71	2/-
5U4G	4/9	12AD6	6/-	35Z4GT	4/9	EBF80	5/9	EF50	2/6	EY91	3/-	PCF801	7/-	TY86F	12/2	UF85	6/9	AC168	7/6	BF154	5/-	OC72	2/-
5V4G	7/6	12AE6	7/6	35Z5GT	6/-	EBF83	8/-	EF73	6/6	EZ40	7/3	PCF802	9/-	U10	9/-	UF86	9/-	AC177	5/6	BF159	5/-	OC74	2/6
5Y3GT	5/6	12AT6	4/6	50B5	6/3	EBF89	6/3	EF80	4/6	EZ41	7/3	PCF805	8/9	U12/14	7/6	UF89	6/3	ACY17	3/-	BF163	4/-	OC75	2/-
5Z3	8/-	12AU6	4/9	50L6GT	6/-	EBL21	11/-	EF83	9/6	EZ80	4/3	PCF806	11/6	U16	15/-	UL41	9/6	ACY18	3/8	BFY50	4/-	OC76	2/6
6/30L2	12/6	12AV6	5/6	72	6/6	EC53	12/6	EF85	5/3	EZ81	4/6	PCL81	9/-	U18/20	10/-	UL84	6/6	ACY19	3/9	BFY51	4/-	OC77	2/6
6AC7	3/-	12BA6	6/-	85A2	8/6	EC70	4/9	EF86	6/-	GZ33	12/6	PCL82	7/-	U19	34/6	UM80	5/-	ACY20	3/6	BFY52	4/6	OC78	3/-
6AG7	5/9	12BE6	5/9	90C1	16/-	EC86	10/3	EF89	4/9	GZ34	10/-	PCL83	8/9	U22	7/9	UR1C	10/6	ACY21	3/9	BY100	3/6	OC78D	3/-
6AQ5	4/9	12BH7	6/-	90CG	34/-	EC88	10/3	EF91	3/3	GZ37	14/6	PCL84	7/6	U25	13/-	UU8	14/-	ACY22	3/6	BY234	4/-	OC81	2/-
6AT6	4/-	12J7GT	6/6	90CV	33/6	EC92	6/6	EF92	2/6	HABC80	8/-	PCL85	8/3	U26	11/9	UY1N	9/-	ACY28	4/-	BY236	4/-	OC81D	2/-
6AU6	5/-	12K5	10/-	150B2	14/6	ECC31	15/6	EF95	4/6	HN309	27/4	PCL86	8/3	U31	6/-	UY21	9/6	AD140	7/6	BY238	4/-	OC82	2/3
6AV6	5/6	19AQ5	4/9	807	11/9	ECC40	9/6	EF97	10/-	HVR2	8/9	PEN45	7/-	U33	29/6	UY41	6/9	AD149	8/-	BYZ12	5/-	OC82D	2/3
6BA6	4/-	19H1	40/-	5763	10/-	ECC81	3/9	EF98	10/6	HVR2A	8/9	PEN45DD		U35	16/6	UY85	5/6	AF114	4/-	BYZ13	5/-	OC83	2/-
6BE6	4/3	20D1	13/-	7475	4/-	ECC82	4/6	EF183	5/9	KT41	19/6		12/-	U37	34/11	VP1B	10/6	AF115	3/-	GET103	4/-	OC84	3/-
6BH6	7/6	20D4	20/5	AC2PEN		ECC83	4/6	EF184	5/9	KT44	20/-	PEN46	4/-	U45	15/6	VR105	5/-	AF116	3/-	GET113	4/-	OC123	4/6
6BJ6	6/9	20F2	14/-	DD	19/6	ECC84	5/6	EF804	20/5	KT61	12/-	PFL200	12/-	U76	4/9	VR150	5/-	AF117	2/9	GET118	4/-	OC169	3/6
6BQ7A	7/-	20L1	13/-	AC6PEN	4/9	ECC85	5/-	EH90	6/6	KT63	4/-	PL33	19/6	U191	12/6	VU111	7/3	AF119	3/-	OA70	3/-	OC170	2/6
6BR7	8/6	20P1	17/6	AC/TP	19/6	ECC88	7/-	EL32	3/6	KT66	17/3	PL36	9/6	U251	16/-	W107	7/-	AF125	3/6	OA79	1/9	OC171	3/4
6BR8	8/-	20P3	18/-	AZ31	8/9	ECC91	3/-	EL33	12/-	KT88	29/-	PL38	19/9	U282	8/-	W729	10/-	AF127	3/6	OA81	1/9	OC172	4/-
6BW6	12/3	20P4	18/6	AZ41	7/6	ECC189	9/6	EL34	9/6	KTW61	8/6	PL81	7/3	U301	11/-	X41	10/-	AF178	10/-	OA90	2/6	OC200	4/4
6BW7	11/-	20P5	18/-	CBL1	19/6	ECF80	6/6	EL36	8/6	KTW62	10/-	PL81A	10/6	U404	7/6	X66	7/6	AF180	9/6	OA91	1/9	OC202	4/6
6C9	11/-	25Y5G	8/6	CL33	18/6	ECF82	6/6	EL41	9/3	KTW63	5/9	PL82	6/6	U801	17/6	Y63	5/-	AFZ12	5/-	OA95	1/9	OC203	4/6
6CD6G	19/6	25Z4G	6/-	CY31	7/6	ECF86	9/-	EL42	9/9	MHD4	8/3	PL83	6/6	U4020	6/9	*Transistors*		ASY28	6/6	OA182	2/-	OCP71	27/6
6CH6	6/-	25Z6GT	8/6	DAF96	6/-	ECF804	42/-	EL81	8/-	MHLD6	7/6	PL84	6/3	UABC80	5/9	*and diodes*		BA115	2/8	OA200	1/-	MAT100	7/9
6F1	8/9	30C15	13/6	DF96	6/-	ECF805	12/6	EL83	6/9	MU12/14	4/-	PL500	12/-	UAF42	9/6	2N404	6/-	BA129	2/6	OA202	2/-	MAT101	8/6
6F18	7/6	30C17	12/6	DF97	10/-	ECH21	12/6	EL84	4/6	N78	38/4	PL504	12/6	UB41	6/6	2N2297	4/6	BA130	2/-	OC22	5/-	MAT120	7/9
6F23	12/3	30C18	8/9	DK40	10/-	ECH35	5/9	EL85	7/6	N108	26/7	PL509	28/9	UBC41	7/6	2N2369A	4/3	BC107	4/-	OC23	5/-	MAT121	8/6
6K7G	2/-	30F5	11/9	DK92	7/9	ECH42	9/6	EL86	8/-	PABC80	7/3	PM84	7/9	UBC81	7/-								
6K8G	3/-	30FL1	15/-	DK96	7/-	ECH81	5/3	EL91	2/6	P61	2/6	PY31	6/6	UBF80	5/9								
6L6GT	7/9	30FL12	16/-	DL72	15/-	ECH83	8/-	EL95	5/-	PC86	9/6	PY32	9/6	UBF89	6/9								
6L19	19/-	30FL13	8/-	DL96	7/-	ECH84	7/-																
6Q7G	6/-	30FL14	12/6	DM70	6/-	ECL80	6/6																
6U4GT	12/-	30L15	13/9	DM71	7/6	ECL82	6/-																

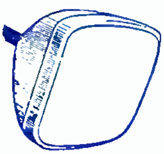
We require for prompt cash settlement all types of above goods, loose or boxed, but MUST be new. Offers made by return.

Terms of business:—Cash with order only. No C.O.D. Postage/Packing 6d. per item. Orders over £5 post free. Any parcel insured against damage in transit for only 6d. extra. Business hours: Mon.—Fri. 9 a.m.—5.30 p.m. Sats. 9 a.m. —1 p.m. No enquiries answered unless S.A.E. is enclosed for reply.

All goods are new first quality manufacture only and subject to makers' full guarantee. We do not handle manufacturers' seconds or rejects which are often described as "new and tested" but which have a limited and unreliable life. Complete catalogue of over 1,000 valves actually in stock with resistors, condensers, transformers, microphones, speakers, metal rectifiers with terms of business, 10d., post free.

T.V. TUBES **"VIDEOCHROME"** T.V. TUBES

FOR **BRILLIANCE** & DEFINITION



COMPARE OUR PRICES

CASH OR CHEQUE WITH ORDER

17"—£4-15-0
19"—£5-5-0
21"—£6-10-0
23"—£7-10-0

TRADE SUPPLIED

ALL TUBES PRECISION REBUILT AT OUR OWN FACTORY BY SKILLED CRAFTSMEN WHO HAVE BEEN REBUILDING TUBES FOR OVER 10 YEARS ● EACH TUBE BENCH AND SET TESTED TO A VERY HIGH STANDARD BEFORE DISPATCH

PRICES FOR TWIN PANEL TUBES AVAILABLE ON REQUEST

2 YEARS GUARANTEE ● FREE DELIVERY ANYWHERE IN THE U.K.

VIDEOCHROME TUBES LTD.

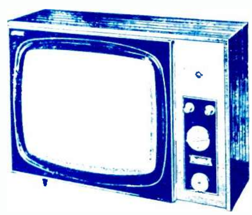
25 BELLEVUE AVENUE, RAMSGATE, KENT. Tel. THANET 52914

17in.—£11.10.0
19in.—SLIMLINE
FERGUSON—24 Gns.

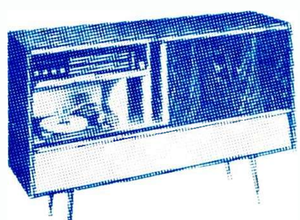
TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS

FREE ILLUSTRATED LIST OF TELEVISIONS
17"—19"—21"—23"
Carr. Ins. 30/-.
WIDE RANGE OF MODELS SIZES AND PRICES
DEMONSTRATIONS DAILY

TWO-YEAR GUARANTEED REGUNNED TUBES
70° & 90 14in.—69/6 17in.—89/6 21 in.—99/6. 110°
17in., 19 in. & 21in.—99/6.
23° (not bonded)—119/6.
Exchanged Bowls. Carr. 10/6



COCKTAIL/STEREOGRAM CABINET £25



Polished walnut veneer with elegant glass fronted cocktail compartment, padded position for two 10in. elliptical speakers. Record storage space. Height 35¼in., Width 52¾in., Depth 14½in. Legs 1 gn. extra. **Other models. Send for free list.**

TRANSISTOR CHASSIS D.1 49/6
6 Transistors, LW/MW, Brand New. Famous British Manufacturer (LESS SPEAKERS). P. & P. 4/6.

TRANSISTOR CASES 19/6. Cloth covered, many colours. Size 9½"×6½"×3½". P.&P. 4/6. Similar cases in plastic 7/6.

TRANSISTOR RECORD PLAYER CABINETS 19/6. 11"×14½"×5½" and 14"×15"×5½" P. & P. 5/6.

DUKE & CO. (LONDON) LTD.
621/3 ROMFORD ROAD, E.12 01-478 6001-2-3

Practical Television

FEBRUARY 1969
VOL. 19 No. 5
issue 221

WAKE UP!

MANY years ago, the Americans were looking for a Caucasian pugilist capable of winning the heavyweight championship. More recently, our ailing TV industry was similarly seeking a Great White Hope. With colour TV (paradoxically!) it looked as though the search was over.

Yet what is the position today? Colour on all channels is scheduled for end of this year and already BBC-2 is doing a noble job in that direction. There are now something like 100,000 colour sets in homes. We have the advantage of the PAL system which is undoubtedly the best potential system in the world (even the Americans now agree on this). But . . .

Many retailers do not appear to have a proper appreciation of colour TV, or are too lackadaisical to bother. Pictures are rarely set up properly and converged. Sets are often shown to their disadvantage in brightly lit windows. A recent spot survey in one district, not necessarily representative but a guide, located eight colour sets on view to the public and only one of these (in the background of a rental company's showroom) did any justification to the transmission.

One reason is the critical shortage of trained engineers capable of handling colour sets. Manufacturers and rental companies have been busily occupied running courses for their staff, but many retailers have done little in this direction, obviously expecting their engineers to pick it up as they go along.

This, of course, is not good enough. Retailers, service engineers and everyone else in the trade have got to realise that colour TV needs specialised know-how. They must also realise that to handle colour, service workshops must have adequate test equipment. Unless these facts are noted and heeded, the anticipated colour bonanza may not happen. The public must be convinced that they will get good value for their money, including competent after-sales service.

The colour boom took 10 years to mature in the USA because transmissions were poor (which should not affect us), demonstrations were poor and service even worse. If the British industry is to grasp the opportunity of colour TV it must not make the same mistakes.

W. N. STEVENS, *Editor*.

THIS MONTH

THE NEXT ISSUE DATED MARCH WILL BE PUBLISHED ON FEBRUARY 21

THE EVR TELEPLAYER

PLUG in a film of your own choice and watch it on your own television—this is basically the purpose of the Teleplayer, a new audio-visual system developed by the EVR partnership. At the beginning of December EVR (Electronic Video Recording and Reproduction), comprising CBS-EVR of the USA, ICI of UK and CIBA of Switzerland, announced a machine which plays special photographic film through a flying spot scanning system to produce a 625-line video signal suitable for connecting to a TV set. The photograph shows how compact the device is—it is completely self-contained—and it can accept cassettes known as telecartridges. It is mainly intended for the educational/instruction market, but as demand increases and the price drops, it could find its way into the domestic market. A built-in stop-start facility also provides some glimmers of hope for industrial documentation applications, as a form of micro-film replaying machine.

The recording medium is a special film, the photographic images being applied by an electron beam recorder to give a far higher degree of definition than any conventional photographic technique. This enables the film width to be kept down to 8.75 mm, into which are squeezed *two* "tracks," plus two magnetic stripes for the sound, and a row of synchronising pulses. Up to 750ft. of film can be accommodated in a cassette, equivalent to 1 hour total playing time. The cassette reel locks the film in place, sealing it from dust and mishandling, and only opens when in position in the Teleplayer. Film is threaded automatically, eliminating the need for the operator to touch or see it. Changing channels is instantaneous, for one control moves the optical system to scan the other half of the film. As mentioned earlier, the film can be stopped to display a single frame, with no fear of damage. The output is normal video or 175-Mc/s modulated r.f. for connecting to a TV set aerial terminal via coaxial cable.

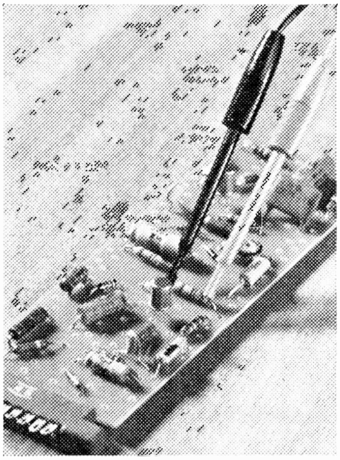
This system was announced simultaneously in the UK, USA and on the continent. The electronics were developed principally by CBS in America, the prototype seen at a recent demonstration being an imported model. Development of the photographic process, however, was due to Ilford in this country, who will be responsible for a processing service to transfer customer's material on to the film. There will be production of the machines in this country shortly, the first manufacturing and distribution licence having been granted to Rank Bush-Murphy. Negotiations with other companies were under way when this was written.

Production of the films requires bulky and very expensive equipment, which means that this can only be done by Ilford—ruling out the possibility of "rolling your own." Fairly large runs are necessitated for economy, and so the company has tooled up for production of between 100 and 1,000 copies of any one pair of originals.

The commercial introduction of the Teleplayer should be in mid-1970. The cost will at first be a little under £200 per machine, and it is hoped to reduce this figure significantly later. Plans for the more distant future include colour, where the luminance signal would be contained on one track, with chrominance information on the other. Colour film would be no more expensive, the only penalty being a playing time reduction to ½ hour. Tapes would be compatible between the two types of machine.

The EVR Teleplayer—it measures only 18 in. square by 5 in. high, and weighs just 35 lb, but can hold a one-hour film cassette and play it through a normal 625-line TV set. It should be available by mid-1970, costing just under £200.

NEW PROBE CLIP



A NEW, long-necked insulated probe clip designed and manufactured by Futters (London) Ltd., of Harlesden, in conjunction with Radiospares makes use of the toughness and resilience of Kematal, ICI's acetal copolymer, as well as its good insulation properties.

The probe body is moulded in two parts entirely from Kematal, in either red or black, and gives full insulation to the gold-plated 0·032in. wire which is threaded through the neck. This insulation ensures that the probe clip will not cause a short circuit if it touches any adjacent wiring when in use. The length of the neck enables components and connections to be reached deep down in the workings of the apparatus without the need to dismantle the circuitry. The collar part of the moulding snap-fits on to a grip on the neck and completely insulates the test leads which can be attached by means of a screw fitting or by soldering.

The neck is spring loaded and a sliding action between finger and thumb on the grip retracts the neck so that the hook end can be fastened to the component to be tested to give a positive connection.

NEW COLOUR TV BOOK FROM MULLARD

"COLOUR TELEVISION: A Background to Colour Tube Adjustments for the Service Engineer" is the title of a new book just published by Mullard Ltd. Based on the long experience of the company's colour TV design engineers, it has been specially written for service men.

The book is divided into two parts. Part I gives a brief description of the shadowmask picture tube and the operation of its associated assemblies, explaining convergence and colour purity and describing in simple terms how a good colour picture is obtained.

Part II gives a typical setting-up procedure in easy-to-follow, step-by-step form. Stress is again laid on the importance of correct adjustment of colour purity and convergence in obtaining a good picture.

Figures and circuit diagrams illustrate the operation of the picture tube and its assemblies, colour pictures and diagrams being used to show the operation of the various controls and to give examples of the displayed picture before and after adjustments are made.

The book has 48 pages and measures 8½in. by 6in.—a convenient size for carrying around. It is bound in an attractively designed stiff board cover and there are 45 black-and-white and colour diagrams and photographs.

Copies are available direct from Mullard Ltd., Distributor Sales Division, Mullard House, Torrington Place, London, W.C.1, at 17s. 6d. per copy plus 1s. 6d to cover postage and packing, cash with order

NEW ELECTROLUBE GUIDE

THE latest version of the Electrolube Application Guide is now available free from Electrolube, makers of the Electrolube range of electrical and mechanical lubricants and Electrolube Freezer.

Electrolube Ltd., Oxford Avenue, Slough, Bucks.

PRACTICAL WIRELESS and TELEVISION FILM SHOW 1969

THE annual film show, organised jointly by Mullard Ltd. and Practical Wireless and Practical Television, is to be held once again at Caxton Hall, Caxton Street, Westminster, London, S.W.1. The date is Friday, March 28th, and the show will start at 7.15 p.m.

The programme will include a talk entitled Colour Television, covers setting-up procedure and deals in detail with degaussing, purity, convergence and grey scale tracking.

The film, called "It's the Tube that Makes the Colour", describes the manufacture of Mullard "ColourScreen" TV tubes.

Refreshments will be served.

Applications for free tickets should be made now to: FILM SHOW, Practical Wireless and Practical Television, Tower House, Southampton Street, London, W.C.2.

A stamped, addressed envelope must be included.

SOVIET TELEVISION PROGRESSES

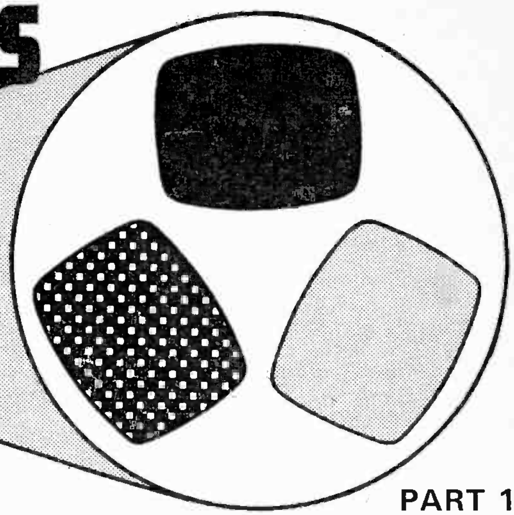
NEW designs of large television screens suitable for installation in urban cinemas are now being developed by Soviet scientists. Professor Mark Krivosheyev, one of the leaders of the USSR Society for Radio Technique and Electrical Communications, reported this at the opening in Moscow on December 10 of a scientific conference of the Society.

Scientists from Britain, Bulgaria, Hungary, East Germany, Poland, the United States, Finland and West Germany are attending the conference, and also representatives of the International Consultative Radio Committee.

Professor Krivosheyev mentioned the Secam-3 colour TV system developed by the USSR and France and distinguished by comparative simplicity and better colour effect in transmission over long distances. Colour transmissions began simultaneously in Moscow and Paris just over a year ago.

Within three years all Soviet TV stations will be able to receive the programme of Moscow's central television, he said. Over 900 TV and relay centres now serve half the population of the country. Twenty million TV viewers of the Far North and Far East areas of the USSR can now regularly watch Moscow transmissions thanks to the *Molniya-1* series of satellites and the network of *Orbita* ground receiving stations.

EXPERIMENTS IN COLOUR TV



MARTIN L. MICHAELIS, M.A.

PART 1

THE colour television experimental applications to be described involve the use of triple sequential switching needed in field or line sequential colour television equipment and certain forms of telecine. Such a triple switch circuit is generally known as a *tritch* by contraction of the words triple and switch.

SEQUENTIAL COLOUR TV

In field or line sequential colour television equipment groups of three successive fields or lines are used cyclically to cover the three primary colours red, green and blue. The field sequential system is more common because mechanical devices operating a colour sector disc in front of a monochrome picture tube and some auxiliary circuits readily added to most modern monochrome receivers suffice to give reasonably good colour reproduction from a basic monochrome receiver. In a line sequential system purely electronic methods are required for the much higher colour switching rate so that a colour tube has to be used and there is virtually no advantage over a proper simultaneous colour dot system as used in standard commercial colour receivers.

The tritch design described in this article is equally suitable for field or line sequential switching however. Its basic logic function is to accept field or line sync pulses of any standard or non-standard frequency from zero to 16kc/s, producing three mutually decoupled outputs at one third of the input frequency, mutually staggered by one input pulse interval (see waveforms, Fig. 1). These outputs can be used for cyclic gating of the three primary colours and for synchronising a colour sector disc rotated in front of a monochrome picture tube.

USING A MONOCHROME RECEIVER

In principle any good monochrome television receiver with an ordinary monochrome picture tube can be adapted to give quite good colour reproduction of PAL, NTSC or SECAM transmissions on a field sequential basis. After making sure that the passband up to the video detector is adequate and properly aligned, a conventional decoder module as used in ordinary colour receivers can be employed at this point to derive the red, green and blue signals. These can then be fed through three separate amplifiers whose gains can be adjusted individually and the amplifiers gated cyclically by the tritch outputs so that each passes the respective primary colour component *in succession* for one field period. The outputs of the three primary-colour amplifiers are then combined in a common load resistor from which the existing video output stage and monochrome picture tube are fed.

At the same time the tritch outputs can be used to synchronise a motor driving a large card or plywood disc in front of the picture tube. This disc carries consecutive sectors of red, green and blue celluloid shaped so that each sector comes in front of the screen for one field period. Simple arrangements use a d.c. motor whose speed is coarsely adjusted with a series potentiometer until lock-in to the field sequence is obtained. For this purpose small magnets are mounted on the rim of the colour disc. Small solenoids are mounted at the correct angular positions near the disc rim but stationary on the frame. These solenoids are fed with pulses from the tritch outputs and the phasing can be adjusted by the positioning of the magnets on the colour disc.

The outputs of the tritch described in this article will generally be adequate to drive low-resistance relay coils or coils removed from electric bells or buzzers, directly as sync solenoids. The staggered 2 : 1 ratio square-waves at the junctions of R2, R3 can be taken via emitter-followers to gate the three primary-colour amplifiers between the decoder and the video output stage.

None of these circuits is unusual apart from the tritch. Decoder circuits have been described in this magazine and may be taken over or adapted from any commercial circuit. But no commercial colour receiver requires a tritch so this is the only new item peculiar to a field sequential system.

