# TELEVISION

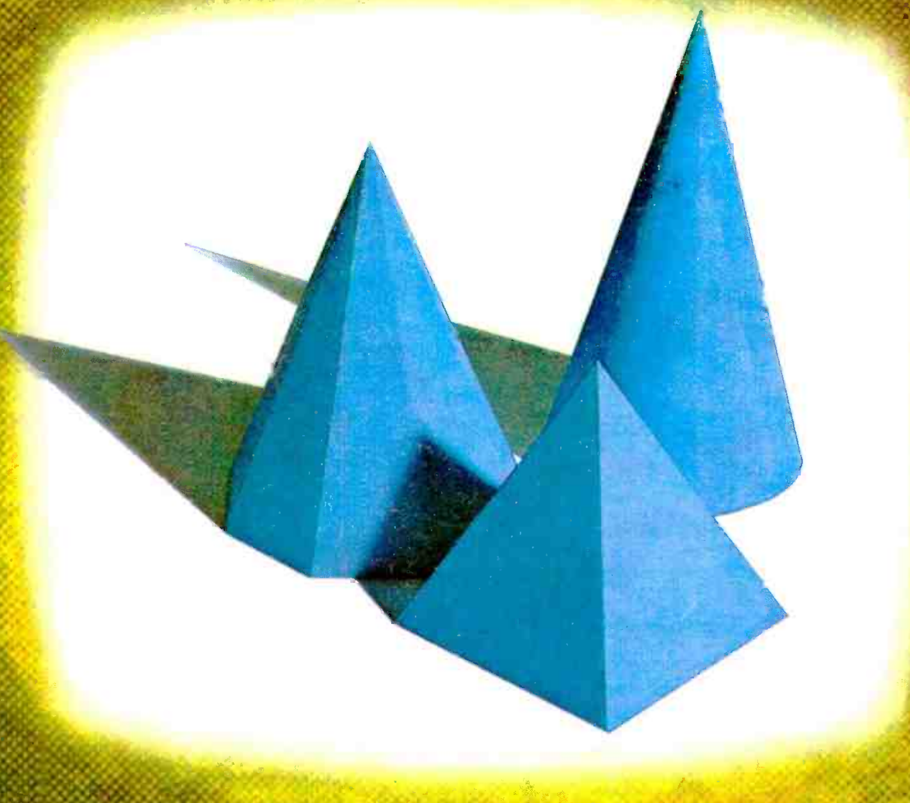
3'6 (17½ new pence)

JANUARY 1971

SERVICING · CONSTRUCTION · COLOUR · DEVELOPMENTS

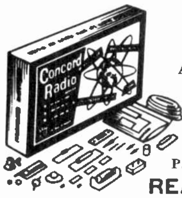

## HOLOGRAPHY

### 3-DIMENSIONAL DISPLAY



also SYNCHRONOUS DETECTORS • BAND III PREAMP

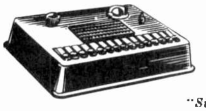
SERVICING THE BAIRD 620–640 SERIES




## MAKES 4 DIFFERENT RADIOS + AMPLIFIER Limited Quantity

Amazing Radio Construction set! Become a radio expert for 39/6 **39'6** A complete Home Radio Course. No experience needed. Parts including instructions for each design. Step-by-step plan, all Transistors, loud speaker, personal 'phone, knobs, screws, etc., all you need. Presentation box size 14" × 10" × 2" 5/6 extra (parts available separately). Send only 39/6 + 4/6 P. & P. Money back guaarnteed.

## REAL WORKING ELECTRONIC ORGAN



ONLY **55'-**

*Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds etc.* Eight months were spent in creating and testing this superb, revolutionary electronic organ. Fully transistorized—no valves. **Proper self-contained loudspeaker.** *Fifteen separate keys span two full octaves*—play the *"Yellow Rose of Texas,"* play *"Silent Night,"* play *"Auld Lang Syne,"* play *lots and lots of similar tunes* on this real working electronic organ. Although it's no theatre organ it's certainly no tiny thing, it measures 13¾" × 10" × 2½". Uses standard battery. You have the thrill and excitement of building it together with the pleasure of playing a real, live, throbbing electronic organ. *Take it anywhere—play it anywhere.* **NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED—NONE WHATEVER.** No soldering necessary. **Anyone from nine years upwards can build it easily in one short evening** following the fully illustrated, step-by-step, simply worded instructions. **BIG DEMAND ANTICIPATED FOR THIS UNIQUE INSTRUMENT** at our low, low price. **ONLY 55/-** + 4/6 P. & P. for all parts, including case, loudspeaker, transistors, condensers, resistors, knobs, transformers, volume control, wire, nuts, screws, simple (but full) instructions, etc. etc. (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone Money back guarantee.