The advantages of the field sequential system

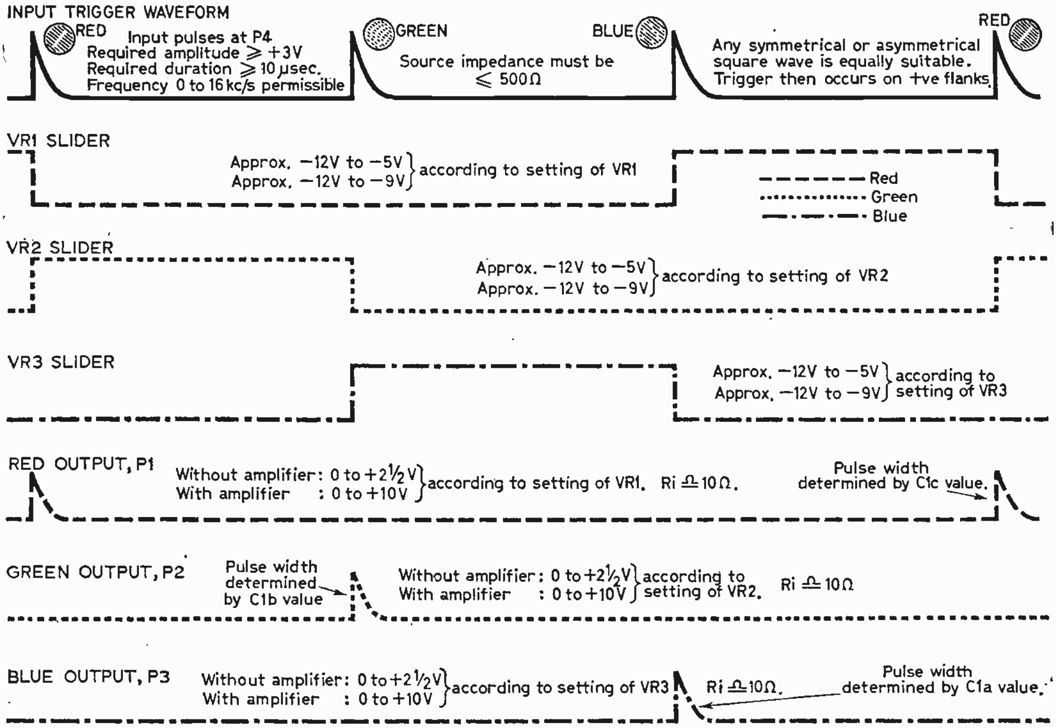


Fig. 1: Nominal colour tritch output waveforms.

are as follows. Use is made of all the circuits in an existing monochrome receiver including its monochrome picture tube. A decoder module, a tritch module and a triple-gated amplifier module are the only required circuit additions. None of these is expensive or critical and accommodation for them can usually be found in the receiver cabinet. Although using several germanium transistors the tritch circuit here described will operate satisfactorily up to over 50°C so that heat generated from valves inside the monochrome receiver is not likely to lead to trouble provided the colour modules are mounted in a reasonably cool position and suitable heat baffles are added where necessary. The expense of a colour tube, stabilised e.h.t. circuit and the critical problems of colour beam alignment are all avoided by the field sequential system.

The disadvantages are chiefly twofold. There will be some flicker since a complete picture is produced only once every three fields. The effective flicker frequency is thus 16·7c/s which is the same as that of normal 8mm. amateur cinematography, i.e. quite acceptable. A more serious drawback is the large colour disc rotating in front of the picture screen. This may be unsightly and can give rise to mechanical noise. However skilful wooden panelling is well within the scope of the amateur carpenter and will solve both problems. Use panelling, not total enclosures which would obstruct heat dissipation from the receiver. The diameter of the colour disc must be about twice the screen diagonal, giving rise to quite formidable dimensions. Another possible approach for experimenters with good lathe facilities and skill in optical fine mechanics is to produce a low-power binocular system with very small colour discs rotating at an optically neutral point. There will then be virtually no externally visible modifications to the monochrome receiver.

AN INVITATION:

The colour tritch described in this article can be used in a number of different ways as indicated and is a useful "basic module" for the experimenter. We propose to feature tested designs for other modules in future issues and readers are invited to write to the Editor stating the circuits they would like to see included.

TELECINE AND CCTV APPLICATIONS

The tritch circuit described in this article is equally suitable for telecine and general CCTV applications in colour using an adapted monochrome receiver as described above or a standard commercial colour receiver. In the latter case the three sequentially gated signals from the monochrome CCTV camera are fed directly to the three gun amplifiers of the receiver colour tube. Rotating colour discs will be very small for

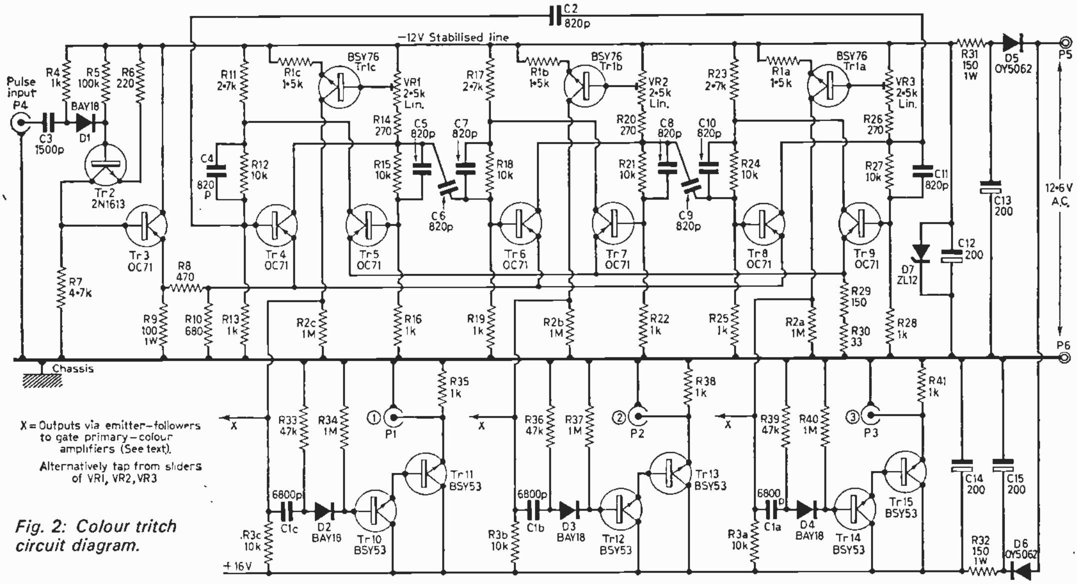


Fig. 2: Colour tritch circuit diagram.

amateur CCTV equipment because this mostly uses 1in. vidicons. Mechanical problems will hardly arise in this case.

A very elegant solution is possible for colour telecine with a monochrome CCTV camera, using nothing more than the tritch and three gated primary-colour amplifiers (apart from the existing circuitry of a monochrome CCTV camera and a standard colour receiver). A cine projector can be procured or modified to use an approximately synchronous mains motor, driving the shutter wheel at the conventional speed of about 333·3 r.p.m. via fixed gearing. The standard 8mm. cine frame speed is 16·7/sec so that three such frames will appear per revolution of the shutter wheel. The corresponding three openings around

COMPONENTS LIST

Optional amplifier stage

Tr1 BSY76 or any small silicon npn transistor with $\beta \geq 20$ and V_c max ≥ 30v
R1 1·5kΩ
R2 1MΩ
R3 10kΩ

Main circuit

Capacitors:

C1 6,800pF (for field frequency sequential operation; see text for other uses)
C2 820pF 500V ceramic
C3 1500pF 500V ceramic
C4-C11 820pF 500V ceramic
C12-C15 200μF 25V electrolytic

Semiconductors:

Tr2 2N1613
Tr3-Tr9 OC71
Tr10-Tr15 BSY53 or 2N1613
Similar types suitable for substitutes in each case.
D1-D4 BAY18 or any small silicon diode with p.i.v. $\geq$100V and C $\leq$5pF
D5, D6 Silicon l.t. rectifiers, $\geq \frac{1}{2}$A.
D7 12V power zener diode $\geq$50mA.

Resistors:

R4	1kΩ	R23	2·7kΩ
R5	100kΩ	R24	10kΩ
R6	220Ω	R25	1kΩ
R7	4·7kΩ	R26	270Ω
R8	470Ω	R27	10kΩ
R9	100Ω 1W	R28	1kΩ
R10	680Ω*	R29	150Ω*
R11	2·7kΩ	R30	33Ω*
R12	10kΩ	R31	150Ω 1W
R13	1kΩ	R32	150Ω 1W
R14	270Ω	R33	47kΩ
R15	10kΩ	R34	1MΩ
R16	1kΩ	R35	1kΩ
R17	2·7kΩ	R36	47kΩ
R18	10kΩ	R37	1MΩ
R19	1kΩ	R38	1kΩ
R20	270Ω	R39	47kΩ
R21	10kΩ	R40	1MΩ
R22	1kΩ	R41	1kΩ

VR1 2·5kΩ lin. miniature skeleton
VR2 2·5kΩ lin. miniature skeleton
VR3 2·5kΩ lin. miniature skeleton

All 10% $\frac{1}{2}$W unless otherwise stated.
* See text.

the shutter wheel can be fitted with a red-green-blue celluloid sector triplet so that one of the three 50c/s CCTV fields occurring during the exposure of each cine frame is filtered in each primary colour.

Drive pulses from the mains waveform obtained by squaring and differentiation are used to feed the tritch module and to synchronise the CCTV field scan circuit. The outputs from the tritch are fed to magnet and solenoid synchronisers for the shutter wheel of the projector and to gate three primary-colour amplifiers at the output of the CCTV camera. The video signal is fed to the inputs of these amplifiers in parallel, and the outputs of the amplifiers are fed respectively to the gun amplifiers of the colour receiver picture tube. Thus a tritch module is the only additional electronic circuit required to convert a monochrome CCTV camera equipment to colour operation. The other requirements boil down to mechanical and optical measures, which certainly require diligent experimenting for correct functioning but involve no basic problems which cannot be mastered by the reasonably skilled handyman.

The actual materials and hues used for the colour filters are not over-critical. Any reasonably saturated and not too dark red, green and blue films may be used. An acceptable colour balance can be achieved for a wide range of actual "primary" colours by suitable adjustment of the primary-colour amplifier gains. If the filter colours actually used differ too much from the ideal some (but not all) colours become impossible to reproduce correctly. The criterion of what remains acceptable is largely subjective so that it is a matter for personal experiment.

OTHER APPLICATIONS

The tritch module can also be used for three-signal beam switching at the input of the Y amplifier of any ordinary oscilloscope by gating three input stages cyclically. This permits simultaneous display of three colour waveforms in a sequential system, using the triggered or synchronised modes of the oscilloscope, whilst preserving correct mutual phasing with respect to the 120° staggered reference points. This arrangement is equally suitable for any three-phase a.c. signals so that the tritch is useful for work in conjunction with mains power engineering. Conversely the tritch is suitable for controlling various types of three-phase electrical machinery or for driving inverters producing a three-phase a.c. supply from d.c. The input to the tritch will then be derived from a free-running multivibrator which may be mounted on the same printed circuit board.

TO BE CONTINUED

CO-CHANNEL INTERFERENCE—ITA ADVICE

At certain times of the year, some viewers—particularly in areas some way away from the nearest ITA transmitter—experience interference in the form of patterning on the picture or occasionally as disturbance to the sound. The patterning—which may appear as alternate dark and light shadows in herring-bone form—is usually slight, but sometimes may be moderate or even severe.

This form of interference arises in certain weather conditions from the simultaneous reception of the local signals and those from other television transmitting stations, possibly hundreds of miles away. The conditions under which such long-range signals are received at sufficient strength to cause degradation of the local service are fortunately infrequent, usually persist for only a relatively short time, and affect only a small proportion of viewers. Exceptionally, however, such conditions have been known to last for several days, and tend to be most pronounced during evening viewing hours. September to November and February to April are periods when these conditions are more common.

Band III transmissions are never entirely cut off at the line-of-sight boundary but tend to follow the curvature of the earth: this is because of various partial reflections, including those caused by the presence of water vapour in the troposphere, the region of the atmosphere extending upwards to a few miles above ground level. Normally, the amount of Band III signal bending in the troposphere is quite small, the strength of the reflected signals falling off rapidly beyond the horizon. However if, for example, the amount of water vapour at heights of a mile or two increases sharply—as can happen where there is a layer or patch of moist warm air—the range of television signals will be extended.

Weather conditions in which there is high humidity at ground level accompanied by a rapid decrease in humidity with height or where instead of the usual decrease there is an increase in temperature with height (temperature inversion) can result in a very marked temporary extension of the area reached by a particular transmitter. To some extent authorities in meteorology and radio propagation can predict conditions in which long-range Band III interference is most likely to occur—but at present cannot usually forecast exactly when or where or for how long such conditions will arise or persist.

Where such interference occurs only for a few hours or minutes in any year viewers will probably not wish to take special precautions. However at particular locations where this form of interference is common and occurs due to specific co-channel station(s) interference can usually be reduced by improving the directional characteristics of the receiving aerial. This will increase the signal pick-up from the required station while reducing signals from any interfering station(s) off the direction of the main beam. This should be effective except in the special case where the interfering station is along the same, or nearly the same, geographical bearing from the viewer as the wanted local station. Alternatively it may be possible to reorientate an existing aerial to reduce ("null out") the interference from a particular source. A local dealer should be able to advise. ■

dealing with faulty C.R.T.s

VIVIAN CAPEL

SOME years ago the diagnosis of a faulty cathode-ray tube was little short of a catastrophe. Tubes were expensive and carried a large burden of purchase tax. The situation now has greatly improved: purchase tax has been lifted, new tubes are cheaper and re-gunned tubes can be obtained that are even less expensive. Added to this is the fact that more recent types of tube seem to be far more reliable than their earlier counterparts and a tube failure is much less frequent.

Nonetheless faults still occur, especially on the older ones, and where a rather ancient set is concerned—perhaps one that is being used as a second set—the question is bound to arise as to whether the set is worth a replacement even at today's prices. Here then are some methods which have been used by engineers in the past and are still sometimes used today to extend the life of an ageing c.r.t.

The familiar signs of low emission are quite well known. The picture is dull with lack of highlights or the highlights may be actually going negative. Often the images take on a plastic-looking appearance. Different methods of reactivation over a period have been tried with varying degrees of success. Generally however reactivation has proved to be temporary and an extension of perhaps only a few weeks has been obtained. A much longer extension can be obtained by fitting a boost transformer so that the heater voltage rating is exceeded by a fixed percentage. This will often increase the cathode emission for quite a useful period, but of course the risk is run of making the heater go open-circuit as a result of overrunning it.

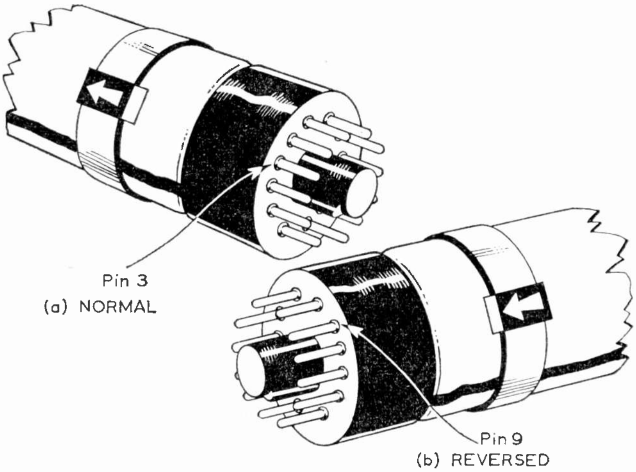
Very often though it is found that the cathode emission is quite in order and the real trouble giving the effect of low emission is that of a short-circuit across the heater. As the heater is in a series heater chain any such shunt across it whether internal or external will starve it of its correct heater current so that it cannot reach its correct operating temperature. If the short is not of too low a resistance fitting a small transformer to supply the correct heater voltage will in most cases prolong the life of the tube for quite a considerable time. No boost is required and the dangers of an overrun heater are thus avoided.

It can quite easily be determined whether or not the heater is short-circuited by simply taking a voltage reading across it with the receiver functioning. If the voltage is more than a few percent lower than the rated voltage then a short-circuit heater is indicated. For example, readings of around 4V are commonly found on a 6·3V heater when a short is present. Just in case there may be some defect in the mains dropper, thermistor, or other valve heaters in the chain it may be as well to take a voltage reading across one of the other valves. If it is near its correct figure then the defective c.r.t. heater is confirmed, but if it too is low by a similar amount in proportion then a fault exists elsewhere in the chain.

The cure is to fit a small transformer to supply the correct voltage. A cheaper method which has often been used but which is not recommended is to fit a high-wattage wire-wound resistor from the mains supply to the top end of the tube heater. This means that the major portion of the mains voltage must be dropped over this resistor and thus a large amount of heat will be generated by it. Heat is a drawback as it is in a television receiver, giving rise to many component failures. Adding to it in this way must therefore be considered bad practice. There would be difficulty too in obtaining a resistor of the precise value to give the required voltage across the heater. And if at any time the short cleared the voltage across the heater would rise resulting in it being overrun, an event that would not occur when using a transformer. Altogether then this method is inelegant and risky and not to be recommended.

It should be pointed out at this point that there are numerous faults in a television receiver which can give symptoms very close to that of a defective tube. The possibility of these should be thoroughly investigated before the tube is condemned. For example a flat picture devoid of highlights which is the major symptom of low emission can also be due to a low-emission video-output valve. Being thus unable to accept the large input video voltage, it overloads giving rise to these symptoms. The difference between the two causes can be seen by turning up the brilliance control while keeping the contrast control well down. If the lighter portions of the picture go grey and the overall effect is dull then indeed it is the tube, but if the picture content is unaffected and the screen floods with light then the fault may be in the video circuit.

Low h.t. can give the effect of a dull picture and inability to focus correctly. In many cases low h.t. results in inability of the timebases to give a full scan either vertically or horizontally or both. In other cases however the main effect is of lowering the e.h.t., giving the symptom described, but as this also increases the tube deflection sensitivity, full scan is obtainable even though the timebases are working at lower output. The main clue—apart from actually measuring the h.t.—is that the focus control will only produce a focus at or near one end of its range, or perhaps will not quite make it.



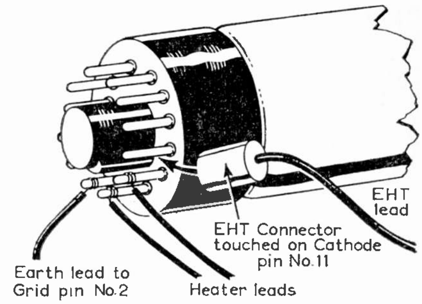


Fig. 2 (above): Using the e.h.t. supply to clear a grid-cathode leak.

Fig. 1 (left): Reversing the position of an ion-trap magnet may improve astigmatism.

A weak ion-trap magnet can also be responsible for poor results. If the magnetic field is insufficient to pull the electron beam back toward the screen then a similar effect to a misadjusted magnet may be obtained. Adjustment of this component should be fairly critical; if it is not, then a weak magnet must be suspected.

ASTIGMATISM

Another fault which is sometimes encountered and which is not unknown to some degree even on new tubes of the ion-trap type is astigmatism. This has to do with electron optics, and the effect is that the raster can be focused in either the vertical or horizontal plane but not in both at the same time. Thus if the scanning lines are focused sharply definition suffers, whereas if the picture is focused for maximum definition the scanning lines are out of focus. Some may feel that this latter condition is an actual improvement and it was deliberately introduced at one time on a few models by means of spot-wobble circuits. However as we are now accustomed to seeing well-defined and focused lines this vertical spreading of the spot tends to give the impression of a generally fuzzy, out-of-focus picture.

While there is no real cure for this aside from a new tube, there is one way whereby an improvement may be effected. There are two positions at which an ion-trap magnet can be set. It can either be set with its polarity in one direction on one side of the tube neck or it can be set with its polarity reversed and positioned on the opposite side of the neck. Thus for Mullard tubes and ion-trap magnets that have an arrow indicating the direction, the magnet is normally set with the arrow at pin number three (see Fig. 1) and pointing towards the *front* of the tube. An alternative setting however is with the arrow at pin number nine and pointing towards the *back* of the tube. It will often be found that the astigmatism is better in one position than in the other so it is always worth a try to set the ion-trap magnet to the opposite position. It may however be found that matters are worse in which case it should be returned to the original setting.

INTERELECTRODE LEAKS

A frequent cause of trouble is an interelectrode leak. The two most common ones are a leak between heater and cathode; and, rather less common, a leak between the grid and cathode. The effect of the heater-cathode leak is loss of detail and smearing of the picture.

The cure for the former in the old days was an isolating transformer which had a low capacitance between the primary and secondary windings. In this way the high-frequency component in the video signal appearing on the cathode was not bypassed to earth. The low inter-winding capacitance was achieved by including a large air space between the windings. Not a cheap component to produce, it went out of use with the coming of low-priced tubes. However one may be fortunate enough to pick up a secondhand one from a scrapped TV receiver and this may be useful in dealing with the fault.

When a leak occurs between the grid and cathode the bias potential between the two is removed and the result is uncontrollable brilliance on the screen. Not much of an external nature could be done here and the only recourse was a new tube. With both heater-cathode and grid-cathode leaks however there is a kill-or-cure method which in many cases has succeeded in removing the short and in only a very few of making matters worse. The method is to blow the short clear by using e.h.t. from the receiver. The heater leads to the c.r.t. base should be disconnected and the base removed. Heater wires can then be fitted temporarily to the tube pins to complete the heater chain and also keep the c.r.t. heater alight. This is necessary because many interelectrode shorts disappear when the tube is cold. In the case of a heater-cathode short the e.h.t. lead is then touched on to the cathode pin (see Fig. 2). There may be some internal arcing as the e.h.t. jumps from the cathode through the leak to the heater which being at the bottom end of the chain is at earth potential. Several applications of e.h.t. may be necessary before the short is cleared.

In the case of a grid-cathode short the cathode must be earthed to the chassis and the e.h.t. lead then applied to the grid pin. It may be that the short or leak is only partially cleared by this method and it remains although of an intermittent nature. In such a case a rather more permanent clearance of the leak may be made by increasing the heater voltage during the operation. To do this a transformer would be necessary and the tube heater leads would be shorted together to maintain heater chain continuity.

More rarely a leak may develop between the grid and the accelerator anode. Being fed from the boost h.t. line this imposes an extra load which may affect other circuits fed from the same source. It may also affect the operation of the brilliance control. The best thing to do here is to insert a high-value series resistor in the lead to the accelerator anode in order to limit the current drawn from the boost line. The picture may lose some of its sparkle. and the value of the resistor will have to be chosen by trial and error, but it may allow the tube to be used for a somewhat longer period until finances permit purchase of a replacement.

Another effect which is sometimes observed is failure of the brilliance control to turn the brilliance down to cut-off point. At first sight this may be mistaken for a grid-cathode short, but in the latter case the brilliance control has no effect on the brilliance at all. Here however the control will operate but simply will not turn down far enough. A simple remedy for this fault is to reduce the accelerator anode voltage by connecting a bleeder network across the boost rail and tapping off. Actual values of the resistors will have to be found again by trial, but it is best not to reduce the voltage below that really necessary since the lower the voltage the less sparkle in the picture. The total value of the bleeder resistors must be at least 2MΩ as otherwise they will impose an unnecessary load on the boost line.

REPLACEMENT TUBES

Of course sooner or later the tube will need replacement and the question will then arise as to what to use. A new tube is probably the safest but also the most expensive. For an older set it may just not be worth it. A tube that has been re-gunned carefully and with a high-quality gun can be as good as a new one. The snag here is that quality is likely to be more variable. There are now a large number of firms that turn out re-gunned tubes: some are excellent but others are not so good. Some may have imperfect air seals which means that they will perform well to start with but slowly become gassy over a period of time. If one hears that a particular make has been recommended then it is wise to use one of that make even though the price may perhaps be a little higher than others. Remember too that should there be any fault develop during the guarantee period a local firm is easier to deal with and no packing up and carriage expenses will be involved.

It is still possible to obtain reactivated tubes at a very low price but these are not really a good buy because as we have seen reactivation is a rather uncertain business. ■

CONVERTING 405 SETS FOR 625 RECEPTION

PART 2

K. CUMMINS

IN Part I we dealt with the problems of line timebase conversion. Now we come to the receiver side of the problem. It is obviously best to avoid complicated modifications to existing r.f. and i.f. stages, since not only does the system need to be switched over to u.h.f. at the tuner but the i.f. bandwidth, sound traps, sound system and vision detector arrangements have to be switched also. To make the situation clear Table I shows the significant differences between the 405-line and 625-line system standards.

one part of the switch and the signal switching on the other. The reader will find that the assembly consists of two slide switches mounted parallel to each other and operated by a common toggle from the system change knob. Remember that the two sliders operate in reverse directions!

The Conversion Kit

It is now necessary to consider the basic conversion kit and what its requirements are. The u.h.f. aerial connects to the u.h.f. tuner which

Table 1: Comparison of system standards

System	*Overall video bandwidth*	*Sound spacing*	*Vision modulation*	*Sound modulation*
405	3·0Mc/s	3·5Mc/s below vision carrier	Positive	A.M.
625	5·25Mc/s	6·0Mc/s above vision carrier	Negative	F.M.