## EAVESDROP ON THE EXCITING WORLD OF AIRCRAFT COMMUNICATIONS. JUST OUT V.H.F. AIRCRAFT BAND CONVERTER only 47'6

**Countless thousands of v.h.f. Aircraft Band Convertors now selling in U.S.A.** *Listen in to* **AIRLINES, PRIVATE PLANES, JET PLANES.** *Eavesdrop on exciting crosstalk between pilots, ground approach, ground control, airport tower. Hear for yourself the disciplined voices hiding tenseness on talk downs.* Be with them when they have to take nerve-ripping decisions in emergencies—Tune in to the international distress frequency. Covers the whole aircraft frequency band including **HEATH ROW- GATWICK, LUTON, RINGWAY, PRESTWICK ETC. ETC. CLEAR AS A BELL.** This fantastic fully transistorised instrument **can be built by anyone nine to ninety in under two hours.** (Our design team built four—everyone worked first time). *No knowledge of radio or electronics required.* No soldering necessary. Fully illustrated simply worked instructions take you step-by-step. Uses standard PP3 battery. Size only 4¾" × 3" × 1½". All you do is extend rod aerial, place close to any ordinary medium-wave radio—(even six transistor portables) **NO CONNECTIONS WHATEVER NEEDED.** Use indoors or outdoors. **THERE WILL BE ENORMOUS DEMAND FOR THIS NEW DESIGN. SEND NOW. ONLY 47/6** for all parts, including case, nuts, screws, wire, etc. etc. (parts available separately). Money back guarantee.

**CONCORD ELECTRONICS LTD. (TV11) 8 Westbourne Grove London W.2. (Nr. Bayswater tube) • Callers Wel. 9-6 inc. Sat.**

# REBUILT TELEVISION TUBES

**STANDARD TYPES:**

| | |
|---|---|
| 17"........£5- 0-0 | 21"........£6- 0-0 |
| 19"........£5-10-0 | 23"........£6-10-0 |

**'PANORAMA' & 'RIMGUARD' TYPES:**

| | |
|---|---|
| 19"........£7- 0-0 | 23"........£9- 0-0 |

**TWIN PANEL or BONDED FACE TYPES:**

| | |
|---|---|
| 19"........£7-10-0 | 23"........£9-10-0 |

★ Complete new gun fitted to every tube.

★ Two years' guarantee.

★ **Free delivery** by our own transport within 250 miles of London. Over this distance 15/- extra for carriage and insurance (Passenger Train).

We have been rebuilding tubes for the past 12 years and can supply any type including 11", 12", 13", 16", etc. and colour tubes. Trade enquiries invited.

**N.G.T. ELECTRONICS LTD.,**
**22 Anerley Station Road,**
**London, S.E.20**
**Telephone: 01-778 9178**

# Available now!


# 175 Naval Apprenticeships

Every six months the Navy needs 175 hand-picked men to train as its future top technicians. You could be one of the next 175. But apply early. Send now for the free booklet, all about Artificer Apprenticeships. It tells you how the Navy gives you one of the finest engineering trainings in the world.

And look what it means: You become the man in charge of advanced modern equipment in ships, submarines and helicopters—like electronic systems, computers, radar, missiles, gas and steam turbines.

In your early twenties you can be a Chief Petty Officer earning over £2,000 a year. And there are very good chances of becoming a commissioned officer.

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Full union status and O.N.C. ensure you a secure, well-paid job for life—in the Navy or out.

You enjoy a life of action—exciting and adventurous, with the chance to see something of the world while you're young.

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## Send for free book.

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**Address** ____________________

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**Date of birth** ____________________
**(Enquiries from U.K. residents only)**

RN ROYAL NAVY

## SEMICONDUCTORS
continued

| Type | Price | Type | Price |
|---|---|---|---|
| GET873 | 2/6 | NKT773 | 5/- |
| GET880 | 6/- | NKT781 | 6/- |
| GET887 | 4/- | NKT10339 | 6/6 |
| GET889 | 4/6 | NKT10419 | 6/- |
| GET890 | 4/6 | NKT10439 | 7/6 |
| GET896 | 4/6 | NKT10519 | 6/6 |
| GET897 | 4/6 | NKT20329 | 9/6 |
| GET898 | 4/6 | NKT80111 | 15/6 |
| MAT100 | 6/- | NKT80112 | 19/6 |
| MAT101 | 6/- | NKT80113 | 22/6 |
| MAT120 | 6/- | NKT80211 | 18/6 |
| MAT121 | 6/- | NKT80212 | 18/6 |
| MJ400 | 21/6 | NKT80213 | 18/6 |
| MJ420 | 22/6 | NKT80214 | 18/6 |
| MJ421 | 22/6 | NKT80215 | 18/6 |
| MJ430 | 20/6 | NKT80216 | 18/6 |
| MJ440 | 19/- | OC20 | 15/- |
| MJ480 | 19/6 | OC22 | 10/- |
| MJ481 | 25/- | OC23 | 10/- |
| MJ490 | 20/- | OC24 | 11/6 |
| MJ491 | 27/6 | OC25 | 10/- |
| MJ1800 | 43/6 | OC26 | 6/6 |
| MJE340 | 12/6 | OC28 | 12/6 |
| MJE520 | 17/6 | OC29 | 15/- |
| MJE521 | 17/6 | OC35 | 8/- |
| MPF102 | 8/6 | OC36 | 12/6 |
| MPF103 | 7/6 | O341 | 4/6 |
| MPF104 | 7/6 | OC42 | 5/- |
| MPF105 | 7/6 | OC44 | 4/- |
| MPS3638 | 6/6 | OC45 | 2/6 |
| NKT0013 | 9/6 | OC46 | 3/- |
| NKT124 | 8/6 | OC70 | 3/- |
| NKT125 | 5/6 | OC71 | 2/6 |
| NKT126 | 5/6 | OC72 | 2/6 |
| NKT128 | 5/6 | OC74 | 6/6 |
| NKT135 | 5/6 | OC75 | 4/6 |
| NKT137 | 6/6 | OC76 | 4/6 |
| NKT210 | 6/- | OC77 | 5/6 |
| NKT211 | 6/- | OC78 | 5/- |
| NKT212 | 6/- | OC81 | 4/- |
| NKT213 | 6/- | OC81D | 4/- |
| NKT214 | 4/6 | OC83 | 5/- |
| NKT215 | 4/6 | OC84 | 5/- |
| NKT216 | 7/6 | OC139 | 6/6 |
| NKT217 | 8/6 | OC140 | 6/6 |
| NKT219 | 6/- | OC169 | 4/8 |
| NKT223 | 5/6 | OC170 | 6/- |
| NKT224 | 5/- | OC171 | 6/- |
| NKT225 | 4/6 | OC200 | 6/6 |
| NKT229 | 6/- | OC201 | 9/6 |
| NKT237 | 7/- | OC202 | 9/6 |
| NKT238 | 5/- | OC203 | 6/6 |
| NKT240 | 5/6 | OC204 | 8/6 |
| NKT241 | 5/6 | OC205 | 8/6 |
| NKT242 | 4/- | OC207 | 12/6 |
| NKT243 | 12/6 | OCP71 | 8/6 |
| NKT244 | 3/6 | P346A | 4/6 |
| NKT245 | 4/- | T1834 | 12/6 |
| NKT261 | 4/- | T1843 | 8/- |
| NKT264 | 6/- | T1844 | 2/6 |
| NKT271 | 4/- | T1845 | 3/6 |
| NKT272 | 4/- | T1846 | 3/6 |
| NKT274 | 4/- | T1847 | 3/6 |
| NKT275 | 4/- | T1848 | 3/6 |
| NKT281 | 4/- | T1849 | 3/6 |
| NKT401 | 17/6 | T1850 | 4/6 |
| NKT402 | 18/- | T1851 | 3/6 |
| NKT403 | 15/- | T1852 | 3/6 |
| NKT404 | 12/6 | T1853 | 6/- |
| NKT405 | 15/- | T1860 | 6/- |
| NKT406 | 12/6 | T1861 | 6/- |
| NKT451 | 12/6 | T1P29A | 13/6 |
| NKT452 | 12/6 | T1P30A | 15/- |
| NKT453 | 9/6 | T1P31A | 16/6 |
| NKT603F | 6/6 | | |
| NKT613F | 6/6 | | |
| NKT674F | 6/- | | |
| NKT677F | 6/- | | |
| NKT713 | 5/- | | |
| NKT717 | 8/6 | | |
| NKT734 | 5/6 | | |
| NKT736 | 7/- | | |

## STYLII

| ACOS | Sapphire | Diamond |
|---|---|---|
| GP59 | 2/6 | 7/6 |
| GP65 | 2/6 | 7/6 |
| GP67 | 2/6 | 7/6 |
| GP73-1 | 6/6 | 9/6 |
| GP73-2 | 6/6 | 9/6 |
| GP79 | 2/6 | 7/6 |
| GP81-1 | 2/6 | 7/6 |
| GP91-1 | 6/6 | 9/6 |
| GP91-2 | 6/6 | 9/6 |
| GP91-3 | 6/6 | 9/6 |
| GP91-1Sc | 6/6 | 9/6 |
| GP91-3Sc | 6/6 | 9/6 |
| HGP37 | 2/6 | 7/6 |
| **B.S.R.** | | |
| BSR C1 (ST3) | 6/6 | 9/6 |
| BSR TC8H | 2/6 | 7/6 |
| BSR TC8M | 2/6 | 7/6 |
| BSR ST8 | 6/6 | 9/6 |
| BSR ST9 | 6/6 | 9/6 |
| BSR ST10 | — | 9/- |
| BSR X1M | 6/6 | 9/6 |
| BSR X1H | 6/6 | 9/6 |
| BSR X3M | 6/6 | 9/6 |
| BSR X3H | 6/6 | 9/6 |
| BSR X5H | 6/6 | 9/6 |
| BSR X4H | 6/6 | 9/6 |
| **COLLARO** | | |
| Collaro Studio 'O' | 2/6 | 7/6 |
| Collaro-Ronett TX88 | 2/6 | 7/6 |
| Collel SK1 | 2/6 | 7/6 |
| Dual CDS2/CDS3 (DN2) | 6/6 | 9/6 |
| Dual CDS/320 (DN3) | 6/6 | 9/6 |
| ELAC KST9 (PE10) | 6/6 | 9/6 |
| ELAC KST9 (PE1B) | 6/6 | 9/6 |
| ER5MB | 6/6 | 9/6 |
| ER5MX | 2/6 | 7/6 |
| ER5 SB | 6/6 | 9/6 |
| ER60 Stereo | 6/6 | 9/6 |