It will be seen that an r.f./i.f. section for a dual-standard receiver should be specifically designed for the job. The writer has built one such receiver and the layout of all the i.f. stages is dictated entirely by the facilities available on the system switch. To include a large system switch in the midst of an existing i.f. strip is in most cases impossible. How then are we to overcome this problem? One manufacturer who believed at one stage in keeping all r.f. and i.f. sections of their receivers completely separate was Philips. The original sets were classed as convertible and had provision for the separate 625 system panels to be fitted as and when 625-line transmissions became available. The conversion kits are now readily available, with circuit, on the surplus market and represent extremely good value. The kit consists of an r.f. tuner and scale mounted on a bracket which also supports a comprehensive system switch, an i.f. panel and a flywheel sync panel.

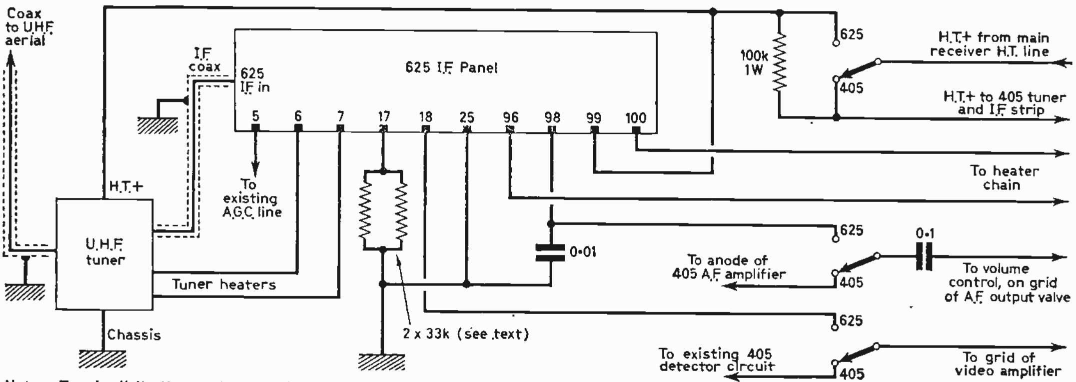
A large number of connections are made via leads and plug-in termination strips to the whole assembly. Apart from the coaxial leads for aerial and i.f. linkage it is best to completely strip all connections from the kit and rewire it from scratch. This avoids any confusion or potential disasters. The flywheel sync panel cannot easily be used other than in the original Philips conversion and is best used as a source of useful components. A circuit diagram is provided with the kit. Suitable positioning for the new equipment must first be found within the cabinet so that the lengths of leads required may be assessed.

The system switch is in two parts. It is best to keep the h.t. and line timebase sections on

links, via a coaxial lead provided in the kit, to the i.f. panel. The u.h.f tuner and i.f. panel both need heater and h.t. supplies. The heaters can be connected in series with the original heater chain at a suitable point, for example between two of the original i.f. stages. The heaters are wired in so that they are always in circuit. It is necessary to isolate the h.t. supply to the 405-line tuner and i.f. stages and arrange for it to be switched between its original function on 405 and the new i.f. and tuner section on 625. As the heaters require a total of 36V at 0·3A approximately it is necessary either to remove 120Ω of dropper resistance or dispense with rectifier valves and replace them with a BY100 silicon rectifier as mentioned in the first article.

The i.f. panel contains two vision i.f. amplifier valves, types EF183 and EF184. The EF183 has a.g.c. applied to it and it is only necessary to parallel up the a.g.c. connection on the i.f. board with the existing a.g.c. rail in the receiver. Also on the i.f. panel are two PCF80 valves. The pentodes are used as intercarrier sound i.f. amplifiers operating at 6Mc/s. One of the triode sections is used as a video cathode-follower and the other as an audio amplifier.

The video signal is d.c. restored and of the correct polarity to drive the grid of the receiver's video amplifier. The audio signal is of such a level as to be able to drive the grid of an audio output tetrode directly. De-emphasis of the audio signal is necessary, and can be simply provided by connecting a 0·01μF capacitor, taken from the flywheel sync panel, between the audio output and earth. Where a volume control is fitted in the audio output valve grid



Note: For simplicity the numbered connections on the 625 IF panel are shown in line; in fact they are distributed around the edge of the board.

Fig. 5: Connections between the 625-line conversion kit and the receiver to be converted.

the situation is ideal for switching since the coupling capacitor connected to the top end of the volume control has only to be switched between its original a.f. valve anode and the new panel. Because of the high audio level at this point there is little risk of hum trouble occurring, but the a.f. leads should still be screened. If the original circuit has the volume control fitted prior to the a.f. amplifier stage it is probably best to modify the audio circuit so that the control is fitted between the a.f. and output valves in order to use the arrangement just described.

One of the most awkward problems involves the switching of the video amplifier grid between its original connection to the 405-line system detector and the new i.f. panel. It is best if possible to avoid screening the leads because of the capacitive loss of high video frequencies which can occur. The leads should be taken to a part of the system switch remote from the line timebase switching so that induction of unwanted signals is avoided. As the leads are not screened it is best to keep them away from all the others and not to loom them up. The writer has found that this arrangement seems to work out very well, generally with no deterioration of the 405-line bandwidth. On 625 lines the problem is not so acute because of the low output impedance of the video cathode-follower fitted on the i.f. panel.

The video stage itself will probably need some attention since it is required to handle a greater bandwidth. While serving a useful purpose on 405 lines peaking coils in the anode circuit can often produce an undesirable peak and ringing on 625 lines. As a rule it is best to damp the peaking coil down with a shunt resistor of between 15 and 22kΩ and if necessary adjust the value of the cathode bypass capacitor, switching between systems if necessary. In some receivers a 3·5Mc/s sound dot-pattern trap circuit is fitted in series with the video amplifier cathode. If left in circuit this will "knock a hole" in the 625-line video response. A section of the system switch should be used to short out the tuned circuit. The amount of 6Mc/s signal produced by the 625 i.f. panel is minimal and does not need further trapping.

Fig. 5 shows the connections to the numbered i.f. panel and u.h.f. tuner. It is necessary to provide a cathode load for the video cathode-follower. This can be made up from two 33kΩ resistors recovered from the flywheel sync panel and connected in parallel across points 17 and 25 as shown. A 100kΩ resistor is fitted between the h.t. rails for the u.h.f. and v.h.f. sections of the receiver. The object of this is to ensure that neither rail drops completely to zero voltage, this precaution being necessary to avoid cathode poisoning of the valves not in use by running their heaters without some positive anode supply. With the 100kΩ resistor shown the voltage will probably be around 30V, insufficient to enable any spurious signals to occur via the stages not in use.

Line Blanking and Brightness Equalisation

In the first part of this series it was stated that means were available for blanking out the 625 retrace if necessary and also for equalising the brilliance setting between standards. If blanking is needed on 625 the simplest way to obtain the required pulse is from a winding on the line output transformer. This may be wound on a leg of the line output transformer, possibly along with the e.h.t. rectifier winding. About five turns is sufficient. There is a way of using the rectifier heater winding itself providing the e.h.t. rectifier is replaced by a metal rectifier. Current production British Radio Corporation receivers use a metal rectifier assembly for the e.h.t. supply, built as a plug-in unit. If one of these is purchased from a dealer (they are quite cheap) all the problems associated with the valve can be eliminated. The heater voltage need no longer cause difficulty and no power is taken out of the timebase for the heater. Most valve heaters (e.g. the EY51 and EY86 used on the vintage sets which we can convert) are 6·3V rated. The line timebase voltage waveform in the heater winding is not sinusoidal and contains a large peak coincident with the flyback period. This peak can be fed to the c.r.t. grid via a network as shown in Fig. 6. If the sense of the winding is reversed, the blanking will become a bright-up!

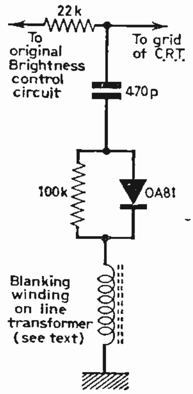


Fig. 6: Line blanking circuit.

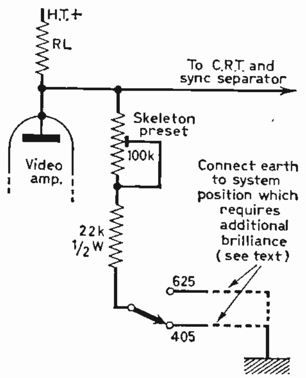


Fig. 7: Brightness equalisation between systems.

If the mean brilliance changes between systems a resistor can be switched in from the video amplifier anode to ground on whichever system is the darker. A simple way of achieving this is shown in Fig. 7. A skeleton 100kΩ potentiometer is wired via a 22kΩ safety resistor to a section of the system switch. The switch is wired so that the additional components are placed in circuit on the system which has the darker presentation. The potentiometer is then adjusted to equalise the brilliance. In order to avoid excessive stray capacitance which could upset the video response the potentiometer should be wired in as close to the video stage as possible.

Switching

Even using the 625-line receiver package as described there is still a formidable list of functions to be switched between systems. These are: (1) h.t. between systems; (2) line speed change; (3) width compensation; (4) video switching; (5) audio switching; (6) boost rail balancing. These six are essential. In addition to these there are the following possibles which experience will indicate to be necessary or otherwise: (a) linearity correction; (b) brightness compensation; (c) third-harmonic tuning of line transformer; (d) switching of 3·5Mc/s trap in video amplifier; (e) video compensation.

From the video stage onward, apart from the line circuits discussed in Part I, there is no reason to suppose that either the sync separator or field circuits will need modification to cope with 625-line operation.

Sensitivity and Earthing

The Philips tuner and i.f. strip is reasonably sensitive but as already mentioned has two i.f. stages only following the tuner. It provides ample signal using a small aerial some 15 miles from the transmitter. The writer does not live in a difficult area, however, and suggests that a transistor preamplifier might be necessary in some locations. This would yield a better signal-to-noise ratio than the provision of additional i.f. amplification.

Experience has shown that good earthing between all sections of the equipment is essential. Probably the best method of interconnection is to use the braid of coaxial cable, soldered and flattened at the ends, with a 4BA bolt passing through it. Good low-impedance earthing between the main chassis, 625 i.f. panel and tuner can be achieved in this way.

Tackling Conversion Problems

It is obvious that such matters as linearity correction, brightness compensation, third-harmonic tuning of the line transformer and video compensation cannot be investigated until a signal is received. Therefore only the main system changeover functions can be wired up initially. It is best to check for short-circuits and any wiring mistakes, using the ohms range of an AVO or similar meter, before power is applied to the receiver. Having satisfied oneself that all is apparently in order the receiver should be switched to 405 and run up to ensure that this part of it is still operating correctly.

Having established that all is well in this direction the receiver can be switched to 625. The 625 i.f. panel has a local-distant link which adjusts the screen grid voltage of the EF183 valve. This should be set for maximum voltage initially. Then connect a suitable u.h.f. aerial and rotate the tuner. At the least a lively "rushing" sound should be heard with the volume control turned up. Sound should be received quite easily. If the vision section is operating correctly it is most likely that an unresolved raster will be visible. Line and field hold controls should be adjusted to lock the picture. Some adjustment of the time-constants in the line oscillator circuit may be necessary in order to achieve line lock. When the picture is fully locked the system balance potentiometer should be adjusted to give the same picture height as on 405-line working. This adjustment will also affect the c.r.t. first anode voltage which in turn will bring about a need to readjust the brightness.

From here on it will be necessary to check and investigate the working of the receiver bearing in mind all the points made in these two articles. A useful last point to remember is that the 625-line transmissions are asynchonous, i.e. not locked to the mains supply. In order to avoid picture weaving, the smoothing capacitors may need to be increased in value. A factor of two, doubling the capacitance, is usually a safe bet to clear the trouble. It may also prove useful in this connection to shift the heater of the line oscillator down the heater chain so that it is next to the c.r.t. Some flywheel timebases need this treatment.

It will be seen that conversions of the kind described cannot be undertaken lightly. The effort involved will probably be prolonged and some setbacks at various stages may be encountered. It has been the object of these two articles to point out the pitfalls and attempt to ensure that whoever sets about the task does so with their eyes open. When satisfactorily concluded however a job of this kind can certainly make all the effort well worthwhile.

INSIDE tv TODAY

PART 16 M. D. BENEDICT

THE BROADCASTERS—2

ADVERTISERS pay for their commercials at a rate proportional to their audience. To do this accurately an independent company called Audits of Great Britain (AGB) conducts surveys and operates a system to determine which channel is being viewed. These and other devices enable AGB to build up an accurate picture of the audience for each programme in each area. This in turn guides the programme companies and the advertising agencies who place the adverts. It is not possible to buy time in a break in a particular programme, since particular spots are usually filled long before the programme schedules are announced. This again stops adverts being integrated into programmes as there is no guarantee which programme will be on at the time booked by the advertisers. They may, however, make a shrewd guess that the popular programmes will be on at a given time.

Naturally the BBC operates an Audience Research Department, which interviews an average of 2,280 people every day. Each interviewer determines what programmes the person being interviewed viewed or listened to on the previous day. (Radio is included in this survey.) From other statistics concerning total size of the viewing audience it is possible to determine the number of people watching each channel or not viewing at all.

As well as the size of the audience, a panel of viewers answer questionnaires concerning how much they enjoyed each programme. They determine an "appreciation index" which is not dependent on the size of the audience but on the enjoyability of a programme for the average viewer. Naturally all information is of use to the producer of a programme as well as to the programme planners.

Public Opinion

So both the BBC and ITA are well aware of public opinion and are in a position to decide just how much weight to allow to the many, and often vocal, criticisms of programmes and content. At present no specific rules are applied by the BBC to any debatable or controversial subjects, only general guiding lines, each case being gauged on its own merits. For Independent Television the rules that the ITA lays down tend to restrict the broadcasting of the more advanced ideas as the maxim "if in doubt, cut it out" is applied; a philosophy which would not encourage *Steptoe and Son*, *Till Death Us Do Part*, and many Wednesday plays. As there is not such direct communication between producers and the ITA the rules have to be more all-embracing and cases cannot be judged on their merits to the same extent that occurs within the BBC where a producer can go to his head of department who, in turn, can go right up the chain of command to the Director General. Hence guidance can be given at the required level.

No Independent company can really afford to transmit much material of an experimental nature as its primary function is to provide a profit for its shareholders. Consistently unpopular programmes mean smaller audiences and loss of advertising revenue.

Advertising Revenue

Most of the revenue of the Independent companies is, of course, derived from selling time to advertisers. Time on television is very expensive; a peak spot in London for example costs £2,600 per minute. Since the advertisers are looking for the cheapest way of covering the largest audience, advertising rates follow the population of the area covered and the time of day, the peak viewing times of 7.00-10.00p.m. being the most popular. Rediffusion in London for example reaches 4½ million households and charges a peak rate of £2,600 for 60 seconds. Southern ITV with an audience of 1½ million homes charges £1,000 for the same period. As the many viewers arrive home and the audience builds up, so do the prices. Compare the figures quoted above which apply to the 7.00-10.00p.m. period with the rate of £150 per minute for London and £40 per minute in the South for afternoon spots.

Spots are sold in units of 7, 15, 30, 45 and 60 seconds. Most companies, particularly the smaller regional companies, offer a service for smaller advertisers by joining their short adverts together to form a complete 60 second spot which is then transmitted under a name such as *Market Place*. A similar service is a still caption or slide with a studio announcer reading short announcements to aid businesses and services. These form a very large proportion of the new adverts checked by the ITA.

Sale of Programmes

Besides revenue from adverts a considerable proportion of some companies' profits is earned from the sale of programmes both abroad and to other companies. Economic facts of television life tend to favour the larger companies in their more densely populated areas of the country as they have the larger audiences and so can afford more production and technical facilities. So the present Big Five companies tend to produce more than their share of programmes, the smaller companies tending to operate on filmed programmes and those of local interest. Naturally the rates asked for each programme are varied from area to area so that a suitable balance between supply and demand is achieved. All arrangements for networking one company's programmes to other areas are made by ITA, who also try to encourage a suitable balance between locally originated programmes and networked programmes. It will be noted the the effect of most of the recent reorganisation of the programme contractors has been to spread the areas now available to the Big Five programme contractors to make them a bit thinner and encourage a regional outlook at the boardroom level. No contractor has to take a programme offered and it may not want it at the times offered so that exact arrangements have to be sorted out under the guidance of the ITA who also book transmission and distribution lines as well as the other facilities required for networking.

Popular series such as *The Saint, The Avengers, Thunderbirds* and several others are filmed by the programme contractors and their associated companies for sale abroad. In these days of export drives many of our programmes are sold abroad, earning a considerable amount of foreign currency. Costs of filming are much higher but film is not dependent on the line standards of the transmitting station and it is easier to produce in colour using film than using video-tape recording techniques.

Against these incomes have to be set several forms of tax levied on the programme companies and the rentals paid to the ITA to cover the cost of the transmitters, lines and other services provided by the ITA. Taxes are to the tune of £21 million a year and are paid direct to the Exchequer before the normal taxes on profits and company taxes, which total around £11 million, are paid. In addition the ITA is taxed on its surplus rentals after the running costs have been deducted (£2 million) and some of the remainder has to be paid direct to the Exchequer (about £3 million). So about £37 million is taken by the Chancellor as a result of the efforts of commercial television, nearly half the total advertising revenue of all the programme companies.

BBC Revenue

By far the greatest part of the BBC's revenue comes from licence fees. At £6 per monochrome television set and £11 per colour television set this represents a total income of £75 million, the BBC receiving £71 million of which about £51 million is spent on television broadcasting. In addition to this Television Enterprises has sold over 2,800 programmes abroad, for a total of over £1 million. Enterprises usually sells programmes intended for the home audiences altering them where necessary, for example by dubbing into other languages, unlike the independent companies who make film with an international flavour for the international markets. In addition to complete programmes Enterprises handles the licensing of manufacturers of toys and models of popular characters in BBC programmes, Daleks and model Dougals from the *Magic Roundabout* being the most popular. In addition to these about £11 million is provided by the Government to cover the cost of the External Services, who broadcast to the world with 95 hours of programmes each day in over 40 languages. As these services are regarded as Great Britain's voice to the world the Government makes a grant in Aid to cover the cost of these very valuable facilities.

With so much interest being paid to increasing productivity it is very interesting to note that the average cost per hour of television broadcasting has dropped from £3,800 in 1962 to £3,100 in 1966, the cost for sound radio being £590 and £490 per hour respectively. And these figures are achieved in spite of more complex and expensive programmes.

BBC Regional Centres

Right from the start of sound broadcasting the BBC has encouraged regional studio centres to produce a local programme with local talents. As television spread over the country, television studios were added to the sound studio centres and in some cases completely separate television studio complexes have been built. At present there are major studio centres at Belfast, Birmingham, Bristol, Cardiff, Glasgow and Manchester, each with several large studios and a smaller news studio. In addition to these, small news studios are to be found in Aberdeen, Edinburgh, Leeds, Newcastle, Norwich and Southampton. Besides providing an invaluable network of news gathering centres all are used to provide a local news programme which is usually broadcast just after the National News and weather at 6.00p.m. At this time each studio switches into the transmission circuit to the local transmitter or transmitters and radiates a regional programme. At other times, a region will opt out of the network to show a programme of local interest.

When not being used for these purposes news film of an event shot remotely from the London news centre can be rushed to the nearest region where it is developed, edited and loaded into a telecine channel. Post Office lines are set up to feed the pictures to a video-tape recorder at Alexandra Palace, the London News studios. After recording the film on the video-tape recorder it is possible to play back the item into a news bulletin without upsetting the regional work and saving the time taken to rush the film to London.

All the larger studio centres produce programmes for transmission nationally as well as the more complex programmes for local transmission. Some regions specialise in particular types of programmes; the West Region in Bristol, for example, have a reputation for Natural History and Exploration films such as the *Look* and *Travellers' Tales* series. Besides the two or three studios at each larger centre a large film department is to be found with processing and editing facilities. In addition each region will have several camera teams as well as news cameramen and "stringers" (freelance cameramen who are hired by the BBC or ITV when required to cover a story). Sub-regions usually have one BBC news team and rely on stringers for the rest of their film effort. Each of the regions has Outside Broadcast facilities, a system which reduces travelling times to more distant events as well as allowing local items to be covered for regional programmes.

Centred in a new studio centre in Cardiff, BBC Wales provides a separate service with a larger percentage of Welsh-speaking programmes as an alternative to the usual BBC-1 programmes. These are broadcast by Band III transmitters co-sited at the Wenvoe Band I transmitting station and broadcasting on Channel 13 which is not used by the ITA in this area. No such Scottish National service in Gaelic exists.

Of an approximate total of 5,900 programmes networked on BBC-1 and BBC-2 815 are produced by the regions. In addition to these nearly 2,000 hours of programmes are produced for local viewing.

ITA Regional Broadcasting

By its very constitution ITV has a regional nature. Each programme company produces programmes for local audiences as well as for network. As with the BBC the smaller companies tend to specialise in the type of programmes they produce, with Tyne Tees and Ulster offering many Adult Education Programmes and Southern ITV specialising in outdoor interest programmes. In the same way too the ITA requires a Welsh service and this was provided by TWW. One of the reasons suggested for TWW losing their contract to the Harlech Consortium was that insufficient coverage was given to Welsh programmes, so presumably the Harlech Consortium will be presenting even more Welsh programmes.

Unlike the BBC's regional divisions there is no one network of programmes with opt-outs for each region. Rather the programmes consist of recorded and live programmes from various sources round the country interspersed with locally originated films, recordings and live programmes. Thus although many programmes can be seen in all parts of the country at any one time, many are seen at different times and some film serials may be seen months later in a different area. *Batman* and *Peyton Place* were seen in London many months after some other areas. Local programmes and different timings mean that each company has to juggle programmes available to it to fit the schedule and yet fit in with the requirements of the network.

Training

Although some ITV companies and the ITA do have training schemes for their staff the BBC train the vast majority of broadcasters. On the engineering side a comprehensive training course exists with three 6-12 week residential courses spent at the Evesham College, training on the job, and a system of promotion up to a certain grade based on examination success. Operational staff spend two periods of several months at Evesham being trained in the framework of operational techniques. In order to do this the Engineering Training Centre at Wood Norton near Evesham, Worcestershire is equipped with a four-camera studio and control rooms, video-tape recorder, telecine, o.b. equipment, television transmitters and film processing equipment. Recently the colour television facilities have been expanded considerably to help train engineers for colour working on BBC-2. Sound broadcasting is catered for by a considerable number of control rooms and recording facilities. Each year 1,000 engineers attend 59 courses on various aspects of television work.

Some training schemes exist within the ITV companies—the Thompson Organisation operate in conjunction with Scottish Television a training school for staff from any organisation, and the ITA runs a training scheme for its engineers. Except for these schemes little other formal training is offered as many engineers are attracted from the BBC by higher salaries and the greater responsibility to be found in many Independent Television companies.

Naturally a considerable proportion of the BBC staff are under training whilst the ITV companies employ only experienced staff. Hence the standard of competence is somewhat higher within the ITV as is required by their complex networking arrangements. As the programme companies are commercial organisations no more staff are employed than is absolutely necessary, unlike the BBC who employ more than enough people to allow for those absent and at the Evesham training centre.

Promotion within the BBC is by appointment boards who select the best candidate for a job. ITV engineers seeking promotion are able to apply for a senior post with a different company and face outside competition for higher posts within their own company.

Programme staff, too, are largely BBC trained, but not to the same extent as the engineers. A very effective training method often used within the BBC is for the trainee to work with a given production team and learn the ropes by assisting the team in a junior post. A considerable amount of experience is gained this way, but in addition to this a training course is arranged so that the basic principles are learned and put into practice. Secretarial and Administration training is also given to ensure that, as far as possible, all staff appreciate the special problems of working in a broadcasting organisation.

Many ITV staff learn on the job without benefit of formal courses but since the production staff in particular often work on short term contract, being employed by different ITV companies as well as the BBC, the standard required is similar to the BBC. This method of semi-freelance working allows the BBC and ITV to employ production personnel best suited for a given programme. As in engineering, production teams tend to be smaller than the corresponding BBC production teams.