| GARRARD | Sapphire | Diamond |
|---|---|---|
| EV26 Stereo | 2/6 | 7/6 |
| GC2 | 2/6 | 7/6 |
| GC8 | 2/6 | 7/6 |
| GCE12 | 2/6 | 7/6 |
| GCS10/1 | 2/6 | 7/6 |
| GCS10/2 | 2/6 | 7/6 |
| S 1—2—3 | 6/6 | 9/6 |
| TS1 | 6/6 | 9/6 |
| TS2 | 6/6 | 9/6 |
| TS3 | 6/6 | 9/6 |
| **GOLDRING** | | |
| CM50 | 2/6 | 7/6 |
| CM60 | 2/6 | 7/6 |
| MX1 | 2/6 | 7/6 |
| MX2 | 2/6 | 7/6 |
| Stereo CS80 | 2/6 | 7/6 |
| **PERPETUUM EBNER** | | |
| PE188 | 6/6 | 9/6 |
| **PHILIPS** | | |
| AG3016 | 2/6 | 7/6 |
| AG3063 | 2/6 | 7/6 |
| AG3306 | 6/6 | 9/6 |
| AG3310/3306 | 6/6 | 9/6 |
| AG3400 | 2/6 | 7/6 |
| **RONETTE BINOFLUID** | | |
| BF40 | 2/6 | 7/6 |
| DC284 | 2/6 | 7/6 |
| **SONOTONE** | | |
| 2T | 6/6 | 9/6 |
| 3T | 6/6 | 9/6 |
| 8T4A | 6/6 | 9/6 |
| 9TA | 6/6 | 9/6 |
| 9TA/HC | 6/6 | 9/6 |
| 19T | 2/6 | 7/6 |
| 20T | 2/6 | 7/6 |

**The Diamond Tip is ·007 in. radius, thus making it compatible to play stereo records on mono equipment without damage to the record; and of course full stereo.**
**BRITISH MADE**
**EXPORT ENQUIRIES WELCOMED**

## CARTRIDGES

| ACOS | | Inc. P.T. each |
|---|---|---|
| GP79 | | 12/6 |
| GP91-1SC | - 1 | 21/- |
| | 2- 11 | 17/9 |
| | 12- 49 | 15/6 |
| | 50-500 | 13/6 |
| GP91-2SC | | *As above* |
| GP91-3SC | | *As above* |
| Suitable to replace TC8, etc. | | |
| GP92 | | 26/5 |
| GP93-1 | | 24/9 |
| GP94-1 | | 31/- |
| GP94-5 | | 36/- |
| GP95 | | 24/9 |
| GP96 | | 31/6 |
| Acos 104 | 1- 10 | 41/10 |
| | 11- 25 | 39/9 |
| | 25- 50 | 38/3 |
| | 51-499 | 35/5 |

| B.S.R. | | Inc. P.T each |
|---|---|---|
| X3M | S/S | 27/9 |
| X3H | S/S | 27/9 |
| X5M | S/S | 27/9 |
| X5H | S/S | 27/9 |
| SX5M | S/S | 36/3 |
| SX5H | S/S | 36/3 |
| SX5M | D/S | 39/11 |
| SX5H | D/S | 39/11 |
| X4N | D/S | 27/3 |
| **RONETTE** | | |
| 105 | S/S | 19/10 |
| 106 | S/S | 19/10 |
| DC400 | S/S | 14/- |
| DC400SC | S/S | 14/- |
| 105 | D/S | 22/4 |
| 106 | D/S | 22/4 |
| DC400 | D/S | 16/9 |
| DC400SC | D/S | 16/9 |
| **SONOTONE** | | |
| 8TA | D/S | 25/- |
| 9TA | D/S | 35/10 |
| 9TAHC | D/S | 35/10 |

## CATHODE RAY TUBES

New and Budget tubes made by the leading British manufacturers. Guaranteed for 2 years. In the event of failure under guarantee, replacement is made without the usual time wasting forms and postage expense.

| Type | | New £ | Budget £ |
|---|---|---|---|
| MW36-20 | | | 4/10/- |
| MW36-21 | | | 4/10/- |
| MW43-69Z | CRM171 | | |
| | CRM172 | 6/12/- | 4/12/6 |
| MW43-80Z | CRM173 | 6/12/- | 4/12/6 |
| AW43-80Z | CME1702 | 6/12/- | 4/12/6 |
| | CME1703 | 6/12/- | 4/12/6 |
| | CME1706 | 6/12/- | 4/12/6 |
| | C17AA | 6/12/- | 4/12/6 |
| | C17AF | 6/12/- | 4/12/6 |
| AW43-88 | CME1705 | 6/12/- | 4/12/6 |
| AW47-90 | | | |
| AW47-91 | A47 14W | 7/13/4 | 5/7/6 |
| A47 14W | CME1901 | 7/13/4 | 5/7/6 |
| | CME1902 | 7/13/4 | 5/7/6 |
| | CME1903 | 7/13/4 | 5/7/6 |
| | C19AH | 7/13/4 | 5/7/6 |
| A47 13W | CME1906 | 10/5/6 | 8/10/- |
| A47-11W | CME1905 | 8/17/3 | 7/-/- |
| A47-26W | CME1905 | 8/17/3 | 7/15/- |
| A47-26W/R | CME1913R | 9/6/8 | |

| Type | | New £ | Budget £ |
|---|---|---|---|
| A50-120W/R | CME2013 | 10/17/- | |
| AW53-80 | | 8/18/8 | 6/5/- |
| AW53-88 | CME2101 | 8/18/8 | 6/5/- |
| AW59-90 | | | |
| AW59-91 | CME2303 | 9/11/8 | 7/4/- |
| A59-15W | CME2301 | | |
| | CME2302 | | |
| | CME2303 | 9/11/8 | 7/4/- |
| A59-11W | CME2305 | | |
| A59-13W | CME2306 | 13/13/- | 10/19/6 |
| A59-16W | CME2306 | 13/13/- | 10/19/6 |
| A59-23W | CME2305 | 12/12/- | 10/10/- |
| A59-23W/R | | 12/12/- | 10/10/- |
| PORTABLE SET TUBES | | | |
| TSD217 | | | 6/15/- |
| TSD282 | | | 6/15/- |
| A28-14W | | 9/3/4 | Not supplied |
| CME1601 | | | 7/15/- |
| CME1602 | | | 8/-/- |

A discount of 10% is also given for the purchase of 3 or more *New* tubes at any one time.
All types of tubes in stock. Carriage and insurance 15/-.

## TRANSISTORISED UHF TUNER UNITS
## NEW AND GUARANTEED FOR 3 MONTHS

Complete with Aerial Socket and wires for Radio and Allied TV sets but can be used for most makes.
Continuous Tuning, 90/-; Push Button, 100/-.

## PLUGS

| Jack Plugs and Sockets | | Co-Axial Plugs | |
|---|---|---|---|
| Standard Plugs | 3/10 | Belling Lee (or similar type) | 1/3 |
| Standard Sockets | 2/6 | Add 5d. per doz. p. & p. | |

## DE BANKS MAGNETIC RECORDING TAPES

| POLYESTER Length | Spool Size in. | Price |
|---|---|---|
| **Standard Play** | | |
| 600 ft. | 5 | 10/- |
| 850 ft. | 5¾ | 12/6 |
| 1200 ft. | 7 | 14/- |
| **Long Play** | | |
| 210 ft. | 3 | 5/6 |
| 450 ft. | 4 | 8/6 |
| 900 ft. | 5 | 14/- |
| 1200 ft. | 5¾ | 17/- |
| 1800 ft. | 77 | 20/- |
| **Double Play** | | |
| 1200 ft. | 5 | 17/6 |
| 1800 ft. | 5¾ | 22/- |
| 2400 ft. | 7 | 26/- |

## EMPTY TAPE REELS

| | |
|---|---|
| 3 in. | 1/6 |
| 4 in. | 1/10 |
| 5 in. | 2/3 |
| 5¾ in. | 2/6 |
| 7 in. | 2/7 |

## CASSETTES

Boxed in Plastic Library Packs

| | |
|---|---|
| C60 | 10/6 |
| C90 | 12/6 |
| C120 | 17/6 |

P. & P. 1/6 on all orders.

# WILLOW VALE ELECTRONICS

## LIMITED

## *The Service Department Wholesalers*

# *Compare our prices*

e.g. NEW **19" C.R.T's** . . . OUR PRICE **£5.19.0** Plus 12/6 carriage

**Please note: Components are sold in packs, quantities per pack are shown under each heading. Prices are per piece of each value.**