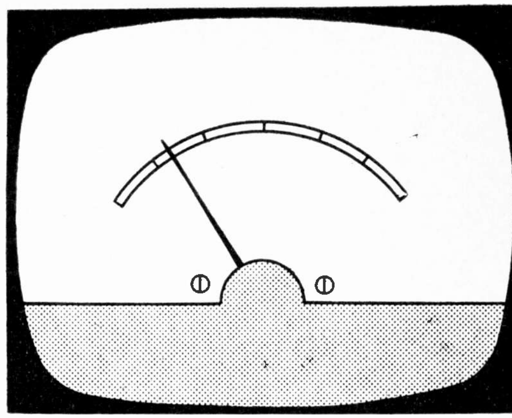
Staff Relations

Trade Unions are a very powerful force in broadcasting, disputes having occasionally put programmes off the air. Engineers are represented by the ACTT (The Association of Cinematograph, Television and Allied Technicians), which is not recognised by the BBC, and the Association of

—continued on page 218.

TELEVISION RECEIVER TESTING

Part 8 by Gordon J. King



POWER SUPPLY TESTS

THERE are four primary power supplies in any television set, (1) the h.t. supply for the anodes and screen grids of the valves, (2) the l.t. supply for the heaters of the valves, (3) the e.h.t. supply for the final anode of the picture tube and (4) the boosted h.t. supply for the first anode of the picture tube, the tube focus circuit and often for the field timebase generator stage. The latest hybrid sets—containing both valves and transistors—have an additional supply which is the l.t. for the transistors.

When a set fails on both sound and vision—with no signs of life from the speaker or picture tube—the first move is to remove the rear cover to see whether the heaters of the valves are glowing. If they are, then of course the l.t. supply is active. The next move is to check the h.t. supply, but this demands a d.c. voltmeter at least. A good point for speedy h.t. testing is on a primary tag of the speaker transformer, for one of these tags is directly connected to the h.t. line, as shown in Fig. 1. A meter for h.t. line testing need not be of very high resistance—1,000Ω/volt sensitivity being adequate—but for testing voltage at the end of a high-resistance feed circuit, for example, a voltmeter with a higher sensitivity is essential—a fair value is 20,000Ω/volt—to avoid shunting the circuit too much with the meter's terminal resistance, and this applies, as we shall see in the next instalment, particularly when testing for boosted h.t. voltage.

It is as well to stay with this meter sensitivity question for a while for it not uncommonly confuses the beginner to TV servicing. For example the service chart may indicate that a voltage of a certain value should exist at, say, the first anode of the picture tube, yet the test meter registers a voltage of significantly lower value even when the set is working correctly!

Meter sensitivity is governed by the sensitivity of the movement around which it is built; that is, how much current it requiries to cause the pointer to deflect to the full-scale reading. If a current of 1mA is required the movement is not particularly sensitive, but it would be remarkably sensitive if, for example, full-scale deflection (f.s.d.) were achieved with a current as low as 10μA. Now to get a meter which responds to current to measure voltage demands the inclusion of a *series* resistance, the purpose of which is to reduce the current due to the applied voltage to a value to match the sensitivity of the movement. Let us take a simple case of a 1mA movement arranged to read 1V f.s.d. From Ohm's law ($R=E/I$) we find that a resistance R of 1,000Ω is required to pass a current I of 1mA from a voltage E of 1V, which means that by making the *total* resistance of the system 1,000Ω a 1mA movement would give exactly f.s.d. from 1V—see Fig. 2(a). The voltmeter sensitivity of the arrangement, therefore, is 1,000Ω/volt—simply because for each f.s.d. volt indicated by the movement the total series resistance needs to be 1,000Ω. Thus to read 300V f.s.d. the total resistance would need to be 300,000Ω. This is all there is to it, but enthusiasts now deciding to make up their surplus current meters into voltmeters must remember that the total resistance *includes* the winding resistance of the current meter itself, so this value must be

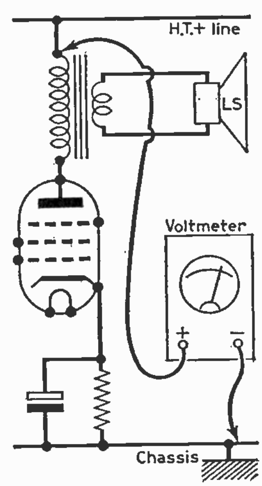


Fig. 1 (right): An accessible h.t. test point is one of the tags of the primary of the audio output transformer. A low-sensitivity voltmeter is suitable for this test but one of greater sensitivity is required for accurate tests in high-resistance circuits.

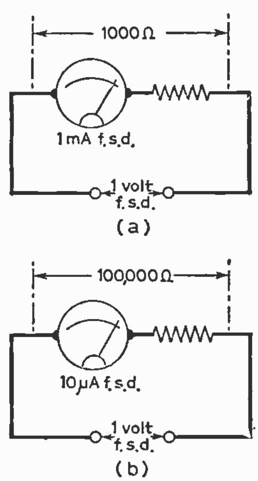


Fig. 2 (left): Voltmeter sensitivity is expressed in ohms/volt. (a) How a 1mA movement results in a sensitivity of 1000Ω/volt while (b) a 10μA movement has a sensitivity of 100,000Ω/volt.

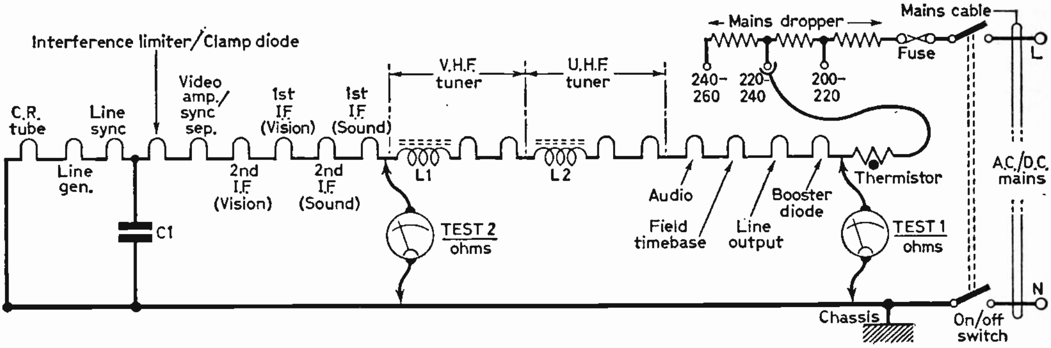


Fig. 3: A typical heater chain circuit, showing tests.

subtracted from the series resistance value calculated in the manner described.

Using the same simple calculation we will discover that a 10μA movement yields a voltmeter sensitivity of 100,000Ω/volt—see Fig. 2(b)—while the useful sensitivity of 10,000Ω/volt is given by a movement of 100μA (0·1mA) f.s.d.

We shall be returning to the question of meter sensitivity later, but for the time being let us return to our supposedly defunct set. If we find the heaters unlit we have a host of possible fault conditions to run through, including a blown fuse in the domestic mains supply or in the ring-mains type plug if such terminates the set's mains cable. These obvious possibilities should be checked before delving into the set for it is most disconcerting to discover that the trouble is caused by lack of mains voltage after dismantling the set and spending considerable time checking through its circuits!

Most receivers today are designed for a.c./d.c. mains operation. This means for one thing that the heaters of all the valves and the picture tube are connected together in series like the bulbs on a set of Christmas-tree lights. Thus if one heater fails the circuit is broken and they all go out. A conventional heater current is 300mA (0·3A) and this current is reasonably closely controlled by a large wire-wound resistor in series with the heaters and the mains supply—but there are other items in the circuit too, as shown in Fig. 3.

Running through this circuit we have first the mains cable, then the on/off switch—usually coupled to the volume control—and next on the "live" side the mains fuse (not to be confused with the h.t. fuse, if fitted) followed by the wire-wound resistor, called the mains dropper, and a thermistor, after which come all the valve heaters in series, including the picture tube heater which invariably is the final heater in the chain.

To block r.f. signals in the heater chain stopper chokes such as L1 and L2 are often included in series with the valve heaters, especially in the v.h.f. and u.h.f. tuners, while capacitors are fitted as decouplers at critical points along the chain, e.g. C1 in Fig. 3.

Now everything in the circuit is geared to provide the required heater current—typically 0·3A—which means that the mains voltage, as matched by the tapping on the mains dropper, will drive the correct current through the circuit thereby ensuring that the heaters of all the valves and the picture tube will have the correct voltage developed across them. Again this is an exercise in Ohm's law, for the total resistance in the circuit is adjusted—by the mains dropper, for instance—so that the voltage dropped is equal to the difference between the total voltage required by all the heaters in series and the mains supply voltage. For example if the heaters together require 100V (their series value of voltages) and the mains voltage is 240V then the dropper and other resistive elements have to drop 140V.

The most vulnerable item in the chain is the fuse, and whether this is responsible or not can be discovered either by checking its continuity with an ohmmeter (or by some less scientific means—such as with a battery and bulb) or by trying another fuse known to be in good order. Incidentally, all the heater chain checks should be carried out with the mains completely removed from the set—by pulling out the mains plug first.

The on/off switch is best checked with an ohmmeter, making sure that the correct two tags corresponding to each of the two sections of the switch are connected across the ohmmeter in turn. It is not uncommon to find one section open-circuit. Some "technicians" get the set working again by bridging the faulty section, but this is a singularly dangerous practice for it could well mean that the set remains in the live condition even when the on/off switch is off. For example if the bottom section of the switch in Fig. 3 is permanently bridged and the mains lead connected to that section happens to be connected to mains live then the set's chassis or negative line will always be live to earth. The correct way of wiring the lead to the mains is, of course, for the lead connected to the switch section on the chassis to be terminated to the mains plug neutral pin.

An ohmmeter is also necessary for making a proper test of the mains dropper and the thermistor. A thermistor is a resistor whose value falls swiftly as its temperature rises, so when checked "cold" it will have a highish value—sometimes in the region of thousands of ohms. The purpose of this component is to maintain a low value of chain current when the valve heaters are cold—for then they themselves have a lowish resistance—rising to the correct value as the valve heaters *and* the thermistor warm up. Thus the thermistor runs very hot and is also a vulnerable component. It appears something like a black rod of carbon and is often thought by the newcomer to be a burnt-out resistor! Since it runs hot the leadout wires not uncommonly become partly detached from the element causing sparking and intermittently-operating heaters. If in doubt change the component and make sure that the leadout wires are not cut too short for to some extent they must isolate the heat from the circuit to which they are soldered. Moreover if they are cut too short the solder will melt as the component warms up.

Most technicians make Test 1 in Fig. 3 the first heater chain test, for if continuity shows at this point one can be fairly certain that all the heaters and chokes in the chain are intact and that the lack of overall continuity is caused by trouble from—and including—the thermistor, via the mains dropper, fuse and on/off switch to the mains input. Each item separately must then be tested. If there is no continuity at Test 1 a heater or choke is open-circuit, but while performing this test it is a good idea to connect the mains input wires together (the neutral and live leads at the plug end) to ensure that the remainder of the chain (the items just referred to) is intact—shown by a continuity deflection on the meter.

Assuming that the connected together mains wires result in an indication of continuity at the mains supply end of the chain but that the continuity collapses when the mains input wires are parted when making Test 1, the next move should be to making Test 2; that is, to connect the ohmmeter somewhere towards the middle of the chain relative to chassis, as shown in Fig. 3. A good point of connection is, as shown, at the heater tag of one of the tuners. If continuity is indicated with the mains wires parted, all the heaters and chokes in the earthy side of the chain will be proven in order and the trouble will exist in the other half of the chain. Conversely of course an open-circuit indication will mean that the chain components from Test 2 down to chassis will have to be checked. It should be easy enough to move down the chain with the ohmmeter to discover the heater or choke (or valveholder) which is at fault.

Some "technicians" endeavour to check for an open-circuit heater by operating the set from the mains and measuring the a.c. voltage on a suitable meter along the line from the "live" mains input. This is not a very good idea for when the chain goes open-circuit a number of valves are likely to receive a greater-than-designed-for potential between heater and cathode, because when the heater chain current is lacking the full a.c. mains voltage appears on all the heaters relative to chassis. For example, should the heater of the line generator valve fuse (the valve next to the picture tube in Fig. 3) all the heaters to the mains side of the chain will be removed from chassis return so that they will all be at the same potential as the mains input end of the chain. Moreover since the cathodes of the valves eventually connect to chassis the heater-cathode potential of all of them will rise to a dangerous value. This is indeed one of the reasons why the heater of the picture tube—the most expensive item in the set—is returned direct to chassis at the end of the chain, for an open-circuit anywhere else in the chain will fail to reflect a heater-cathode potential rise to the tube.

The valves are placed in the chain in an order to satisfy (a) their heater-cathode vulnerability and (b) their sensitivity to heater-cathode leakages in terms of hum effects. Fig. 3 shows a typical order.

The chain sometimes partially shorts out, leaving only a few of the valves alight with a corresponding rise in heater current through those ones that remain in circuit. This would happen for instance if C1 in Fig. 3 shorted, for then the last three heaters in the chain would be bypassed and the voltage usually across these would be introduced across all the heaters remaining in the chain, causing slight over-running. Much more severe over-running results when a short like this takes place towards the mains input side of the chain. Imagine a short between the field timebase valve heater and the heater of the line output valve (see Fig. 3) to chassis. This would leave only the first two valves in the chain and these would certainly light very brightly and possibly fuse.

Another cause of this trouble is a heater-cathode short in a valve whose cathode is connected direct to chassis, as shown in Fig. 4 (a). If the cathode is in series with a lowish value resistor, then the a.c. bypass current will flow through that overheating it badly and certainly blowing any electrolytic capacitor connected in parallel with it—see Fig. 4 (b).

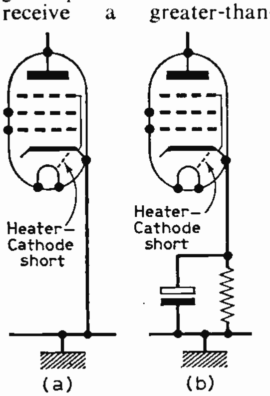


Fig. 4: (a) With no cathode resistor a heater-cathode short will short a section of the heater chain. In (b) a short will result in the a.c. bypass current flowing through the cathode resistor, which will overheat badly, while as the parallel electrolytic capacitor will be of low d.c. working voltage the a.c. from the short will almost certainly make it fail—or possibly explode!

Shorts or leaks from the heater line to chassis can be checked with an ohmmeter after first removing the socket from the base of the picture tube (so as to disconnect the heater line from chassis). The ohmmeter can be connected anywhere on the line, and the insulation to chassis should be very high indeed—as an open-circuit. Of course, the mains must be removed from the set for this test. A valve with a heater-cathode short or leak will be indicated by a low resistance from chain to chassis, and the valve responsible will cause a substantial increase in measured resistance when lifted from its holder so as to clear the heater pins from the sockets of the holder. It is best to apply the meter as for Test 1 (Fig. 3) and lift each valve up in turn until the faulty one is located.

Some heater chains employ a semiconductor rectifier instead of a mains dropper of the conventional type, and this may also be used to supply l.t. voltage for the transistors in a hybrid set; but we shall have to leave testing of this sort of circuit until next month.

CONTINUES NEXT MONTH

SPEEDIER TV TUBE 'GUN' ASSEMBLY

RICHARD COLLINS REPORTS . . .

A joint project between engineers at the Mullard TV picture tube plant at Simonstone, near Burnley, Lancs., and the Department of Production Engineering and Production Management of Nottingham University has resulted in the development of a machine that automatically assembles part of the complex electron gun of a TV picture tube. Because of its modular construction, it is hoped that the machine might also form the basis of others for the automatic assembly of many of the intricate parts of electronic devices and other engineering assemblies.

The idea of getting industry to support projects of this kind at Nottingham University is largely that of Professor W. B. Heginbotham and his colleagues in the Department of Production Engineering and Production Management.

In 1966 Professor Heginbotham outlined to a number of firms some ideas his department had about automatic assembly methods. Wide interest was aroused and in August 1967 a consortium was formed between five firms, each with a particular interest in advanced automatic assembly methods. Each firm contributed £500 for which they got a basic pick-and-place automatic assembly machine.

The long-term hope

The long-term hope was that firms would ask the department to develop the basic prototype into a machine more suited to their particular needs. For this, firms would contribute the necessary financial assistance.

"To date the idea is working splendidly" said Professor Heginbotham. "Detailed discussions are in progress with a number of firms. However the first to come to fruition will be an advanced machine for electron gun assembly at the Simonstone plant of Mullard Ltd.

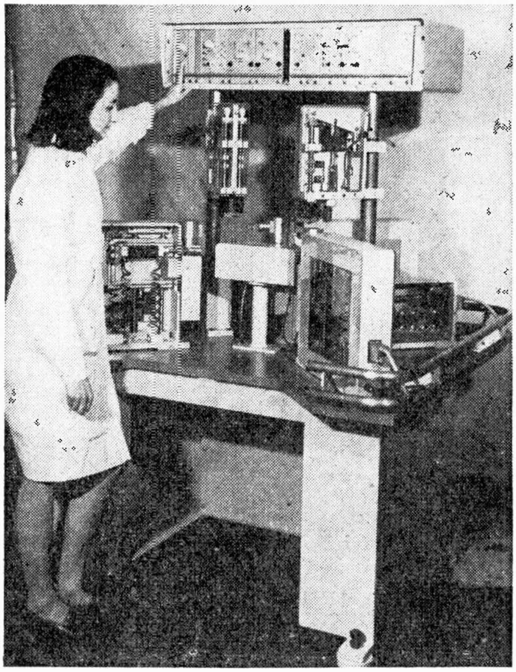
"Academically the spin-off from this activity is of enormous value to us here at Nottingham. By helping to solve some of these complex assembly problems we not only keep ourselves up-to-date but are also able to get over to students some of the very real problems they will meet when they leave here and enter industry."

Mr. E. Gaskell, chief engineer at Mullard Simonstone, describes the project as "highly successful and a very good example of the way in which industry can benefit by this kind of co-operation with universities."

Method of operation

The electron gun of a TV picture tube is a precision sub-assembly comprising a large number of small components requiring the use of highly-skilled labour.

The machine developed for Simonstone auto-



This machine, developed and built by the Department of Production Engineering & Production Management of Nottingham University for the Mullard television picture tube plant at Simonstone, Nr. Burnley, Lancs., automatically assembles part of the electron gun of a television picture tube. It takes three components of the electron gun and makes a total of eight welds to produce the 'grid 3' sub-assembly.

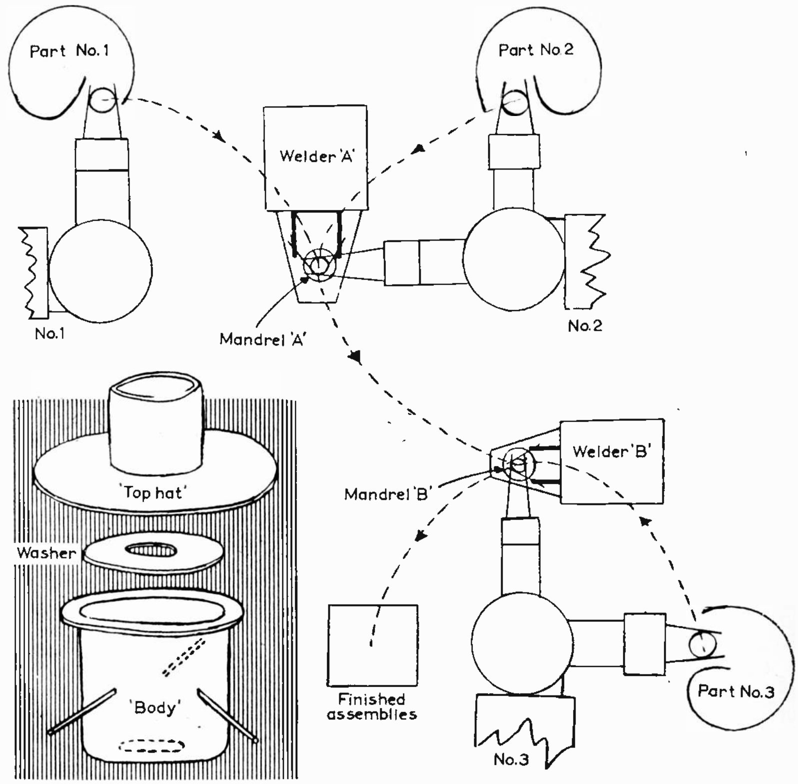
matically assembles three of these components and makes a total of eight welds to produce a sub-assembly (grid 3) for a TV tube electron gun. The three components are:

1. A flat washer, 8mm diameter by 0·11mm thick with a central hole 1·5mm diameter.

   A 12mm 'top hat' with a 3mm high 4·5mm diameter central cylindical section.

   An 8mm diameter by 7mm deep 'body' with a 10mm diameter top flange and three 1mm diameter by 5mm long pins welded radially to the body.

The parts are assembled by welding together parts 1 and 2 with four spot welds, then welding this sub-assembly to part 3 to produce the assembly shown in the diagram.



Layout of the assembly machine.

In the assembly machine, the component parts are fed by vibratory feeders to three 'pick-and-place' units which pick up the components and place them on mandrels at welding stations. These pick-and-place units are built as modular assemblies with a variety of pick-up heads (e.g. gripping fingers or vacuum pick-ups) so that machines for different tasks can be built up. These units are pneumatically actuated and the sequence of operations is electronically controlled. Three basic operations are involved; component pick-up or release; raise or lower; rotary or linear motion to transfer components from one station to another. In the Mullard machine the transfer motion is rotary.

The basic layout of the assembly machine is shown in the diagram with the mechanism in the start position. All three pick-and-place machines operate simultaneously.

Assembly stages

Stage 1. Part 1 is picked up by pick-and-place unit No. 1 and transferred to mandrel A. Part No. 2 is also transferred to this mandrel by pick-and-place unit No. 2. The previous sub-assembly of parts 1 and 2 is transferred from mandrel A to mandrel B. Whilst this is taking place the component No. 3 is transferred from the feeder and also placed on mandrel B.

A completed assembly is removed from mandrel B and placed into a tote bin.

Stage 2. At both welding stations A and B a double-headed welding unit makes two spot welds, then the mandrel is rotated and another two welds made.

Stage 3. All three pick-and-place units return to the start position and a new cycle can commence.

Part location

Because the location for parts 1 and 2 has to be on their inside diameters, part No. 1 has to be assembled on top of part No. 2. For welding to part No. 3 it has to be turned the other way up. To accomplish this, the first arm of pick-and-place unit No. 2 rotates through 180° about its own axis while transferring between mandrels A and B.

This sequence of events is repeated continuously to produce the completed assemblies at a rate of up to 1,000/hour. Interlocks and part detecting devices are built into the machine to ensure correct operation. ■

DON'T FORGET THE 1969 P.W. and P.TV. FILMSHOW — SEE PAGE 197.

FLYING SPOT

A SI

S

THIS article is aimed specifically at beginners, outlining the underlaying principles before showing how these can be applied in building a simple flying-spot scanner system. The primary considerations were simplicity and economy (the author's financial outlay did not exceed £5). The versatility of the system may leave a lot to be desired although reasonable results may be achieved by the layman.

A device for picture transmission must provide information about light intensity at any given point at any given time. Changes of light intensity can be converted into changes of electric current (rendering them suitable for transmission) by means of a photocell. One type, the photoemissive cell, releases electrons from its cathode in proportion to the intensity of the light falling on it and also to some extent on the frequency of the incident light. As these electrons are attracted to the positive anode a current proportional to the incident light intensity flows in the external circuit. The photocell by itself is inadequate for television purposes however since the anode current is proportional to the overall illumination intensity of the picture regardless of detail. For example the black-and-white patterns shown at (a) and (b) in Fig. 1 cause the same overall amount of light to fall on the photocell cathode, the net result being equivalent to grey. This problem is overcome by scanning, that is by dividing the picture into a large number of parts or "picture elements" and transmitting information about the illumination intensity of each in turn. The larger the number of elements the higher the definition of the picture.

Scanning

In the flying-spot scanner the picture to be transmitted is illuminated by a moving point of light which scans the picture or alternatively scans a transparency so that at any one time only one small point is illuminated. The light reflected from the picture or passing through the transparency excites a photocell. The practical problems are (a) how to scan the picture and (b) how to reproduce it.

The scanning system adopted uses an unmodulated raster to scan the picture, slide, etc. The spot of light on the face of the cathode-ray tube traverses the screen in just under 100μS (at 405 lines per field) before commencing the next line, the process being repeated until the whole screen has been covered. Due to persistence of vision the eye sees only a complete raster whereas a photocell "sees" the raster as a fast moving spot of light which if passed for example through a transparency varies in intensity as the optical density of the slide varies. At any one instant the spot of light picks out one picture element. Fig. 2 shows the flying-spot system being used to scan a transparency.

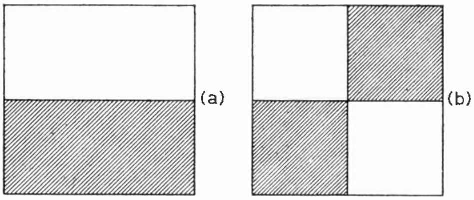


Fig. 1: A photocell would produce the same output when presented with these patterns—hence the need for a scanning system.