### TUBULAR CAPACITORS (3's)

| | | |
|---|---|---|
| ·001 | 400v. | 9d. |
| ·0022 | 600v. | 9d. |
| ·0033 | 600/1500v. | 9d. |
| ·0047 | 600/1500v. | 9d. |
| ·01 | 400v. | 10d. |
| ·022 | 600v. | 11d. |
| ·033 | 600v. | 11d. |
| ·047 | 600v. | 11d. |
| ·1 | 600v. | 1/0d. |
| ·22 | 600v. | 2/0d. |
| ·47 | 600v. | 2/10d. |
| ·01 | 1000v. | 1/1d. |
| ·022 | 1000v. | 1/1d. |
| ·047 | 1000v. | 1/8d. |
| ·1 | 1000v. | 1/8d. |
| ·22 | 1000v. | 2/8d. |
| ·47 | 1000v. | 3/8d. |
| ·001 | 1500v. | 1/6d. |

### WIRE-WOUND RESISTORS (3's)

10 watt rating, suitable for mains dropper sections.

| | | |
|---|---|---|
| 1 | Ohm | 1/9d. |
| 10 | Ohms | 1/9d. |
| 13 | ,, | 1/9d. |
| 25 | ,, | 1/9d. |
| 33 | ,, | 1/9d. |
| 50 | ,, | 1/9d. |
| 87 | ,, | 1/9d. |
| 100 | ,, | 1/9d. |
| 150 | ,, | 1/9d. |
| 220 | ,, | 1/9d. |
| 330 | ,, | 1/9d. |
| 1K | ,, | 1/9d. |
| 2·2K | ,, | 1/9d. |
| 3·3K | ,, | 1/9d. |
| 4·7K | ,, | 1/9d. |

### PULSE CERAMICS (3's) 12KV

| | | |
|---|---|---|
| 100pf | 22pf | 1/1d. |
| 120pf | 47pf | 1/1d. |
| 180pf | 68pf | 1/1d. |
| 250pf | | 1/1d. |

Tubular type for use in Scan correction circuits and Line Outputs.

### CERAMICS (6's)

| | | |
|---|---|---|
| 500pf | 22pf | 8d. |
| 680pf | 47pf | 8d. |
| 820pf | 68pf | 8d. |
| 1000pf | 100pf | 8d. |
| 1500pf | 120pf | 8d. |
| 3000pf | 180pf | 8d. |
| 5000pf | | 8d. |

### BIAS ELECTROLYTICS (3's)

| | | |
|---|---|---|
| 25mfd | 25v. | 1/6d. |
| 50mfd | 25v. | 1/8d. |
| 100mfd | 25v. | 1/11d. |
| 250mfd | 25v. | 3/0d. |
| 500mfd | 25v. | 3/8d. |
| 1000mfd | 12v. | 6/0d. |
| 1000mfd | 30v. | 5/9d. |
| 2000mfd | 25v. | 7/0d. |
| 2500mfd | 30v. | 9/0d. |
| 3000mfd | 30v. | 9/6d. |
| 5000mfd | 30v. | 10/0d. |
| 25mfd | 50v. | 1/8d. |
| 50mfd | 50v. | 2/0d. |
| 100mfd | 50v. | 2/6d. |
| 250mfd | 50v. | 3/8d. |
| 500mfd | 50v. | 4/6d. |
| 2000mfd | 50v. | 9/0d. |
| 2500mfd | 50v. | 10/6d. |

### SMOOTHING ELECTROLYTICS

Wire ended, 450v. working.

| | |
|---|---|
| 1mfd | 1/6d. |
| 2mfd | 1/6d. |
| 4mfd | 2/3d. |
| 8mfd | 2/6d. |
| 16mfd | 3/0d. |
| 32mfd | 4/6d. |
| 50mfd | 5/0d. |
| 8/8mfd | 4/0d. |
| 8/16mfd | 5/0d. |
| 16/16mfd | 5/0d. |
| 16/32mfd | 5/0d. |
| 32/32mfd | 5/0d. |
| 50/50mfd | 8/0d. |
| 50/50/50mfd | 10/0d. |

### CANNED ELECTROLYTICS

| | |
|---|---|
| 100/200mfd | 12/6d. |
| 100/400mfd | 16/6d. |
| 200/200mfd | 16/0d. |
| 200/200/100mfd | 18/6d. |
| 200/400/32mfd | 18/6d. |
| 100/300/100/16 | 18/6d. |
| 100/400/32mfd | 18/6d. |
| 100/400/64/16 | 21/0d. |