If a raster identical to that displayed on the scanning tube is displayed on another cathode-ray tube the output from the photocell can be used to modulate the raster on this second tube. It is extremely important that the two rasters be exactly synchronised, i.e., they should commence and scan each line and field together. Thus if for example a transparency having a vertical black bar is fixed to the face of the scanning screen, the instant the spot is hidden from the photocell by the black bar on the face of this screen the spot on the display screen will be in exactly the same position on its tube face and, if modulated by the photocell output so that zero illumination of the photocell corresponds to zero illumination or black on the display screen, then the spot will appear black at this position and when the raster on both screens is complete the result will be a vertical black bar on the display screen. This process raises two

SIMPLE FLYING SPOT SCANNER

PART 1

S. M. LINDSAY

problems (a) how to modulate the display screen from the photocell output and (b) how to keep the two rasters exactly synchronised.

CRT modulation

When the electron beam in the c.r.t. strikes the phosphor-coated screen light is emitted, the brilliance of the light spot depending on the velocity of the electrons. The negative electrons are accelerated towards the screen by a high positive voltage on the final anode of the tube. The higher this voltage the higher the velocity of the electrons and the brighter the spot. The voltage difference between the cathode and final anode can be increased by making the cathode less positive with respect to earth or the acceleration of the electrons can be increased by making the grid of the tube less negative with respect to the cathode.

The voltage output of the photocell is 180° out of phase with the light input. That is peak white illumination corresponds to maximum electron emission and hence maximum anode current. This corresponds to minimum anode voltage due to the series anode resistor, giving negative modulation.

Thus on a transparency being scanned white detail will produce a negative output pulse (relative to the voltage output at black or zero illumination level) from the photocell. This pulse can be amplified (with the phasing maintained) and applied to the cathode of the display tube. The potential between the cathode and final anode is thus increased resulting in a corresponding increase in the brightness of the spot at the appropriate point on the display tube. The video amplifier may alternatively provide phase inversion in which case the grid of the display tube is used.

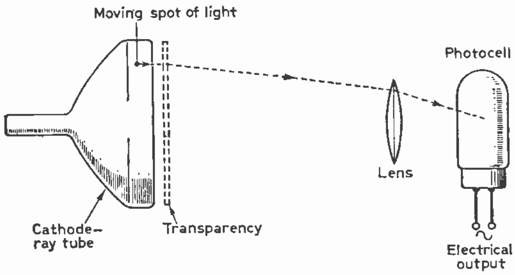


Fig. 2: Simple practical flying-spot system.

The output of the photocell is essentially a pulse waveform which means that it can be resolved into an infinite number of harmonics, theoretically requiring the use of a video amplifier with an infinite frequency response. Fortunately in practice matters are simpler. A fairly linear response between d.c. and 2Mc/s is sufficient.

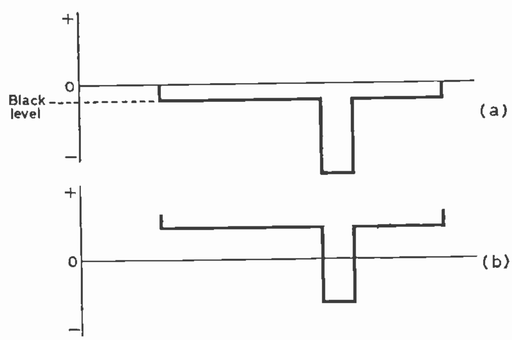


Fig. 3: (a) Signal with d.c. component. (b) Loss of d.c. component due to RC coupling.

Another consideration in the video amplifier is d.c. restoration. After passing through *RC* coupled stages the d.c. level of the signal is lost and it distributes itself symmetrically around a mean zero level (see Fig. 3). Although not serious this can produce certain shading effects on the display tube. The d.c. level can be restored by means of a diode in shunt with the grid leak resistor of the video output stage.

The displays can be synchronised as in normal television practice by using sync pulses to keep the scanning and display rasters in synchronism.

Simple closed circuit system

The foregoing comments indicate what is needed for a closed-circuit flying-spot set up and the

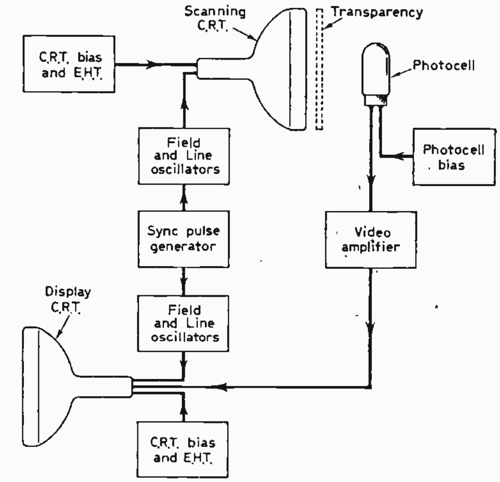


Fig. 4: Basic requirements of a flying-spot scanning system.

arrangement shown in Fig. 4 would seem to be the simplest approach. A great deal of experience would however be needed to build and set up such an arrangement from scratch and the expense would bar most constructors.

The hard work can, however, be avoided. The ordinary domestic television set contains besides its cathode-ray tube all the biasing and scanning mechanisms needed and when for example receiving BBC the raster on the screen is automatically locked to the BBC's sync pulses. Any two sets properly tuned to the same station must therefore have their rasters locked in phase since they each receive the same sync pulses and the only problem is to remove the transmitted video information in the case of the scanner to leave a plain white raster (our scanning light source) and in the case of the display set to replace the transmitted video signals with the signals from the photocell. This is a simple thing to do: all we have to do is replace the input to the appropriate display tube electrode from the set's internal video amplifier with the output from our own equipment.

Figure 5 shows the simple set-up used. Two

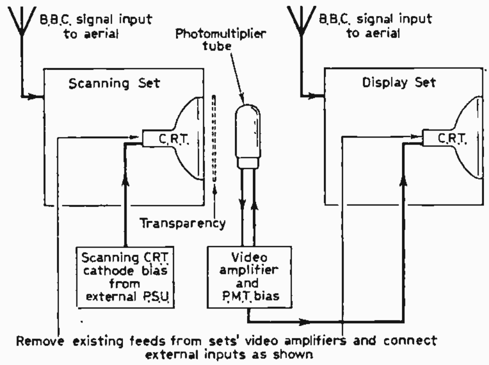


Fig. 5: Use of two modified standard sets for scanning the transparency and displaying the picture.

domestic TV sets are used and it can be seen that they require very little doctoring. The family TV set can be adapted with virtually no fear of not being able to return it to its normal condition for the evening's viewing after its service as the scanning unit. For the display unit it should be possible to pick up an old trade-in set in reasonable working order for as little as £2 (the author picked up an excellent little BBC/ITV set for 2gns.). The only other expense is the photomultiplier tube (a more sensitive form of photocell). This, type 931A, should be fairly easily obtained from surplus stores at around 40s. (the modern British equivalent costs around £30) and providing the constructor has a good junk box the video amplifier and power supply units required should cost very little representing a total cost of around £5.

CONSTRUCTIONAL DETAILS NEXT MONTH

INSIDE TV TODAY

—from page 210

Broadcasting Staff (a recently recognised union which was the BBC staff association and covers all types of jobs in broadcasting). Studio personnel such as scenehands and electricians are covered by NATKE (National Association of Theatrical and Kine Employees) and the ETU. Many production staff are members of the NUJ (National Union of Journalists).

As in any industry staff relations vary from one moment to the next, but in general the ITV is less monolithic and more flexible over its dealings than the BBC. For example when the ABS started its first ever industrial and largely ineffective action against the BBC some months ago one point of conflict was over claims made over two years previously, showing the lethargy of both the BBC and the ABS.

During the changeover of staff to the new independent companies from those closing down or reducing their staff the ACTT declared a closed shop principle where no non-union members could work for an independent company. This was to ensure that any redundant ACTT members would be re-employed before technicians from the BBC or industry. This was in spite of the considerable redundancy pay offered to those losing jobs and the fact that due to the extra programme area more jobs would be created than the number of technicians losing a job. Increased staffing for colour television—now imminent—would effect this situation favourably.

Although there are many points of similarity between the BBC and the Independent Television companies these are not the most important points. Naturally two organisations doing a similar job with a considerable interchange of personnel will tend to have the same operating conditions and techniques. However the basic organisation or establishment of the BBC is far more complex and conservative than the commercially orientated opposite in the ITA. Attitudes amongst many of the staff do tend to reflect the differences between the two systems.

TO BE CONTINUED

INSTALLING and SERVICING COLOUR RECEIVERS

PART 5

P. G. ALFRED

THERE are two basic approaches to the problem of fault-finding. The first depends upon experience and the laws of probability and the second upon a process of logical deduction. In practice a mixture of both is used, some engineers having a bias towards knowledge gained by experience and others favouring the elegance of logic. We make the distinction here because both techniques have their proper place in the scheme of things; the skilled engineer knows instinctively which to apply and when to abandon one in favour of the other.

Common Faults

When you service a large number of receivers of a particular design you very soon find that a large proportion of the failures are the result of a small number of different causes peculiar to that model. No sound is nearly always caused by a dud sound output valve; non-linear field scan by a several megohm resistor going open-circuit; no line scan by a pulsed capacitor breaking down and so on. Each model has its own pattern of faults. So when you are fault-finding in a receiver which shows a characteristic defect you naturally exploit the fruits of your experience and the laws of probability and try the "standard" cure first. If this fails you have to ask yourself "do I use testgear and logic, or try some other probable cures first?" This is where experience comes in. Just how "probable" are these cures?

Probable Causes

Human nature presents many subtle traps for the unwary. You may spend a great deal of time on these lesser probables, assuming that you are taking a short cut. But quite possibly you are refusing to face up to a difficult situation and instead proceeding by trial and error. Now under normal conditions fault-finding by trial and error is a dead loss. It takes a great deal of time, is wasteful of components and teaches you very little. It may perhaps add one more standard cure to your repertoire, but you have learnt nothing about how to find faults nor anything about how the apparatus works.

There is only one use for trial and error methods. If you have isolated a fault to a particular circuit, stage or group of components and are sure of your diagnosis but without the necessary testgear to pinpoint the particular item at fault, it may be quicker and cheaper simply to change the lot. Even so it is often possible to narrow down the field very considerably by measuring voltages, currents and resistances with a multi-range meter making full use of your knowledge of how the circuit works and what operating conditions are to be expected. And this, of course, is fault-finding by logic. You expect a certain voltage on a valve electrode and if it is not present you have an important clue. Is the valve faulty, or an external component? It is surprising how often you can deduce the exact cause of the trouble, and then produce an inner glow of satisfaction by changing the component and proving you are right. Trial and error methods might have taken a very long time.

Without the simple logic of the kind that anyone can master or detailed knowledge of correct circuit voltages etc. it can be surprisingly difficult on occasions to isolate a fault in a perfectly straightforward stage. You gaze blankly at a group of components and think "where do I go from here?" With the right approach, however, a routine drill will provide the answer quite quickly. We will illustrate this point in detail when we discuss the systematic approach to colour fault-finding later on.

Standard Cures

Every engineer knows the standard cures for receivers of a type which he has worked on for a considerable period of time. When a new model comes along he knows the categories of components which are most likely to cause trouble, but it takes time to learn the set's own particular idiosyncracies. Only experience will provide this knowledge; and properly collated information from the whole workshop and any others in the same company will be of great benefit. This is particularly true when a large number of different makes of receiver are handled or when they are as complex as a typical colour receiver.

Component Defects

It would be invidious to name makes of components which on the basis of probability are much more likely to fail than others, but here are some general categories of likely faults: power valves—output stages, rectifiers etc.; high-voltage valves—e.h.t. diodes, boost diodes; contacts—system switches and plugged connections; dry-joints—mostly on printed panels; capacitors—any type with high voltage d.c. or pulses; resistors—several megohms with high-voltage d.c. or pulses; coils—complicated coil assemblies; h.t. lines—fuses or wire-wound droppers; transistors—especially when exposed to damage by c.r.t. flash-over.

Valves are bound to have a shorter life than

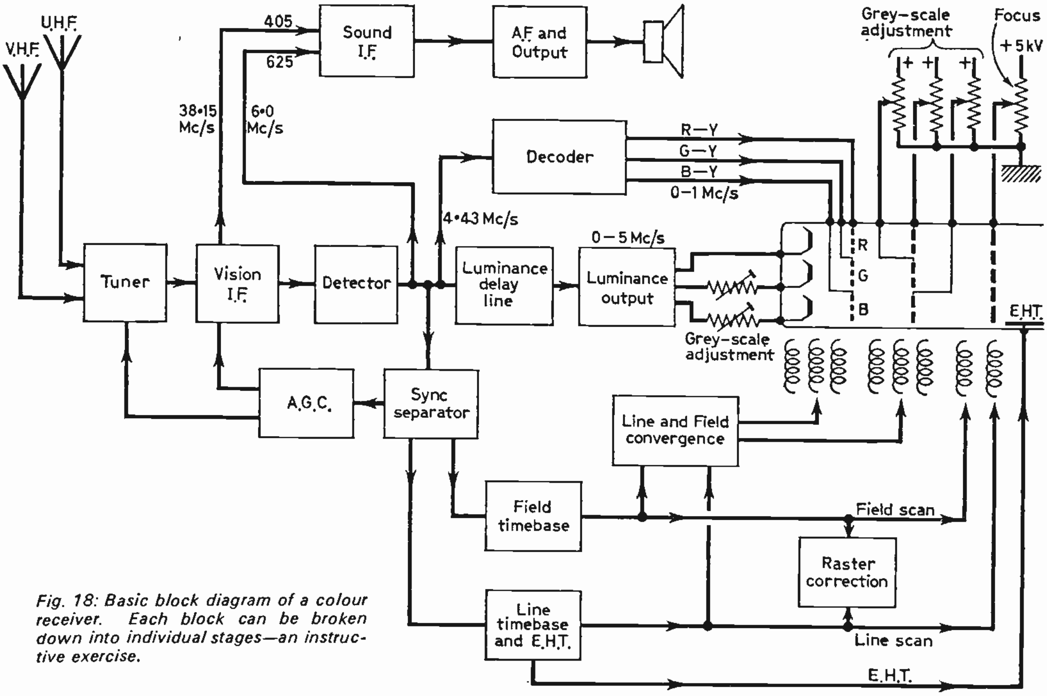


Fig. 18: Basic block diagram of a colour receiver. Each block can be broken down into individual stages—an instructive exercise.

some other components from their very nature and the problems inherent in mass production. On the whole they reflect great credit on the valve making industry but it is only to be expected that high-power or high-voltage types will need replacement sometime during the life of the receiver. Common faults are loss of emission or heater-cathode, cathode-grid or cathode-screen short-circuits.

Most capacitors and resistors are very reliable except for a few ceramic capacitors used for interstage coupling and those used in the applications listed above.

Transistors too are extremely reliable providing they are properly used in the design. The only real hazards apart from the defective one that slips past the factory inspector are c.r.t. flashover and careless circuit testing. A flashover can blow up a whole series of transistors scattered all over the receiver if the flashover path has not been foreseen by the designers and suitably blocked. Techniques have now been devised that make this fault an uncommon one, but the problems can be very subtle.

Complicated coil assemblies tend to be a little unreliable. This is partly because some of them contain a large number of components and soldered joints and partly because it is all too easy to leave a whisker of wire sticking out which can short-circuit to a neighbouring lead or to the can.

In spite of the foregoing list of troubles, which perhaps makes rather gloomy reading, it is fair to say that once a receiver has been in the field for a month or two and has been de-bugged it can be expected to give a high standard of reliable service for 7-10 years. Bearing in mind that it contains some hundreds of components and soldered joints this is really quite an achievement.

Logical Fault-finding

Logical fault-finding is simply the systematic approach based on the techniques of the best detective story. Gather all the clues you can find; think of ways of obtaining others; deduce where the guilt lies; devise tests to prove your theory, and then confront the culprit.

The first step is *observation*. Suppose you have the complaint of no picture on a monochrome receiver. You look at the screen and observe that it is black. Ask yourself: is there no picture because there is no c.r.t. drive; or because the c.r.t. is cut off; or is the problem due to the absence of e.h.t. or because there is no scanning current? You need further information so you must devise means of obtaining it. Turn up the brightness and contrast controls; listen to the line and field timebases whilst you adjust the hold controls, and listen for the sigh of the c.r.t. as you switch off and switch on again. You should now have enough information to *deduce* which of the general possibilities is likely to be the correct one, and you have not yet touched a piece of test equipment.

Proving the Fault

Suppose you decide that the c.r.t. is cut off. You must *prove* it. Take a voltmeter and in three minutes you can prove or disprove your theory. Let us assume that you were correct

Table 4: Checking procedure for no picture, raster, or spot on 405- or 625-line operation
Basic causes: No drive to c.r.t.—c.r.t. cut off—no line scan current—no e.h.t.

Test	*Result*	*Deduce*	*Check*
(1) Turn up brightness control	No raster visible	C.R.T. cut off *or* line timebase faulty	Item (4) Items (2) and (3)
	Raster but no picture	No drive to c.r.t.	Using scope check backwards to video output stage and detector. 405 sound indicates tuner OK; 625 sound shows tuner and i.f.s OK
(2) Listen for line timebase whistle (easier on 405 lines!)	Normal transformer noise	Line timebase basically OK	Check e.h.t.—item (3)
	Line oscillator noise only (adjust line hold control)	Line output stage faulty	Carry out complete check of line output stage
	No noise at all	Line oscillator faulty	Check oscillator and drive to output stage
(3) Switch receiver off/on	Sigh from c.r.t.	E.H.T. present in c.r.t.	—
	No sigh	No e.h.t.	Assess with item (2) and establish whether the fault lies in the line timebase drive, scanning or e.h.t. circuits
(4) Measure c.r.t. electrode voltages (use multirange meter or d.c. coupled scope or valve voltmeter)	Low e.h.t.	Faulty line timebase	Line timebase as above
	Low first anode voltage	If e.h.t. is OK then the boost h.t. should be all right	Check h.t. or boost h.t. feed to the first anode for voltage and continuity
	Low grid voltage	Faulty brightness circuit	Check d.c. feed to grid
	High cathode voltage	Video output stage cut off or low-emission valve	Check d.c. potential of output valve anode and other electrodes. Deduce type of fault.

Note how much information can be obtained from very simple processes of testing and deduction.

and that the c.r.t. is cut off. You cannot confront the culprit because you do not yet know the cause. All you know is that a c.r.t. electrode voltage is faulty. So you start again, but the field has been greatly narrowed down. You need more clues so you devise tests to obtain them. You measure more voltages, deduce which component has failed, test it, change it, and prove the correctness of your diagnosis by getting the picture back.

This is a straightforward case which illustrates fairly clearly the logical approach. Naturally there are plenty of faults which do not respond so quickly to a few simple, well-directed tests. But imagine how much time could have been spent poking about haphazardly in a hit-or-miss attempt to find the culprit!

Knowledge Required

Now what sort of information do we need in order to tackle the job properly? First we need to know *how* a television receiver works; secondly we need to know the *circuit* of this particular model, and thirdly we need to know the *layout* of the components.

It is not possible to tackle any operation systematically unless you have an understanding of the system. If you are well taught you begin learning about television receivers in a simple, fundamental way and then the whole subject is broken down level-by-level until finally the detail of individual circuits has been covered. This process supplies the basic tools for building up a complete personal technique for logical fault-finding. Knowledge of individual circuit diagrams and layouts comes from experience, or can be acquired more quickly by careful study of workshop manuals. The important thing is to know the system principles.

Block Diagrams and Check Lists

The best way to get your thoughts clear about the working of a colour receiver is to adopt this level-by-level approach in block diagram form. The basic building bricks such as i.f.s, decoder, convergence, timebases, and e.h.t. are common to all, but when you begin to get down to greater detail you have to draw a different block diagram for each new design of receiver. This is well worth doing because it gives you the complete knowledge of a receiver that enables you to carry out a proper process of deduction with less chance of missing a trick. A basic colour receiver block diagram is shown in Fig. 18.

Once a basic understanding is acquired it is time to begin fault-finding in logical terms. It is possible to draw up endless check lists of procedure and this is not only good practice but helps to highlight key points which are easily missed on the job when there is not really enough time to think carefully. Just to illustrate the process Table 4 takes the already mentioned example of no picture covering the possibilities in rather more detail. It shows what a surprising amount of information can be obtained from very quick and simple tests without the use of elaborate measurements.

This checking process is made a great deal more fruitful if it is known what voltages, currents, impedances and waveforms are to be expected at each point. Every time a new measurement is made the results should be marked up on a circuit diagram for future use.

TO BE CONTINUED

ITA's TV Gallery

WHAT is believed to be the only Television Gallery of its type in the world has recently been opened at the headquarters of the Independent Television Authority in Knightsbridge, London. This has been designed to give the public and those concerned with television a memorable impression of the development and day-to-day operation of world television, showing how programmes are created and reach the viewers.

The "Television Story" is presented with the aid of many static and animated displays, making full use of advanced forms of multiple-screen optical projection with snap and variable-speed dissolves. The slides projected on multiple screens can be changed every 0·1 sec. Also used are preprogrammed magnetic tapes including techniques normally associated with "Son et Lumiere" events.

The multiple screen effects are enhanced by the twin automatic projectors having electromagnetically controlled shutters for snap changes and electronic dimmers for the lap dissolves. The magnetic tape control equipment uses time division multiplex (p.c.m.) and endless loops. Other advanced display techniques, including the use of a television slide scanner, are to be found throughout the Gallery.

TV HISTORY

The displays trace the earliest development of television from animated toys and Zoetrope moving pictures to continuous film cinematography and so to the era of low-definition mechanical television. An original Baird 30-line Televisor—the world's first commercial television display unit (on loan from the Science Museum)—and a replica of his earliest scanning disc transmitter recall the television of the 1920s and early 1930s. The development of fully electronic television systems is traced from the proposals of Campbell Swinton and Rosing to the pioneer work of Zworykin and the team under Shoenberg.

PROGRAMME PRODUCTION

A series of snap-change slides present scenes from the BBC "Ally-Pally" (Alexandra Palace) where the first regular public high-definition television service began in 1936. Then several displays dip into the origination of programmes: one automatic 13-screen presentation combines optical and television displays giving a vivid insight into the background to news bulletins and outside broadcasts. Another, using light-transparency boxes, floodlighting and controlled revolves, traces the production of a drama series of programmes from the first idea to final transmission. Sound and light effects show the work and responsibilities of producer, script editor, writers and technicians, and indicate how sets are planned and built, dressed and lit. Casting of actors, rehearsals and the shooting of scenes in studios and on location can be followed.

The story of television advertising and audience research is shown on another series of multiple screens with dissolve-changes; the changing patterns of programme content over the past decades being presented in animation by means of a large-diameter concealed drum.

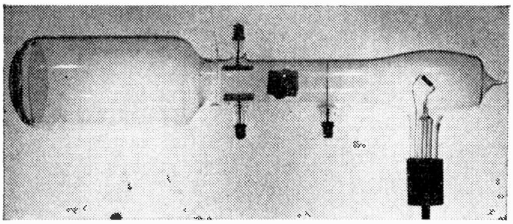
ENGINEERING

Engineering aspects of television include demonstrations of network switching and transmission, and also a simple explanation of colour television principles with a working mechanical/optical analogue of a shadowmask display tube. Visitors are also shown the rôle of space satellites in international relays; television in education; and how British independent television is organised.

GALLERY TOURS

The Gallery occupies the major part of the first floor at 70 Brompton Road. A full tour takes about 90 minutes, though the display system allows the programmed events to be varied. Since the official opening of the ITA Television Gallery by Earl Mountbatten of Burma on September 25, 1968, members of interested groups and also the public have been able to tour the Gallery *by appointment*. It is open daily from Mondays to Fridays.

Associated with the Gallery is the ITA Library and reading room, both of which are open to all persons making a serious study of either the technical or production side of television. ■



Left: One of the earliest cathode-ray tubes, the 1905 Wehnelt hot-cathode tube, on display at the ITA TV gallery. The cathode can be seen on the right. The electron stream emitted passes through a hole—which focuses the beam—in the anode diaphragm and is then electrostatically deflected by the two sets of deflection plates before striking the fluorescent screen. The tube was first used for recording electrical oscillations. Campbell Swinton suggested using a similar tube for TV picture transmission and reception.

Servicing TELEVISION Receivers

No. 154 DEFIANT 9A61U SERIES

(Plessey chassis)

by L. Lawry-Johns

THIS range of receivers uses a Plessey chassis which will also be found in several other makes under different names and numbers. For example, the Grundig K230 and K450 employ virtually the same layout with very minor differences; the v.h.f. tuner uses a PC900 r.f. amplifier instead of the PCC189 used in the Defiant models and an autotransformer in place of the mains dropper. The Cossor CT962/77 is another very close relative although most Cossor models use the parent Philips chassis. For the sake of clarity however this article is based on the Defiant models 9A61U, 9A62U, 9B63U and 3A66U.

The 3A66U is a 23in. model with a CME2303 tube, the other models using a 19in. CME1903. The equivalent tubes to these are the A59-15W and A47-14W respectively. These are dual-standard models, the 9A61U having a separate switch to change the system whilst the others have the switch ganged to the selector switch of the v.h.f. tuner. The chassis is vertically mounted, hinged at the bottom so that it can be lowered for servicing, and removed completely if necessary.

Common Faults

There are several common faults a knowledge of which can cut time spent on servicing at least by half or more in some cases. The original type of dropper (601AJ) nearly always gave trouble, with either one or another section becoming open-

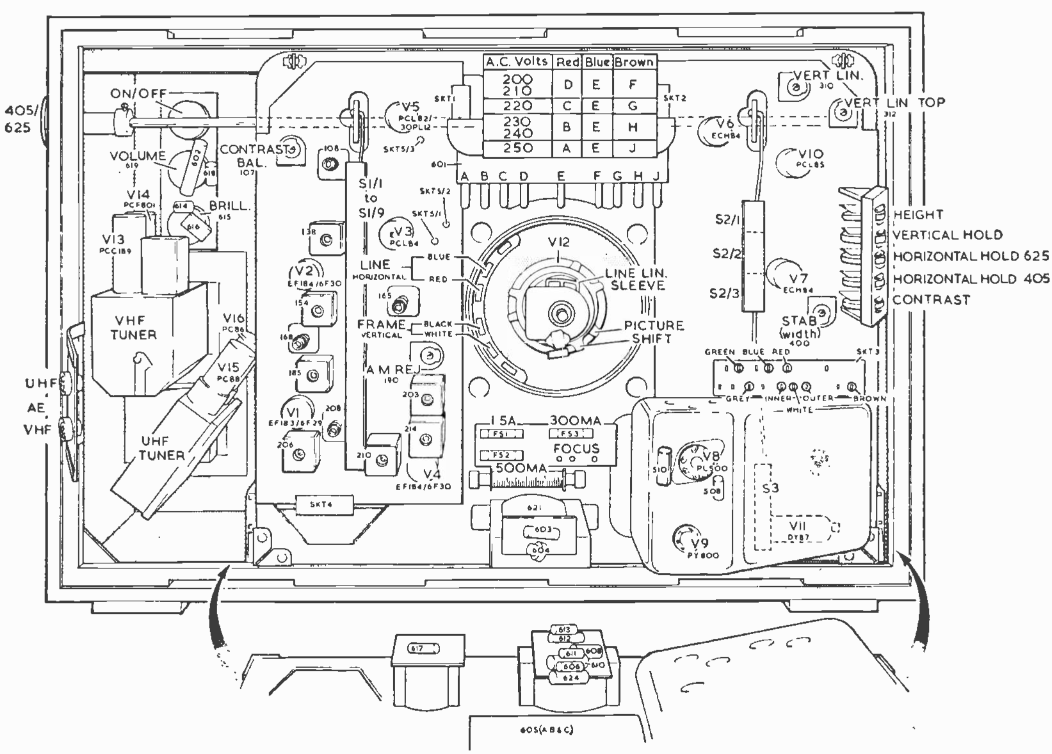


Fig. 1: Rear chassis view.

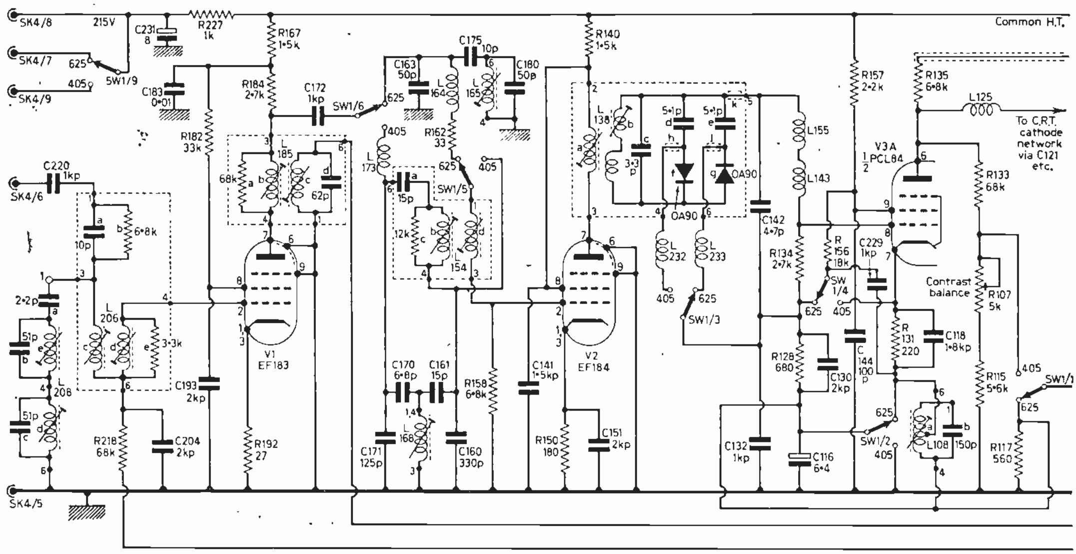


Fig. 2: Circuit diagram of the

circuit. The effect of this of course is to cause the receiver to become inoperative, either because of no h.t. because one of the sections A-E is open-circuit, or when the valves are unheated because one of the sections E-J is open-circuit.

Locating the faulty section is a simple matter, using either an a.c. voltmeter or a neon tester. The presence of mains voltage at one tag but not at the next immediately identifies the faulty section. It is then a matter of deciding whether to replace the section or the whole dropper. The absence of mains voltage at any part of the dropper should of course direct attention to the mains supply and to the 1.5A fuse.

Fuses

There are three fuses in all, the 1.5A mains fuse, and two others. FS2 is the h.t. supply fuse, rated at 500mA, and is located in the smoothed d.c. side. FS3 is the heater supply fuse and is rated at 300mA, anti-surge. All three are together on the centre section under the tube (see Fig. 1).

Line Timebase

There are a number of common faults which affect the working of the line timebase, varying from complete non-operation to lack of width and wrong line speed. By non-operation we mean that there is no picture and no e.h.t. If the line whistle is inaudible, let the chassis down and remove the top cap of the PY800. If this restores some sort of e.h.t., the boost reservoir capacitor 505 should be replaced. This is an 0·25μF capacitor hiding on the line output transformer panel.

To get at this necessitates removing the line output transformer and its screening box, which is on the lower right-hand side. The screws securing the box to the chassis must be released, also the bushed screws which hold the transformer to the box. The front screening box should have already been unclipped and the top caps of the PY800 and PL500 removed. The capacitor is clipped to the small transformer panel and is obvious when the panel and box are separated. A replacement capacitor should be rated at 500V or more. There is no basic reason why this capacitor should not be open-circuit rather than shorted, but in fact this seldom happens.

If the removal of the top cap of the PY800 makes no difference, check this valve and the PL500, which is more likely to be at fault. The 2·2kΩ screen feed resistor 402 is another weak point. This has a habit of becoming open-circuit, sometimes on its own account and sometimes due to the PL500 developing an internal short. This short may be of an intermittent nature, leading one to believe that only the resistor is at fault when the true cause is the valve.

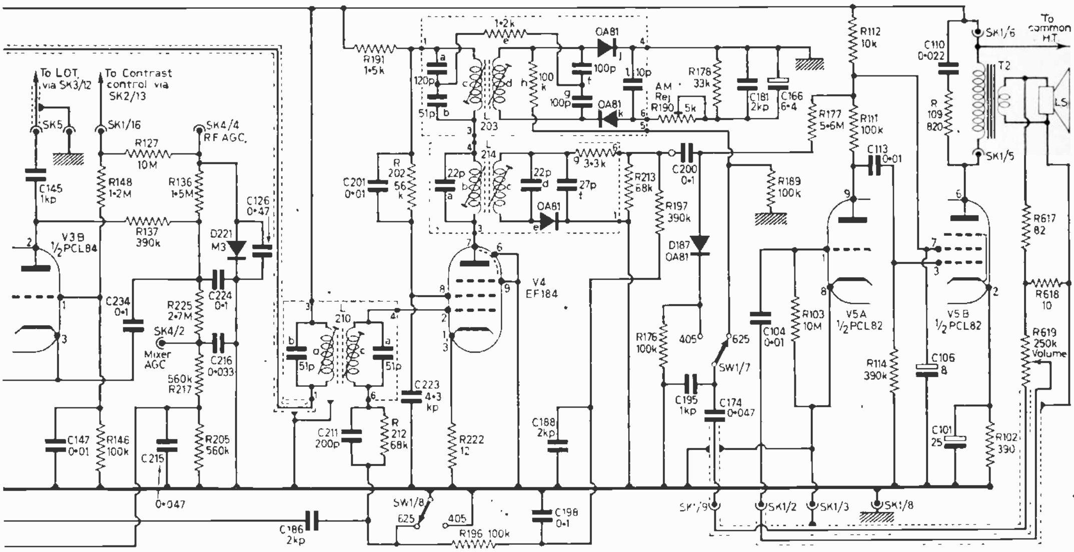
A more obscure cause of no e.h.t. occurs when the line drive is excessive. A meter reading shows that the PL500 is drawing very little current as shown by a very small drop across the 2·2kΩ screen feed resistor. In this case the VDR (401), type E298ZZ/06, is most likely to be at fault. Shunting this with a 200kΩ resistor (approximate value) will restore near normal drive and confirm the diagnosis.

Lack of Width

This can be due to a change in value in a component in the width control circuit, for example the VDR (401), but usually the PL500 line output valve will be found at fault. The PY800 should also be checked as this will occasionally be found to be at fault.

In any line output fault it is worth checking the 100μF electrolytic capacitor in the anode circuit of the PY800 (395) as this has a tendency to split open.

The choke 620 occasionally developes a short to its core. If the short is direct the h.t. fuse



receiver sections of the chassis.

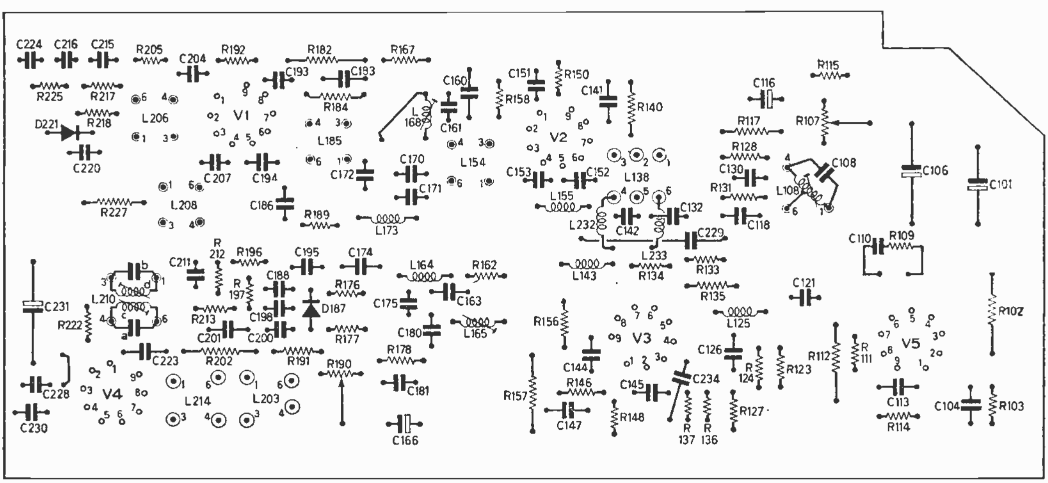


Fig. 3: Layout of the receiver printed panel, viewed from the component side.

FS2 will blow. If the fault is more of a leak the choke will cook up nicely with obvious signs of distress.

No Line Drive

When the more obvious causes have been checked, such as the ECH84 and associated components, it is necessary to check the flywheel sync diodes (360 and 343) and the associated components including capacitor 356 (0·01μF) which may be shorted. Also check 377 (270pF) which may be shorted.

Weak Line Hold

Try interchanging the ECH84 valves, then check the hold circuit resistors. If these are in order, check the diodes and capacitors as above. All have a bearing on the line speed and sync.

EHT Rectifier

This is the DY87. It is prone to two main faults. Whilst both produce a complete loss of raster, an open-circuit heater will leave the line output stage working, evidenced by a healthy line whistle on the 405 standard and the presence of e.h.t. at the top of the DY87. On the other hand if the DY87 is internally shorted the line whistle will be strained or absent until the top cap is removed or the e.h.t. connection to the side of the tube is removed.

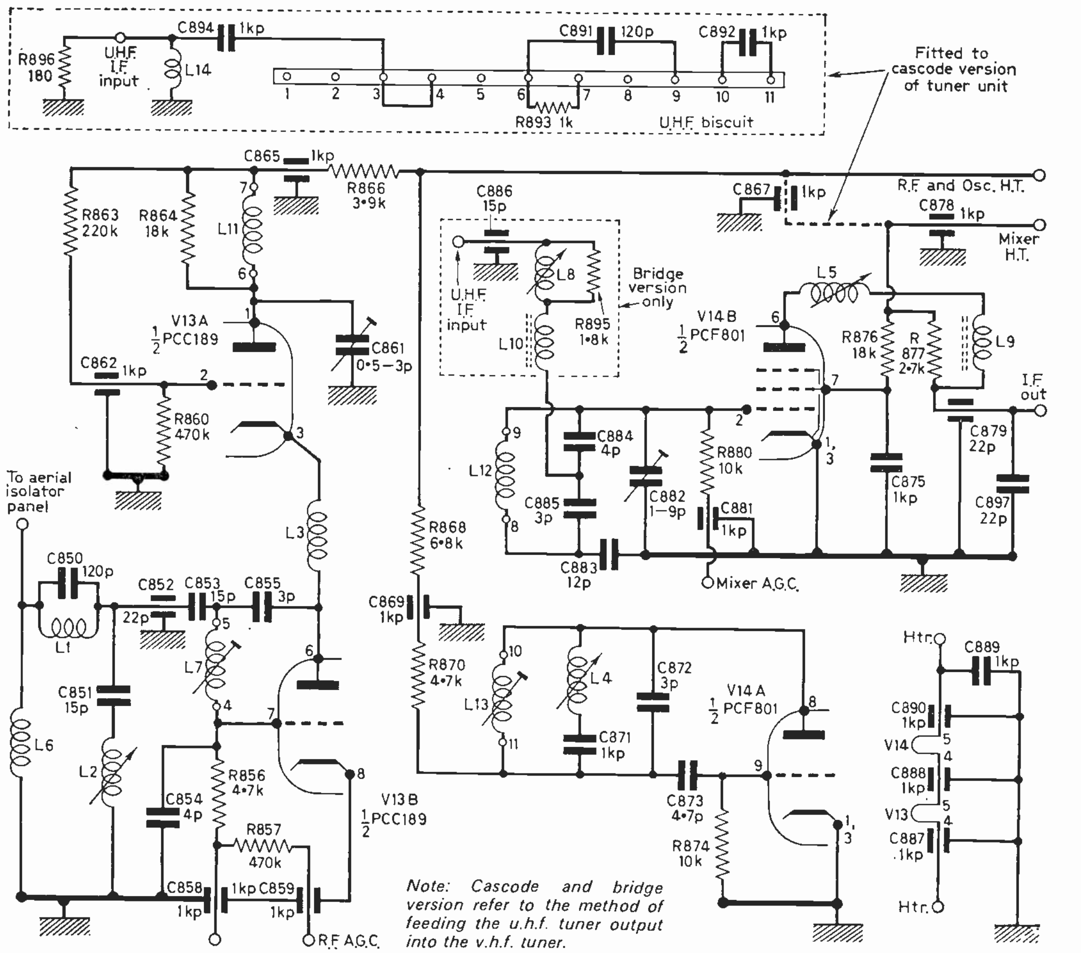


Fig. 4: Circuit diagram of the v.h.f. tuner unit.

Field Timebase

V10 is the field oscillator-output valve, type PCL85. The faults here vary from complete loss of scan, evidenced by a single white line across the centre, to insufficient height or distortion and hold troubles.

If the timebase is not operating at all, attention should be directed to the PCL85 and its valve base voltages. If the valve is not at fault, check the voltage at pin 6. This should be over 200V. Check T1 primary if this voltage is incorrect. T1 is of course the output transformer.

If the voltage at pins 6 and 7 are correct, check at pin 8 (cathode). The bias resistor may be open-circuit and the capacitor 320 blown out. The presence of a high voltage at pin 8 would indicate this. If however the voltage is a normal 20V and the other two voltages are correct, apply a hum test to pin 9 (control grid) which should open up the raster according to the disturbance applied. If there is no movement at all, check the field deflection coils and the series Varite 607 (VA1053).

Insufficient height, which is an even loss top and bottom, should direct attention to the components in the height control circuit and the boost line supply where a resistor may be high or a capacitor leaky or shorted.

When there is field distortion, bottom compression etc. check the PCL85, the bias resistor (360Ω) and the electrolytic 320 (500μF). If these items are in order check capacitors 306, 308, 311 and 314. Disconnect from the circuit and test each for leakage.

If the hold control is at one end of its travel and the picture still rolls or tends to roll check resistors 326 and 351, capacitors 319, 335 and 338. Substitution is the best check, observing the voltage ratings, particularly of 319.

CONTINUED NEXT MONTH

UNDERNEATH the dipole

THERE is one special characteristic which electronic engineers must have—logical acuteness. Not for them the vague intentions of "arts and crafts" nor the gullibility of "education and science." Unrestricted by technical parameters and the British Standards Institution's specifications, the Ministry of Education and Science made colossal technical errors in planning, policy and operation of—for instance—equipment for closed-circuit television in universities and schools. They even form committees to look after such things without a single engineer on them! No wonder thousands of pounds were thrown down the drain before a proper technical committee was constituted in March 1968. But this was started years too late.

Why should the taxpayers' money be wasted on expensive teaching apparatus (selected by technically ill-informed educationalists) which is often unsatisfactory and incompatible for interchange between schools and universities? There are no less than 23 different v.t.r. helical-scan standards in use in 168 different closed-circuit systems under the jurisdiction of 143 local educational authorities in England known to the central administration in Whitehall. This doesn't take into account a few other educational TV venturers who are still playing about with this fascinating new toy, which is a particularly dangerous tool in the hands of irresponsible students.

National film school

It is hard to understand how the minister of state dealing with the setting up of a national school for film production could constitute the Lloyd Committee which did not include a single engineer. Its objectives were to present recommendations to the Government on the policies, planning, construction and operation of a National Film School, to be housed in its own new building if considered necessary. A subcommittee travelled around Europe looking at film schools on both sides of the iron curtain—but forgetting the existence of the most practical film and television school in Europe, the Thomson Foundation's Kirkhill School near Glasgow which they did not visit. There are of course already several film and/or television schools in London such as the London Polytechnic (where years ago Mary Pickford's cameraman Charles Roshes was taught portraiture); the Royal College of Art; The Slade School; the Harrow Technical College; London School of Film Techniques, and others.

Some of these schools give special attention to film editing as well as dealing with all the other particular aspects such as scene design, script writing, motion-picture photography, TV camera work, sound recording, etc. All of these institutions could do with additional facilities, which could be named after famous pioneers of films and television such as Cecil Hepworth, Robert Paul, George Pearson, L. C. MacBean, Charles Rosher, Sir Michael Balcon, Capt. H. J. Round, Peter Eckersley, C. Wottage, etc. "Kinematographic Rules," laid down in 1908 by Cecil Hepworth, are not out of date today and could be profitably studied by professional TV or film cameramen. If the Government really wants to spend its money wisely on such technological matters as film and television training colleges it should abandon the beautifully written flannel provided by that Lloyd Committee.

UK TV standards

I have been asked by an American technical journal to explain in three or four sentences the trends in British television standards from the earliest days of high-definition on 405 lines to the present adoption of 625 lines and the PAL colour system. Here is the story and I hope readers will not disagree with the points made.

After a few years of primitive experimental transmission the public television service was established in Britain in 1936 on 405 lines, 50 fields (our standard mains frequency). Transmission was arranged for positive modulation, maximum signal being white, and the correct reproduction of half-tones was provided by including a d.c. component in the signal. After the war the same line standard was retained: the BBC had kept their equipment dusted and in good order, and the public demanded the return of television as soon as possible. There were only about 47,000 TV receivers in England of which few were usable by 1946 (due to electrolytic capacitors breaking down). The British pre-war government had guaranteed that the 405-line standard would stay put for 10 years, but the first post-war government would have done well to compensate owners for their old TV sets so that a new and better standard could have been developed instead of staying on 405 lines. Such a step would have saved us millions.

That was a regrettable mistake. The UK should have waited longer and even thought a bit more about colour. We all know the fantastic strides that took place in black-and-white television in the USA immediately after the war, with 525 lines, 60 fields and negative modulation. But we were for years chained to 405 lines and to cut the cost of sets saving halfpennies in production many (but not all) receiver manufacturers abandoned d.c. restoration or black-level clamping as it is now called under the unfortunate (but more or less correct) impression that the viewing public would tolerate any kind of picture if the weekly rental was sixpence or the purchase price £2 less. Fade outs became fades to grey and mean-level a.g.c. circuitry turned crystal-clear low-key scenes into a kind of London fog. Faces varied in brightness regulated by the amount of white in the rest of the scene. The set manufacturers' inclinations, like those of some surgeons, leaned towards cutting from the body of a TV

—continued on page 229

ITV PREPARES FOR COLOUR

THE complex structure of Independent Television with its 16 separate contractors supplying programmes over the Post Office network to transmitters built and operated by the ITA has tended to conceal the magnitude of the engineering work necessary in preparing for the start of the duplicated 625-line PAL colour service on u.h.f. The first four main ITV colour u.h.f. transmitting stations (covering about 40 per cent of the population) are expected to be in full operation before the end of 1969—there will inevitably remain areas where colour reception will not be practical for some years to come.

TRANSMITTER NETWORK

A national u.h.f. network comparable in coverage with the 40 or so v.h.f. Band III ITA transmitters is likely to require some 60 main transmitters and several hundreds of lower-power relay stations. About 25 main stations are planned to be operational by the end of 1971, with the first batch of the lower-power stations coming into use during 1970.

The establishment of a comprehensive national network, which for ITV must also split down into separate regional programmes, presents many new technical as well as administrative problems. During the planning stages ITA engineers made detailed assessments of the practices within the large transmitter networks used in more mountainous countries, both in Europe and in other parts of the world.

For the first time in Europe, some of the higher-power transmitters will use integrated five-cavity klystrons in the output stage, making possible the use of all semiconductor drive units even for 40kW transmitters. For some of the low-power 1kW relay stations it is intended to adopt the novel solution of using four 250W travelling-wave tube power amplifiers in a parallel configuration, rather than the more usual single power klystron.

UNATTENDED TRANSMITTERS

National u.h.f. networks would never have been feasible had it not been for the development over the last decade of new techniques for the remote control and supervision of unattended transmitters; many of these developments have been pioneered by ITA engineers. For the new u.h.f. network it is planned that all stations at new sites will operate on an unattended basis, controlled from a series of entirely new master control rooms. In the London area the new u.h.f. transmitter will be co-sited with the BBC-1 and BBC-2 u.h.f. transmitters at the BBC Crystal Palace site but the ITA equipment will be entirely controlled from the long-established ITA v.h.f. station at Croydon, which is currently being completely re-equipped.

ENGINEERING DEVELOPMENTS

New control and monitoring rooms for ITA u.h.f. colour transmissions are to be installed also at Lichfield, Winter Hill, Emley Moor, Black Hill, Chillerton Down, Dover, St. Hilary, Burnhope, Black Mountain, Mendlesham, Caradon Hill, Durris and Caldbeck. These new facilities are based on an extensive programme of research and the development of new methods of remote monitoring, supervision and data transmission.

New forms of data transmission in the field interval of the video waveform are being studied. Another major project has been the development of new high-performance off-air re-broadcast receivers. These have to be capable of picking up weak u.h.f. signals to provide high-grade video and sound for further transmission with a minimum of degradation of the signals. Particular attention is being given to new measuring and monitoring demodulators for these receivers. Advanced semiconductor techniques are being used in the front-end, including the use of pin diodes as constant-impedance, current-controlled attenuators (these have a thin layer of intrinsic semiconductor material between the p and n regions).