### SKELETON PRE-SETS (3's)

| | | |
|---|---|---|
| 25K | Vertical | 1/4d. |
| 50K | ,, | 1/4d. |
| 100K | ,, | 1/4d. |
| 250K | ,, | 1/4d. |
| 500K | ,, | 1/4d. |
| 1 meg | ,, | 1/4d. |
| 2 meg | ,, | 1/4d. |
| 500K | Horizontal | 1/4d. |
| 680V | ,, | 1/4d. |
| 1 meg | ,, | 1/4d. |

### SUB-MINIATURE ELECTROLYTICS (3's)

| | | |
|---|---|---|
| 1mfd | 18v. | 1/8d. |
| 2mfd | 18v. | 1/8d. |
| 4mfd | 18v. | 1/8d. |
| 5mfd | 18v. | 1/8d. |
| 8mfd | 18v. | 1/8d. |
| 10mfd | 18v. | 1/8d. |
| 16mfd | 18v. | 1/8d. |
| 25mfd | 18v. | 1/8d. |
| 32mfd | 18v. | 1/10d. |
| 50mfd | 18v. | 1/10d. |
| 100mfd | 18v. | 1/10d. |
| 200mfd | 18v. | 2/3d. |

### THERMISTORS (3's)

| | |
|---|---|
| Miniature | 1/6d. |
| TH1 | 2/4d. |

### RADIO/TV GLASS FUSES

1 amp, 1·5 amp, 2 amp, 3 amp.
Per dozen 3/0d.

### MAINS FUSES

2 amp, 3 amp, 5 amp, 13 amp.
Per dozen 5/0d.

### TERMINAL STRIPS

| | |
|---|---|
| 2 amp | 2/3d. |
| 5 amp. | 2/10d. |
| 15 amp | 5/9d. |

### RECTIFIERS

**Silicon Mains (3's)**

| | |
|---|---|
| Westinghouse S10AR2 | 6/6d. |
| BY127 Mullard | 5/3d. |
| BY105 Mazda | 7/0d. |
| BY327 | 5/6d. |

### CONTACT COOLED FULL WAVE

| | |
|---|---|
| 75ma | 12/8d. |
| 100ma | 13/8d. |
| 150ma | 16/8d. |

### CO-AXIAL PLUGS

| | |
|---|---|
| Bakelite top | 10d. |
| Egen metal | 1/4d. |
| Single point (car radio) | 2/0d. |

### SLIDER PRE-SETS (3's)

| | |
|---|---|
| 100K | 1/6d. |
| 1 Meg | 1/6d. |
| 2·2 Meg | 1/6d. |

### JACK PLUGS

| | |
|---|---|
| Chrome standard | 4/0d. |
| Standard | 3/0d. |
| 3·5mm. metal | 3/0d. |

### DIN PLUGS (3's)

| | |
|---|---|
| 3-pin | 1/10d. |
| 5-pin | 2/2d. |
| Sockets | 1/0d. |

### CARBON FILM RESISTORS

**½ watt and 1 watt.**

The following values are packed in cartons of *six of each value*. Price 2/6d. per carton.

| | | | |
|---|---|---|---|
| 10 | ohm | 1·2K | 150K |
| 12 | ,, | 1·5K | 180K |
| 15 | ,, | 1·8K | 220K |
| 18 | ,, | 2·2K | 270K |
| 22 | ,, | 2·7K | 330K |
| 27 | ,, | 3·3K | 390K |
| 33 | ,, | 3·9K | 430K |
| 39 | ,, | 4·3K | 470K |
| 43 | ,, | 4·7K | 560K |
| 47 | ,, | 5·6K | 680K |
| 56 | ,, | 6·8K | 820K |
| 68 | ,, | 8·2K | 1M |
| 82 | ,, | 10K | 1·2M |
| 100 | ,, | 12K | 1·5M |
| 120 | ,, | 15K | 1·8M |
| 150 | ,, | 18K | 2·2M |
| 180 | ,, | 22K | 2·7M |
| 220 | ,, | 27K | 3·3M |
| 270 | ,, | 33K | 3·9M |
| 330 | ,, | 39K | 4·3M |
| 390 | ,, | 43K | 4·7M |
| 430 | ,, | 47K | 5·6M |
| 470 | ,, | 56K | 6·8M |
| 560 | ,, | 68K | 8·2M |
| 680 | ,, | 82K | 10M |
| 820 | ,, | 100K | 12M |
| 1K | | 120K | 15M |

All the above values are available in both ½ watt and 1 watt versions.
***Special for Philips TV's:**
8·2M 2-watt, 4/6d. per pack.

### DOUBLE DIODE RECTIFIERS (3's)

Bush/Murphy/BRC, etc.
Line/frame timebases etc.

| | |
|---|---|
| 3 leg | 6/3d. |
| 4 leg | 6/3d. |
| 5 leg | 6/3d. |

### VOLUME CONTROLS

Standard spindle with flat.

| | |
|---|---|
| Double pole switch | 4/7d. |
| Without switch | 3/6d. |

(One per pack)
5K, 10K, 25K, 50K, 100K, 250K, 500K, 1 meg, 2 meg.