Since the ITA is responsible for the technical standards of the network but has direct control only over the transmitting stations, a new technical quality control section has been set up. In collaboration with the programme contractors, a rigorous code of practice is being established to ensure the high quality of all ITV colour transmissions.

STUDIO EQUIPMENT

The new ITA transmitter network is by no means the whole story. The programme companies are currently engaged in massive re-equipment programmes to meet the need for complete 625-line programme origination by all companies (other than Channel) by mid-1969, and at the same time are taking the opportunity to build up their colour facilities. In some cases this will be done by the extensive re-equipping of existing studio centres, but it is already clear that a large number of completely new studio centres designed specifically for colour operation—sometimes to both PAL and NTSC standards—will soon be in operation.

The first purpose-built colour studio centre was that of Yorkshire Television at Leeds (see PRACTICAL TELEVISION, January 1969). Major new centres are also being planned or built for Independent Television News in a ten-storey building on the corner of Wells Street and Riding House Street, London; Southern Independent Television at Southampton; ATV Network as part of the new Paradise Centre in Birmingham; Thames Television at the Euston Centre in London; Ulster Television in Belfast; Scottish Television in Glasgow; and London Weekend Television on the Southbank

MAIN ITA U.H.F. STATIONS EXPECTED TO BE IN OPERATION DURING 1969 AND 1970

Station number	*Station*	*Provisional u.h.f. channel and aerial polarization*	*Maximum effective radiated power (kW)*
101*	Crystal Palace (London)	23 H	1000
102*	Sutton Coldfield (Birmingham)	43 H	1000
103*	Winter Hill (South Lancs.)	59 H	500
104*	Emley Moor (South Yorks.)	47 H	1000
105	Black Hill (Lanarkshire)	43 H	500
106	Wenvoe (S. Wales)	41 H	500
107	Divis (Belfast)	24 H	400
108	Rowridge (Isle of Wight)	27 H	500
109	Pontop Pike (Durham)	61 H	500
110	Mendip Forest (Bristol)	61 H	500
111	Waltham (Notts.)	61 H	250
114	Talconeston (Norfolk)	59 H	250

*To commence colour service simultaneously with BBC-1 about end of 1969.

In addition, satellite relay stations (vertical polarization) should be in operation by about the end of 1970 at Hemel Hempstead, Reigate, Guildford, Tunbridge Wells, Stoke-on-Trent, Brierley Hill, Bromsgrove, Kilvey Hill, Chesterfield, Sheffield, Wharfedale, Pendle Forest.

between Waterloo Bridge and Blackfriars Bridge. Extensive programmes of studio conversion to colour are being undertaken, or are already operational, by Thames at Teddington; LWT at Wembley; ATV at Elstree; Anglia at Norwich; STV at Edinburgh; Granada at Manchester; and Harlech at Bristol.

These centres are being equipped or re-equipped not only with new colour camera chains but also with colour telecines, colour videotape machines, master controls and the many other costly items of hardware associated with high-quality colour operation. By the end of 1969 there are likely to be almost 40 colour studios, over 60 colour-capable v.t.r. machines, over 70 colour telecines, and around 15 colour outside-broadcast units engaged on ITV colour operations—with many other facilities coming into full operation in 1970 and 1971.

The plans of Independent Television for the rapid build-up of its 625-line, colour u.h.f. network can thus be seen as a striking endorsement of its belief in the future of colour television. ■

UNDERNEATH THE DIPOLE

—continued from page 227

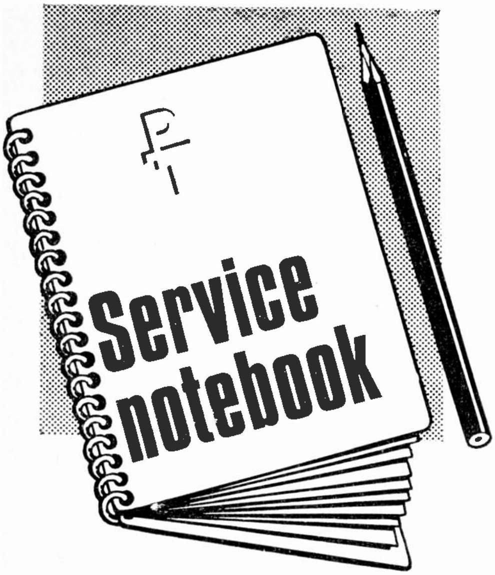
set every little refinement which didn't actually kill the patient or black the set out!

Fortunately there has been a very vocal campaign in the UK, supported by the British Society of Cinematographers, for the restoration of black-level clamping. Cinematographers in Britain were horrified at the poor reproduction by many British television sets of their excellent photography in film studios. This campaign was initiated by the British Kinematograph, Sound and Television Society, supported by the BBC and the Technical Committee of the Independent Television Companies Association. This demand from broadcasters, producers and artists for higher quality eventually affected the British standards for colour, leading to the adoption of the PAL colour system, which is transmitted on 625 lines, 50 fields—giving virtually the same amount of information as with the US 525 lines and 60 fields. The new and better British television standard on 625 lines is now transmitted using negative modulation.

US film and TV technicians to visit UK

California Here I Come used to be the signature tune of show business people on the long, long 3,000-mile train journey from New York to Los Angeles. In June this year the signature tune of 250 film and television engineers flying 3,000 miles from New York to London Airport will probably be: *UK here we come!* during the jet flight of about $6\frac{1}{2}$ hours, travelling against the time by five hours by London's Big Ben time of arrival. So they will lose about five hours of potential sleep. All this is because these engineers, mainly members of the Society of Motion Picture and Television Engineers, are proposing to attend *Film '69*, the International Film Technology Conference and Exhibition, to be promoted by the British Kinematograph, Sound and Television Society. This event will concern all the technical devices used in film production, television production, videotape and fibre optics, a new aid in all these channels.

Iconos



by G. R. WILDING

IF there is one point we constantly make in these columns it is that coil slug adjustments must be considered correct till conclusively proved otherwise. When it does become essential to make a readjustment three points must always be observed: (1) positively identify the coil function; (2) use the correct trimming tool and (3) take extra care when adjusting a slug locked by rubber or textile string. If the adjustment fails to produce the required effect return the slug to its original position.

We had a modern KB 19 in. model for service recently which gave weak line hold on both systems. This type of receiver employs a sinewave line generator—the frequency of which is controlled by a triode arranged as a variable reactance across the tuned circuit, the centre frequency being adjustable by a core on 625 while a compression trimmer and extra fixed capacitor are switched in on 405 to reduce line frequency to the lower rate.

There is a detailed manufacturer's setting up procedure for these models but we found that on adjusting the coil core, locked by a thin string, the screwdriver blade just disintegrated the core end. Fortunately on removing the chassis we found the opposite end of the slug to be accessible and although it was necessary to screw the slug in to get the adjustment we required we unhesitatingly screwed it fully out.

We fitted a new slug without the locking string and having obtained optimum adjustment applied a spot of proprietary locking compound to ensure freedom from drift. If ever faced with a jammed slug, therefore, endeavour to remove it from the opposite end even if this entails removing a second slug as in most i.f. transformers.

If the slugs have a hexagonal hole through the centre there are special trimming tools which permit a bottom slug to be adjusted after passing the tool through the interior of the top slug. Unfortunately it is mainly slugs for screwdriver adjustment that break up if tight in the core.

Three tips when it becomes necessary to alter the setting of this type of slug: (1) use only a screwdriver blade which exactly fills the slit; (2) first screw the slug down to free it from any compound seal, and (3) clean and blow out the inner threads before raising the slug. On occasion a drop of very light lubricating oil assists a tight slug.

CRT connections

Amateurs and professionals alike are sometimes confused by the multiplicity of voltage points and components found on some c.r.t. base connectors when they are investigating lack of raster with e.h.t. present or when it is impossible to sufficiently raise or lower the picture brightness level.

One point easily overlooked is that most modern tubes have two grid connections, and in some models both pins are apparently fed from a different source although in reality they are common. For instance in the Bush/Murphy connector shown (Fig. 1) the variable potential tapped from the brilliance control is fed via a 22kΩ resistor to the grid connection while a series *RC* combination feeds a flyback suppression pulse to the complementary pin. A second point is that especially in older 17 and 21in. models employing the large B12A base some of the unused pin positions, labelled N.P. in data charts, were used as anchoring points for resistors in the focusing system.

When faced with complete lack of raster with e.h.t. present I usually find it best with modern thin neck B8H tubes to first remove the base cap to positively identify which is pin no. 1—first pin clockwise after the spline—so that I can then check cathode, grid and first anode voltages with certainty. Focusing anode voltage at pin 4 has no effect on the absence or presence of a raster. Having replaced the cap I usually first check for first anode voltage since absence of potential here will always prevent raster appearance and in practice often fails due to a short-circuit in the

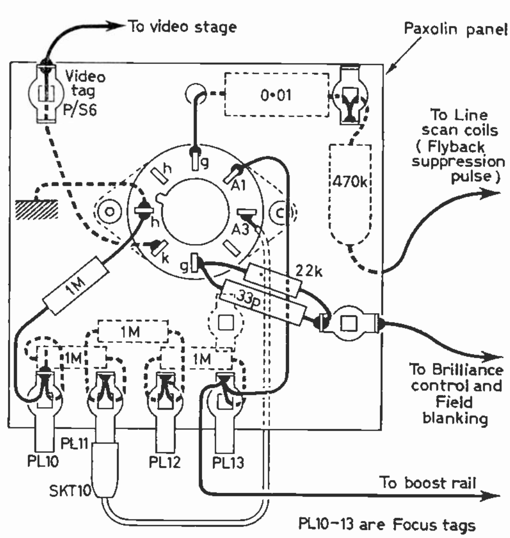


Fig. 1: Typical c.r.t. base panel connections

associated decoupling capacitor. If this first anode voltage is absent an ohms-check will then generally show a short-circuit from this pin to chassis, clinching the supposition. The capacitor is usually easy to find by following the wiring through, but a replacement must be of high working voltage since the first anode feed from the boost h.t. rail can be in the region of 500 to 700V.

Cathode video drive is almost universal practice but whereas in most models the brilliance control varies the grid voltage this is not always the case; in the Thorn 980 series for example and in some Ekco/Pye receivers the grid voltage is held constant while the brilliance control swings the cathode voltage. This system is only possible of course with capacitive video coupling between the video output valve and the c.r.t. grid. However if either the grid or cathode potential varies as the brilliance control is rotated this part of the circuit can be assumed to be in order.

If both c.r.t. grid and cathode vary simultaneously this would imply a short-circuit inside the tube and would result in uncontrollable brilliance. Any slight tendency for the cathode to follow grid voltage variation would indicate the presence of a leak between these two electrodes, causing an inability to fully black out the raster through restricting the maximum voltage swing. While tube replacement is the only cure for the former fault, in the latter case it depends on the severity of the leak and the no-signal brightness level that can be tolerated.

But, returning to complete lack of raster, having established that first anode voltage is present and that there is significant voltage on the grid and cathode pins, temporarily short-circuit these two points and note if a raster appears. If it does then either the cathode voltage is too high or the grid voltage too low at maximum brightness setting. Finding the precise fault, usually a changed value resistor, is then a simple matter if the service manual is available. If, however, shorting the tube grid and cathode pins fails to restore a raster and first anode voltage and e.h.t. are normal, then the only conclusion is that the tube is defective with an internal electrode disconnection.

Before leaving the subject of c.r.t. pin connections it is worth noting that in some tubes the focus electrode is numbered A_3 and in others A_2. In all instances however the focus anode pin is the same, pin 4, its anode number being dependent on gun construction. When the focus electrode is labelled A_2 the final (e.h.t.) anode is A_3, but when the focus electrode is A_3 the final anode assembly comprises A_2 and A_4 internally connected. To revert to the example shown (Fig. 1) it will be seen that there are four series-connected 1MΩ resistors between the boost-rail input (which also supplies the first anode) and the earthed c.r.t. heater pin. Focus adjustment is made by a miniature flying lead to one of the four panel-mounted tags to vary the potential of the focus electrode.

Width control

Width control is now almost universally by means of a stablising circuit in which a proportion of the output line scan is rectified by a v.d.r. and fed back as bias to the line output valve grid. The v.d.r. is able to rectify since the sawtooth waveform is asymmetric. The negative voltage developed, which is proportional to line output, offsets a slight positive d.c. feed supplied by the width control.

Generally speaking such circuits give little trouble in practice, the most common faults being a defective v.d.r. or a width potentiometer with badly contacting slider or with a hairline crack across the element. These small controls must always be adjusted with extreme care and with a well-insulated screwdriver since they carry very high voltages.

We had a 23in. Ferguson model recently which had insufficient width and incorporated one of these stabilising circuits. A new PL500 considerably increased line scan but still left a small margin on each side. We then advanced the width control to obtain full width, but soon after replacing the back for a final test the picture violently shimmered to a narrow strip before the e.h.t. and line whistle suddenly ceased. Ultimately we found the trouble to be a hair line crack in the width control which resulted in an excessive h.t. bleed being applied to the valve grid and v.d.r. To restore normal operation we had to replace both potentiometer and v.d.r.

These width controls must not be regarded as simply the equivalent to height controls since as well as varying the line scan they have a very marked effect on the boost h.t. voltage, e.h.t. and general line circuit operation. In most GEC/Sobell receivers for instance this line width potentiometer is referred to as the "set-boost" control and the manufacturer's drill for adjustment is first to set this to produce a minimum voltage at a selected point on the boost h.t. rail and then having adjusted the line linearity sleeve for optimum to readjust the "set boost" for 770V at this point, when width should be correct. If further adjustment is required to obtain correct width the boost rail voltage must nevertheless be within the limits of 750-790V or damage to the line output stage could be caused.

Similarly in many Philips, Stella and Cossor receivers adjustment of the width control must be set to produce a voltage of 930V at a point on the boost h.t. rail and should be set by voltage measurement whenever a valve or component in the line circuit is changed.

These controls must therefore not be adjusted haphazardly, and a necessity to set one at either extreme to obtain normal scan would almost certainly indicate a fault condition. It should be realised too that excessively advancing the control impairs the degree of stabilisation against mains-voltage variations and changing valve characteristics. The h.t. feed, monitored by the v.d.r. voltage, is usually via resistors of very high value supplied from the boost h.t. rail, and should they still further increase in value width will be restricted.

In many Philips, Stella and Cossor models these resistors comprise two 8·2MΩ and one of 1·8MΩ and whenever full width cannot be restored by valve replacement it will generally be found that one or both of the 8·2MΩ resistors is far in excess of its nominal value.

TO BE CONTINUED

DX-TV

A MONTHLY FEATURE
FOR DX ENTHUSIASTS

by Charles Rafarel

THERE has of course been little or no SpE activity during the present period and what openings there have been were of very short duration. It seems an awfully long time to have to wait for the return of better SpE—about April/May 1969. On a happier note I would like to try a long range forecast: I feel pretty confident that once the sun-spot maximum of this year has passed we can look forward to improved SpE in 1969, but in any case I feel that we can scarcely have another season as bad as the last one!

There have been a few interesting moments in the current period of 11/11/68 to 13/12/68 to relieve the monotony of gazing at a blank screen. However these were not SpE, the only true SpE being USSR R1 on 20/11/68.

The first interesting period was 15 to 19/11/68 when there was significant Leonid Meteor shower activity. The peak here appeared on the 15th, with frequent bursts of USSR and Czech R1 signals and later in the day Spain E2 and E3 as well. The Czech and USSR signals also came in on the following three days, often at very great strength indeed.

The second event was from 10/12/68 to 13/12/68 and is in fact continuing as I write these notes. The USSR forward-scatter network between 35Mc/s and 40Mc/s is extremely active, with the usual counting of Russian numerals. I feel that a new Russian space shot, possibly a Lunar one, may well be on the way very soon, and may be a manned one!

Once again the Trops have taken odd steps forward only to drop back again to their now usual poor state. The best days were 28/11/68 and 2-3/12/68. The log here included 10 French u.h.f., plus a new one, Bourges Ch.26. There was even a weak unidentified West German one as well on Ch.26, and that is almost a miracle these days!

Maurice Opie had some fine reception here in Bournemouth on 2-3/12/68. Apart from the usual French lower frequency u.h.f. channels he had Metz Luttages Ch.34, Le Havre Ch. 43, Rennes Ch. 45, Limoges Ch. 50, and ? Cherbourg Ch. 59; all these on an unusual aerial as well, an omni-directional horizontal Band I X array. This is very interesting: it must resonate on part of the element only. I have a group A 2×23 element array myself and I find that the performance drops off sharply above Ch.40. Maurice is putting up a u.h.f. array soon but I really wonder if there will be a marked improvement.

The predictions for sun-spot activity received from Roger Bunney: the "counts" are as follows, Dec. 1968 102, Jan. 1969 100, Feb. 1969 98, Mar. 1969 96, Apr. 1969 94, May 1969 92. So my DX friends it is now or very soon if you are going to get anything before the next maximum in 11 years time!

NEWS AND REPORTS

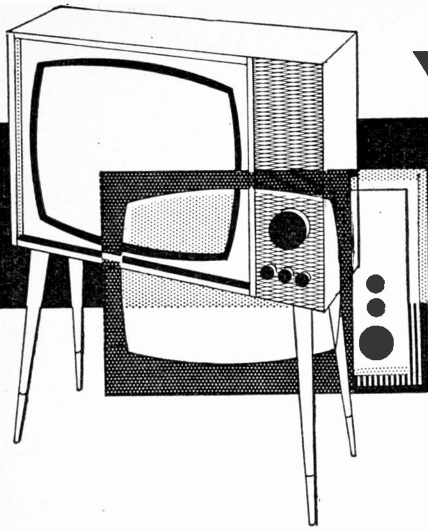
We do however have some F2 DX-TV news. This is a report from R. Ballardie of Dalry, Ayrshire, Scotland of reception of a 525-line 60-field image on Ch.A2 at 12.10 a.m. on 1/11/68. Before this he notes that there was a rumbling on the sound from the TV and black bars appeared on the screen. There was Aurora activity in his area at the time. This is typical of trans-polar Auroral propagation, and when he finally resolved the image it was with his aerial pointing to the North. The image was of a man, followed after five minutes by a test card. This appeared only momentarily and weakly so he could only give us the briefest of details. However I am convinced that they are enough for us to identify the card as the USA bulls-eye type as shown in our Data Sheet No. 21 and the reception must have been of an American station. It is of course much more difficult to say which one, but whatever it was he deserves our heartiest congratulations.

From farther afield Bob Cooper in the Virgin Islands (via R. Bunney) reports the reception of Argentine Ch.A2, Brazil A2, A3 and A4 and Peru A2. These were received by trans-equatorial skip; the images were very garbled though very strong at times. He says concentrate on the sound channels if you want to identify, so now you know!

A Hollywooa USA DXer J. Stiles says he has had Korea TV on two occasions, Philipines Cebu City A3 on 15/8/68, and Iran Teheran A3 test pattern on 26/8/68. Even more startling is his claim for WSJV/TV on u.h.f. Ch.28. I do not know the location of this one but he states that the distance is 1,822 miles away!

There is another new paging station in the USA, Republic KCC266, frequency not yet known.

Following my comment that we do not get many reports from the Midlands we now have one from I. Singh Jabbal of Northampton. He started DX-TV in 1967 with a converted Bush Model TV53 and has now got a 625-line export set which gives him sound and vision together under favourable conditions. During his two years of reception he has had Spain 1st and 2nd chains, France, Belgium, Austria, USSR, Czechoslovakia, Poland, East and West Germany, Norway and Sweden. Like all of us, he is complaining about poor conditions this year, but he received all the above stations on a vertical domestic aerial!



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 page 236 must be attached to all Queries, and a stamped and addressed envelope must be enclosed.

PYE VT7

The sound on this set is perfect but there is no e.h.t. or picture. The EY51 is not lighting up but all the other heaters are. All the fuses are intact and all the valve voltages seem to read O.K. except the MW 43-69 tube pin 10 on which there is no voltage (according to the Pye service sheet this should read 452 volts). There is no spark from the line output transformer with the EY51 disconnected.

On examination of the width and linearity coils they seem to be attempting to fall apart when touched, the outer layers of the enamelled windings being loose. Could I not tighten these up a little and perhaps give a coat of shellac varnish?

I cannot hear a line whistle, but when I put my transistor portable set on top of the TV tuned in to the light programme on long wave, I hear it then (or is it?) and it alters when line hold is altered but screen is blank all the time, no raster no life.—L. J. Aitken (Hampshire).

A faulty line output transformer is indeed the most probable cause of your fault. A good coating of shellac varnish should be sufficient to protect the width and linearity chokes.

PHILIPS 1768U

The h.t. is on the low side. I wish to replace the present PY82 valves with a BY100 rectifier. Probably the valve emission is down and a BY100 may give the h.t. a slight boost—A. Stewart (N. Ireland).

We do not wholly agree with the use of a silicon diode (BY100) in a receiver which has been used to the slow rise of h.t. as given by valves. We would prefer to see a new pair of PY82 valves used.

However, the circuit is quite simple. pins 9 on each valve base are joined, the BY100 is wired from pin 9 to h.t. with pin 3 disconnected on each base.

COSSOR 948F

I have trouble with the line output transformer. Instead of getting the spark on the output wire to the anode of the tube, I get the spark on the glass casing of the rectifier valve EY86 the filament of which does not light up.—J. Hughes (Anglesey).

You may have an open circuit EY86 heater (check with battery), or a short circuit cathode ray tube in which case disconnecting the c.r.t. anode lead will light up the EY86. Check also the valve holder and e.h.t. filament winding on the line output transformer.

DECCA DM45

At first the picture was very bright and it was impossible to darken it with the brightness control. It did not seem to alter at all and the sound was unaffected. I noticed valve 14 (EB91) was not alight, so I changed it but this made no difference. A week or so later the picture went off and now there is just a thin white line across the centre of the screen. Also the sound seems to have deteriorated.

If I switch off ITV and BBC some valves go out and No. 14 (EB91) lights up but the thin white lines goes out. I have changed valves EF80, EB91, PCL84, PL84, ECL80, also No. 17 PY82.

The outer casing on C53 is cracked and the cap on one end of R95 is loose; could these have anything to do with the trouble?

The line whistle is there.—J. Wilkes (Sheffield).

Regarding the brilliance, no control suggests that one of the two capacitors in the brilliance circuit has shorted. Check from pins 2 and 6 of the tube base and the centre tag of the brilliance control to these capacitors on the panel behind the controls. For the white line fault check the correct position of the PCL84, ECL80 and PL84.

Check the capacitors associated with the ECL80 and PL84 valves.

HMV 1847

I have converted this receiver to receive BBC-2 using a Philips u.h.f. conversion kit as used in the Philips 19TG/23TG121A range of receivers and which I believe is numbered 89 384. I have, however, not been able to obtain an alteration in the line flyback velocity which is too low resulting in part of the picture being smeared across the left of the screen. How, if possible, can the line flyback be speeded up?

I appreciate that a speed up will result in a rise in e.h.t. voltage and can you tell me if anything can be done about this. Finally could you please tell me where I can obtain the reference voltage for the flywheel sync of the line timebase. —C. Kennedy (Newcastle upon Tyne 3).

To speed up the flyback you will have to change the line oscillator transformer or connect for multivibrator operation. A reference voltage can be obtained from the orange or yellow lead of the L.O.T. via a high voltage capacitor.

FERGUSON 3618

The following fault occurs only on BBC-2.

A u.h.f. tuner was fitted to this set. The picture on BBC-2 was never very stable and suffered from occasional slip. The picture quality, however, is excellent with my 18 element 30ft. high aerial. The picture slip was getting progressively worse finally with intermittent rapid slipping and tearing. Also, in between unstable periods when the picture seemed to be stationary it was somewhat floating about slowly in a snake-like manner as if there was a slight sinusoidal modulation superimposed on the vertical lines.

On replacement of the PCL84 valve there was some improvement in stability although the above sinusoidal floating persisted with progressive worsening in the matter of weeks back to intermittent slipping and tearing. I replaced three PCL84s in this manner. This was on an advice that if the above valve takes grid current the instability would result on BBC-2.

Recently I was told that early sets of the above model which were sold without u.h.f. tuners fitted suffered with the above fault when the tuners were fitted. I was advised that a simple modification to the circuit was curing this fault. Would you please advise on this modification.—A. Golawski (Cheshire).

The modification is C21 to 1μF with the positive end to L17. Reduce the value of R22 to 470Ω if necessary and change the value of C23 if any traces of instability remain.

EKCO 293T

Since fitting two new tuner valves and a new diode booster, I have recovered a moderate picture and sound in ITV Channel 9, but a poor one on BBC Channel 3. The fine tuner does not work and the picture rolls continuously, the usual adjustments being ineffective.

The line transformer (T1) shows burning and the green insulation has fallen off. Could this the fault?—J. Condliffe (Devon).

The burning of the insulation of the line output transformer does, indeed, indicate that it is about to fail. This however may not be the cause of your poor sensitivity, which could be in either the tuner or the early i.f. stages. If much 'snow' is apparent on the screen, we advise you to suspect your aerial system, particularly the two capacitors behind the aerial panel on the receiver.

EKCO T221

The sound is O.K. There is no raster.

I have replaced L.O.P.T., U25, U301 and 20P4 with no success. When I unplug the scan coils from the chassis the U25 lights with line whistle. —A. W. Harrison (Lincolnshire).

Your fault is apparently within the deflector coils, which may be breaking down to chassis. On some models a lead is provided through the multiway connector to earth the cathode ray tube cradle to chassis itself. This could be disconnected as a quick check.

STELLA ST1007U

The top winding on the longest section of the mains dropper has burned out. Could you please advise on a resistor to put between R108 and R107?—T. Bromelow (Lancashire).

You can fit a 33Ω 15W resistor across the top two of your mains dropper to replace the burnt out R108.

REGENTONE 193

This set has a good raster, very good sound but no picture. All valves are O.K. — W. Hunter (Co. Durham).

Check the 18kΩ resistor from pin 9 of the PCL84 (R24) to pin 7, the 220Ω (R23) to chassis and the 22kΩ resistor from h.t. to pin 9 (R5). If these are in order as is the PCL84, check the chokes to pin 8 (continuity) and the voltages to V2 (EF80) pins 7 and 8. Check the OA70 in the i.f. can if necessary.

PHILCO 1000

The picture is not very clear because there is a double image spaced about ¼in. A good picture can be obtained by adjusting the tuner but then the sound is reduced and a loud hum appears. I have tried adjusting with a knitting needle inside the turret tuner but cannot cure the fault. The valves are in good order.—R. James (Glamorgan).

You will have to realign the i.f. coil cores on the deck. If you do not have a signal generator, adjust the fine tuner for the best picture detail and then align the sound i.fs. for maximum sound (left side).

FERGUSON 306T

The sound is good and vision is obtained but the picture cuts out, leaving the screen blank.

This happens after an hour or two but the picture can be restored by switching off and then on. After a short while it cuts out again.

When the screen is blank, the brightness control seems to work in reverse, the screen getting brighter as the set is turned off. I have replaced all the valves in the line circuit.—H. Wilkinson (London, N.9.).

The fault symptoms indicate that the tube cathode voltage falls drastically when the fault occurs.

This may well be due to a heater-cathode short in the tube; possibly, however, a vision i.f. instability fault. In the former case, tapping the tube neck should indicate that the fault is here; in the latter case, shorting the video grid to the chassis should restore normal control of brilliance.

EKCO TC178

I can obtain a raster but no picture or sound. I have replaced two tuner valves but with no success.—A. Massey (Manchester).

Ensure that the tuner unit valves occupy the correct positions. Check the h.t. feed resistor to the tuner unit.

MURPHY V929U

The picture on this set does not reach full width. There is a black band at least 1in. wide at both sides of the screen. As the set warms up, the width of the bands reduces but they do not disappear.—G. Boardman (Cheshire).

We advise you to replace the PL36 line output valve for a complete cure of the fault.

QUERIES COUPON

This coupon is available until FEBRUARY 21, 1969, and must accompany all Queries sent in accordance with the notice on page 234.

PRACTICAL TELEVISION, FEBRUARY 1969

TEST CASE -75

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 Bush Model TV108 with no raster and very little e.h.t. voltage and pulse voltage at the e.h.t. rectifier anode gave all the usual signs of a satisfactory line drive signal by a pronounced negative reading on a high-resistance voltmeter connected between the control grid of the PL36 line output valve and set chassis. In TV servicing circles a strong negative voltage at the line output valve control grid is taken as a fair indication that the valve is receiving drive from the oscillator, and further proof is given by the reading falling to zero or near when the line oscillator is temporarily muted. A double-triode ECC82 is arranged as a line multivibrator in this Bush model, and sure enough the negative voltage diminished when oscillation was stopped by shorting the cathode coupling resistor of the oscillator.*

It was thus assumed that the fault resided somewhere in the line output stage, and extensive tests were made in this department of the set without any success, including replacing the line output valve, boost diode, boost reservoir capacitor and other vulnerable components.

There was one important aspect of the functioning of the line timebase overlooked by the technician handling this fault. What was it? See next month's PRACTICAL TELEVISION *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 74

Page 188 (last month)

When all the usual causes of sound distortion have been cleared attention should immediately be directed to the sound interference limiter. This is generally a series diode which is biased-on by a high-value resistor between its anode and the h.t. line. Short-duration interference pulses above normal sound signal amplitude block the diode so that the pulses are removed from the sound channel. If the biasing resistor increases in value for some reason or other the diode will clip all signals, including the wanted audio, and bad sound distortion results.

This, in fact, was the trouble with last month's Ferguson receiver, the resistor at fault being the 2.7MΩ, R91. As the set warmed up the resistor value progressively increased and the experimenter found that it was virtually an open-circuit after several hours' operation in the set. Its replacement completely cured the symptom.

Published on or about the 22nd of each month by IPC MAGAZINES LIMITED, Tower House, Southampton Street, London, W.C.2 at the recommended maximum price shown on the cover. Printed in England by Fleetway Printers, 17 Sumner Street, London, S.E.1. Sole Agents for Australia and New Zealand: Gordon & Gotch (A/sia) Ltd. Subscription rate including postage for one year: To any part of the World £1 15s.

Practical Television Classified Advertisements

The pre-paid rate for classified advertisements is 4/- per line (minimum order 12/-), box number 1/- extra. Semi-displayed setting £2 10s. 0d. per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL TELEVISION and crossed "Lloyds Bank Ltd." Treasury notes should always be sent *registered post*. Advertisements, together with remittance, should be sent to the Advertisement Manager, PRACTICAL TELEVISION George Newnes Ltd., 15/17 Long Acre, London, WC2, for insertion in the next available issue.

SITUATIONS VACANT

ENGINEERS. A TECHNICAL CERTIFICATE or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C. Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.). City & Guilds, A.M.I.M.I., A.I.O.B., and G.C.E. Exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto., Electronics, Radio, Computers, Draughts, Buildings, etc. For full details write for FREE 132 page guide: BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, (Dept. 171K), Aldermaston Court, Aldermaston, Berks.

RADIO AND TV Exams and Courses by Britain's finest home study School. Coaching for Brit. I.R.E., City and Guilds Amateur's Licence, R.T.E.B., P.M.G. Certificate etc. Free brochure from British National Radio School, Russell Street, Reading.

EDUCATIONAL

TV and RADIO, A.M.I.E.R.E., City & Guilds, R.T.E.B., Certs., etc. on "Satisfaction or Refund of Fee" terms. Thousands of passes. For full details of exams and home training courses (including practical equipment) in all branches of Radio, TV, Electronics, etc., write for 132-page Handbook—FREE. Please state subject. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 172K), Aldermaston Court, Aldermaston, Berks.

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. home-study courses in radio, TV servicing and maintenance. T.T.E.B. City and Guilds, etc., highly informative 120-page Guide—FREE. CHAMBERS COLLEGE (Dept. 858K), 148 Holborn, London, E.C.1

TRAIN FOR SUCCESS WITH ICS

Study at home for a progressive post in Radio, TV and Electronics. Expert tuition for City & Guilds (Telecoms Techn's Cert. and Radio Amateurs') R.T.E.B., etc. Many non-exam courses incl. Closed circuit TV, Numerical control & Computers. Also self-build kit courses—valve and transistor.

Write for FREE prospectus and find out how ICS can help you in your career.

ICS, DEPT. 560, INTERTEXT HOUSE, LONDON, SWII.

TECHNICAL TRAINING

CITY & GUILDS (electrical, etc.) on "Satisfaction or Refund of Fee" terms. Thousands of passes. For details of modern courses in all branches of electrical engineering, electronics, radio, TV, automation, etc., send for 132-page handbook—FREE. B.I.E.T. (Dept. 173K), Aldermaston Court, Aldermaston, Berks.

FOR SALE

VALVE CARTONS at keen prices. Send 1/- for sample and list. J. & A. BOXMAKERS, 75a Godwin Street, Bradford 1.

TOP TRADE DISCOUNTS FOR ALL COMPONENTS VALVES TUBES TRANSISTORS

Free Trade Catalogue
Engineers & Service Dealers Only

WILLOW VALE,
THE SERVICE DEPT.
WHOLESALERS,
4 The Broadway, Hanwell,
London, W.7
01-567 5400/2971

WANTED

SERVICE SHEETS purchased, HAMILTON RADIO, 54 London Road, Bexhill.

DAMAGED AVO Meters, Models 7 and 8. Also damaged Meggers, any quantity, send for packing instructions. HUGGETTS Ltd. 2/4 Pawsons Road, West Croydon.

WANTED—Popular Brand New Valves—R.H.S., Stamford House, 538 Great Horton Road, Bradford 7.

NEW VALVES WANTED. Popular TV and Radio types. Best cash price by return. DURHAM SUPPLIES, 367A Kensington Street, Bradford 8, Yorkshire.

WANTED new valves, television, radiograms, transistors, etc. STAN WILLETTS 37 High Street, West Bromwich, Staffs. Tel: WES 0186.

RADIO AND TV Servicing, Volumes 1962–63, 1963–64 & 1964–65. Box No. 71.

SERVICE SHEETS

SERVICE SHEETS. Radio, T.V., 5,000 models. List 1/6. S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

BY 100s, 3/9 each; 3 for 10/-, with Free Surge Resistors, Lesmar, 15 Conholt Road, Andover, Hants.

SERVICE SHEETS
RADIO, TELEVISION, TAPE RECORDERS 1925–1968 by return post, from 1/- with free fault-finding guide.

Catalogue 6,000 models, **2/6d.** Please send stamped addressed envelope with all orders/enquiries.

HAMILTON RADIO
54T London Road, Bexhill, Sussex.

RADIO, TELEVISION over 3,000 models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Road, London W.6. SHE 8441.

SERVICE SHEETS with Free Fault Finding Chart, 4/6d. S.A.E. Lesmar, 15 Conholt Rd., Andover, Hants. (Mail only.)

C. & A. SUPPLIERS
SERVICE SHEETS
(T.V., RADIO,
TAPE RECORDERS,
RECORD PLAYERS
TRANSISTORS,
STEREOGRAMS,
RADIOGRAMS)

Only 5/- each, plus S.A.E.

(Uncrossed P.O.'s please, returned if service sheets not available.)

71 BEAUFORT PARK
LONDON, N.W.11

We have the largest supplies of Service Sheets (strictly by return of post). Please state make and model number/alternative.

Mail order only.

SETS & COMPONENTS

150 NEW ASSORTED Capacitors, Resistors, Silvered Mica, Ceramic, etc. Carbon, Hystab, Vitreous, ½-20 watt, 12/6. Post Free. WHITSAM ELECTRICAL, 33 Drayton Green Road, West Ealing, London, W.13.

SETS & COMPONENTS *(continued)*

TELEVISION TUBES

Large stocks of television tubes, London's leading wholesale suppliers, all tubes complete with guarantee card. By return despatch
Terms: Cash with order, s.a.e. all enquiries.

14in. types. AW36/20, AW36/21, AW36/80, MW36/24, CRM141, CRM144, CME1402 etc.	£4 17 6
17in. types. MW43/80, AW43/80, CRM173, CME1702, MW43/69, CRM172, AW43/88, AW43/89, CME1703, CME1705 etc.	£4 17 6
19in. types. AW47/90, AW47/91, CME1901, CME1903, CME1902, C19AH	£4 19 6
21in. types. AW53/88, AW53/89, CME2101, CME2303	£6 12 0
MW53/80, AW53/80, MW53/20, CRM211/2	£8 18 10
23in. types. AW59/90, AW59/91, CME2301, CME2303	£6 12 0
23in. Twin Panel. CME2306, A59-16W	£13 1 0
23in. Panorama. A59/11W etc.	£12 0 0
19in. Twin Panel. A47-13W, CME1906 etc.	£10 1 0
19in. Panorama. A47/11W etc.	£9 0 0

Many other types in stock including G.E.C. and Brimar types. **Carriage and Packing** 12/6d. per British Road Services.
Large stocks of valves, transistors and components. Electrolube, Servisol switch cleaner, Multicore solder. Service Tools etc.

WILLOW VALE ELECTRONICS LTD.

The Service Dept. Wholesalers, 4, The Broadway, Hanwell, London, W.7 Tel: 01-567 2971/5400

CATALOGUE TRADE ONLY. S.A.E. Please

BOB'S BARGAINS. 10 assorted your choice 14/6. 100 assorted £5-10-0. PCF80 PCC84 PL81 PL36 PY81 PCL82 PCL83 EF85 U191 U301 30F5 30P12 PY33 PY32 PY82 EB91 ECL80 ECC82 EBF80 EBF89 6BW7. The following valves only at 12/6 per doz. EF80 EY86. All valves tested. 3 BY100 type rec. with surge res. 9/- p. & p. 6d. New 25k ohm w.w. controls 2/- p. & p. 6d. EKCO U25 type plastic .o.p.t. housings 12/6 p. & p. 2/-. Mail Order Only. 2 St. James St., Rawtenstall, Rossendale, Lancs.

THIS MONTH'S SCOOP!

CRM 141, CRM 142, CRM 153

NEW BOXED MAZDA

57/6d. (Carr. & ins. 12/6d)

TELEVISION TUBE SHOP

48 Battersea Bridge Road, S.W.11

R & R RADIO

51 Burnley Road, Rawtenstall

Rossendale, Lancs

Tel.: Rossendale 3152

VALVES BOXED, TESTED & GUARANTEED

EBC41	4/6	PCC84	3/-	PY82	3/-
EBF80	3/-	PCF80	3/-	U191	4/6
EBF89	3/6	PCF82	3/6	6F23	5/-
ECC82	3/-	PCL82	4/-	30F5	2/6
ECC83	4/-	PCL83	4/-	30L15	5/-
ECL80	3/-	PCL84	5/-	30P12	4/6
EF80	1/6	PL36	5/-	30C15	5/-
EF85	3/-	PL81	4/-	30PL13	5/6
EF183	3/6	PL82	4/6	30PL14	5/6
EY86	4/-	PL83	4/-	50CD6	7/6
EL41	5/-	PY33	5/-		
EZ40	4/6	PY81	3/6		
		PY800	3/6		

POST ONE VALVE **9d.** TWO TO SIX **6d.** OVER SIX POST PAID.

AW43/80 **£2,** MW43/69 **30/-,** AW59/90 **£5.**

EX N.E.V. C.C.T.V. Camera and Monitor Circuits, S.A.E. for list. LOWE, 35 Hensley Point, Hackney, London, E.9.

BARGAIN PARCELS

10—13/-, 20—24/-, 100—£5 FROM THE FOLLOWING LIST:—

ECC82, ECL80, EBF89, EF80, EF85, EF91, EB91, EY86, PCC84, PCF80, PCL82, PCL83, PL36, PL81, PL82, PL83, PY33, PY81, PY82, 6-30L2 30FL1, 30F5, 10F1.

S. ASHWORTH

9 MANDEVILLE TERRACE, HAWKSHAW, VIA BURY, LANCS.

LOOK! Nearly every type in stock now!!

NEW TELEVISION TUBES!

TWO YEAR FULL REPLACEMENT GUARANTEE

SEE THE DIFFERENCE A NEW TUBE CAN MAKE TO YOUR VIEWING—LATEST SCREENING TECHNIQUES INCLUDING TINTED SCREENS ON 19″ & 23″ TYPES

Large stocks by Cathodeon & other leading manufacturers so why buy ordinary rebuilds? Colour tubes available!

12″ £3 0 0 (not 110°) 14″ to 16″ (not 110°) £4 15 0
17″ £5 15 6 19″ 1901 & 19AH £7 10 0

Other 19″ mono tubes—all £6 17 6. Carriage all 12/-. Most 21″ mono tubes—£7 15.0 23″ mono tubes £9 10 0. Carriage 15/-.

RIMBANDS, 19″ £8 10 0; 23″ £11 10 0
TWIN PANELS, 19″ £9 17 6; 23″ £12 10 0 Carriage 20/-

Bulk enquiries welcomed, special terms.

LOOK! BVA VALVES

Vast selection available. Slightly dearer than most valves but worth the extra cost! SAE for lists.

For example:—PY81/800, EF80, PL84 8/3, PL81, PCF80, PCL82, 4, 5 10/3, PCC89, PCL83, PCF86 12/3 PL36, 30 P19, 30FLI 12/9 PFL200, U25, U26 14/9 etc.
Also introductory offer post paid, **LATEST** higher rating BY100 & 33 ohm res, 4/-
Also lists smoothing condensers etc.

PHILIP H. BEARMAN

(Suppliers to H.M. Govt. etc.),

6 POTTERS ROAD, NEW BARNET, HERTS.

Closed Thurs & Sat afternoons **TEL. 449/1934 & 7873** **(Robophone Service)**

SETS & COMPONENTS
(continued)

TELEVISION TUBE SHOP

ALL THE LATEST NEW TUBES AT REDUCED PRICES

A28-14W	£11. 0.0
A47-11W	£19.19.6
A47-13W	£10.18.6
A47-14W	£7.12.6
A59-11W	£12.19.6
A59-13W	£13.10.0
A59-15W	£9.10.0
A59-16W	£13.10.0
AW21-11	£10.10.0
AW36-20, 21	£5.12.6
AW36-80	£5. 7.6
AW43-80	£6. 7.6
AW43-88, 43-89	£6.12.6
AW47-90, 91	£7.10.0
AW53-80	£8.12.6
AW53-88, 53-89	£8. 5.0
AW59-90, 59-91	£8.15.0
C17BM, FM, HM	£6. 7.6
C17LM, PM, SM	£6.12.6
C21HM, SM, TM	£7.17.6
CME 1201	£12.10.0
CME1601	£10. 5.0
CME1702, 1703	£6.12.6
CME1705	£7. 7.0
CME1901, 1903	£7.10.0
CME2101, 2104	£8. 5.0
CME2301, 2302	£8.15.0
CME2306	£13.10.0
CRM93	£5.10.0
CRM124	£5.10.0
CRM141, 2, 3, 4	£5. 2.6
CRM171, 2, 3	£6. 7.6
CRM211, 212	£8.17.6
MW36-24, 44	£5. 2.6
MW43-64, 69	£6. 7.6
MW43-80	£6. 7.6
MW53-20	£8.17.6
MW53-80	£8.17.6
7405A	£6.12.6
TSD217, 282	£10.10.0

All tubes tested before despatch and guaranteed for 12 months.

Re-processed tubes also available at reduced prices.

CARRIAGE 10/-, via B.R.S. or 15/- via passenger train. Add 2/6 for Comprehensive insurance.

Midland Stockists:—

Amateur Electronics,
518/520 Alum Rock Road,
Birmingham 8

TELEVISION TUBE SHOP

48 BATTERSEA BRIDGE ROAD
LONDON S.W.11. BAT 6859

WE GIVE GREEN SHIELD STAMPS

SETS & COMPONENTS
(continued)

TOWERBY LTD

For Line Outputs and Deflector Coils

We have the Country's largest stock of Manufacturer's Original (or Authorised Replacement) Line Output Transformers for many "difficult" makes, including **Ambassador, Baird, Cossor, Decca, Dynatron, Ekco, Ferguson, G.E.C., H.M.V., KB., Masteradio, Peto-Scott, Philips, Regentone, RGD, Sobell, Ultra,** etc. Also deflector coils output and oscillator transformers, inc. **Alba, Bush, Murphy.** Examples, L.O.P.T. **Murphy** 310/350/410/540/659/759, **117/-; Bush** TV80 **117/-**, TV22 & 24, **78/6; Cossor** 950 **77/6; Ferguson** 306/308 **79/6; Philips 1768U** L.O.P.T. assembly **122/6; Ultra** 1984-200c **101/3.**
Rewind most L.O.P.T. **90/-.**

SPECIAL OFFER

Ekco improved type for Models T221, 231, 310 all at **45/-; Ferranti** 14T4 series inserts **25/-; Philco** 1019/1021 **52/6.** Terms: C.W.O. or C.O.D. (3/6) post/packing 6/-; 2 or more L.O.P.T.s post/packing free.
All enquiries answered but regret no lists available. Same day delivery on most types.

TOWERBY LTD

MAIL ORDER DIVISION OF T.C.S. LTD.
70 STREATHAM HILL, LONDON, SW2
Tel: 01-674 2185.

BY100 TYPE 6 for 10/-.
SUPER SILICON RECTIFIERS
TV etc., 1200 PIV, 800 MA 5/- or complete with instructions, resistor, condenser 6/6, 400 PIV.H.W. 6 Amp 6/-, 200 PIV.HW 6 amp 6/-, 14RA1282/FC101 7/6, 18RD2281/FC124FW 13/6, EC1 12/6, EC2 12/6, 30v. 250mA. FW 7/6, 250v 100mA FW Grundig 12/6, FC116 7/6.
Equivs for RM4 9/6, 14A97 13/6, 14A86 10/6, 14A100 10/6, RM3 3/-.
F.W. 12 volt 1A 5/-, 2A 7/-, 4 amp 10/6.
CHARGER 4 Amp 12/6/2 volt 21/6. Plus 3/- P. & P.
TRANSFORMER
LINE O.P. TRANS; All 30/- each.
Cossor 948, KB Queen, Peto Scott 1920, 1726, 1729, 1730, Murphy V350 and V230, Philips 1446U/45 and 1746U/45 with EY51.
MULTIMETERS from 32/-.
Stamped envelope for full latest selection and bargain offers in **CHEAP METERS, RADIOS, BABY ALARMS, INTERCOMS, WALKIE-TALKIES, SINCLAIR & EAGLE.** Under £1 P. & P. 6d. Over £1 Post free. No C.O.D.
MAIL ORDER ONLY

DURHAM SUPPLIES

367A KENSINGTON ST., BRADFORD 8, YORKS.

WITWORTH TRANSFORMERS LTD.

Dept. P.T., 26 All Saints Road, North Kensington, W.11
Telephone: 01-229 9071. 9 a.m. till 5 p.m.

TELEVISION LINE OUTPUT TRANSFORMERS

PRACTICALLY ANY MAKE OR MODEL SUPPLIED OR REWOUND

EKCO, FERRANTI, DYNATRON
Replacement cases **16/-** each, please state model.

S.A.E. for return of post quotation.
TERMS: Cash with order or C.O.D., please add **4s.** for postage.

C.O.D. orders will be charged **6s.**
Transformers fully guaranteed. *(98*

SETS & COMPONENTS
(continued)

VALVE BARGAINS

ANY 5—9/-, 10—14/-, 100—£5-10.

FROM THE LIST BELOW

ECC82, ECC83, ECL80, EF80, EBF89, EF91, EB91, EF85, EF184, EF183, EY86, PCC84, PCF80, PCL82, PCL83, PCL84, PL36, PL81, PL82, PL83, PY32, PY33, PY81, PY82, PY800, 30PL14, U26, U191, 6-30L2, 30FL1, 30P4, 30P12, 30PL1, 30F5, 20L1, 10F1, 20D1.

P. & P. 1/-.

MANY OTHER TYPES OF TV VALVES IN STOCK.

3 BY100 TYPE RECTIFIERS 10/-

VELCO ELECTRONICS

49 Bridge St., Ramsbottom, via Bury, Lancs.

AERIALS

TV AERIALS

Band I. H. Mast Fitting	£1 15 0
Band III. 5 Ele Mast Fitting	£1 10 0
Band I/III. S/D and 4-Array	£1 15 0
Band IV. 10 Ele Array	£1 10 0
Band IV. 18 Ele Array	£2 18 6

Lashing Kits from **10/-**; Poles, Co-ax **9d.**, Grade "A" **1/6.** Plugs **7d.**

P. & P. 7/6. C.W.O., S.A.E. for list.

TELEINDUSTRIES LTD.
BREAKSPEAR ROAD, RUISLIP, Middx.

MISCELLANEOUS

CONVERT ANY T.V. Into an Oscilloscope. Instructions $2. REDMOND, P.O. Box 38397, Los Angeles, California 90038.

D.I.Y. TELEREPAIRS. Forward your fault query for an immediate analysis by our team of experts. Make and Model No. with full description of fault together with P.O. or cheque for 10/-, to 48 Armson Avenue, Kirby Muxloe, Leics.

Please mention

PRACTICAL TELEVISION

when replying to

ADVERTISEMENTS