### RECORD PLAYER CARTRIDGES

| | |
|---|---|
| ACOS: GP67/2g. High gain general purpose Mono | 16/8d. |
| GP91/SC. Stereo-compatible replacement | 22/0d. |
| GP91/3SC. High gain version of above | 22/0d. |
| GP94/1SS. Stereo cartridge | 37/9d. |
| GENERAL PURPOSE REPLACEMENT FOR TC8's etc. | |
| High gain, plenty of output (Jap.) | 19/10d. |
| Stereo version | 37/9d. |

### SERVISOL AND ELECTROLUBE PRODUCTS (Nett trade)

| | |
|---|---|
| Servisol aerosol can | 12/6d. nett |
| Electrolube 2AX aerosol | 14/0d. nett |
| Servisol Freezit | 9/6d. nett |
| Electrolube No. 1 Snorkel | 18/0d. nett |
| Electrolube 2GX Grease | 8/4d. nett |
| Servisol Aero-Clene for tape heads | 10/6d. nett |
| Servisol Aero-Duster | 10/6d. nett |

### REPLACEMENT STYLI

| | |
|---|---|
| TC8 | 4/6d. |
| GC8 | 4/6d. |


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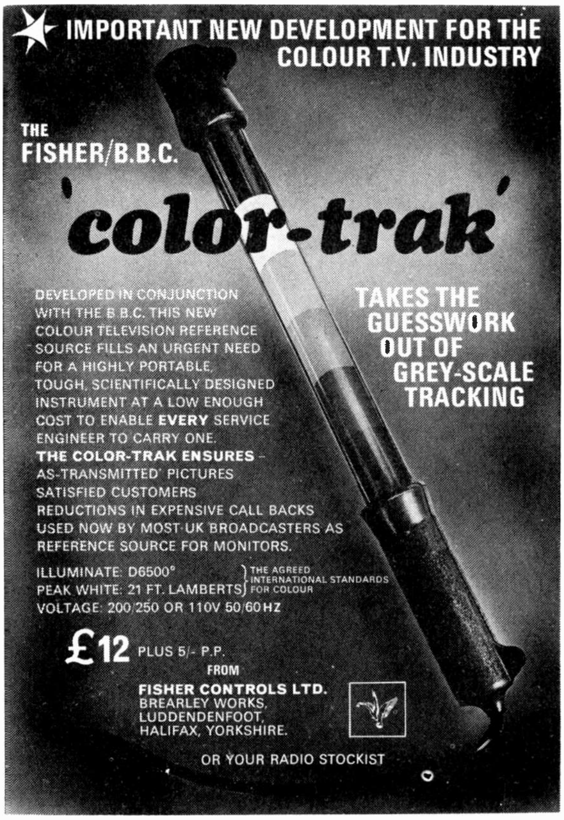
Complete untested 17" T.V. Sets 12 Channel **50/-**. Carriage £1.
**Top Grade Mylar Tapes.** 7" Long Play 14/-, 7" Standard 11/6, 5" Long Play 10/-, 5" Standard 7/9. Post and packing on any Tape 1/9.

**VALVE LIST EX EQUIPMENT**
**3 months' guarantee. Single Valves.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ARP12 | 1/6 | PCC84 | 2/– | PL36 | 5/– | 688 | 1/6 |
| EB91 | 9d. | PCF80 | 2/– | PL81 | 4/– | 68W7 | 2/6 |
| EBF89 | 3/– | PCC89 | 3/– | PY81 | 1/6 | 6U4 | 4/– |
| ECC82 | 3/– | PCL85 | 5/– | PY800 | 3/6 | 20D1 | 3/– |
| ECL80 | 1/6 | PCL84 | 4/– | PY82 | 1/6 | 20P1 | 5/– |
| EF183 | 3/– | PCL82 | 4/– | PY33 | 5/– | 20P3 | 2/6 |
| EF184 | 3/– | PCF86 | 4/– | U191 | 4/– | 30PL1 | 5/– |
| EY86 | 4/– | PCL83 | 3/– | 6F23 | 4/– | 30P12 | 4/6 |
| | | | | | | 30F5 | 2/9 |



TELEVISION

SERVICING·CONSTRUCTION·COLOUR·DEVELOPMENTS

VOL 21 No 3
ISSUE 243

JANUARY 1971

## EXPLANATIONS

This is the first TELEVISION to appear since our November issue was published on October 23rd last, so we must start with an apology to our readers—and also our advertisers and regular contributors—for the loss of the December issue and the very late appearance of this one—on the date when normally our February issue would have been published. Most of the features in the present issue are those which would have appeared in the lost December issue, and all series are being resumed where they left off, so readers will find no editorial gaps in the contents of the current volume. The industrial dispute that lead to the loss of the December issue and the late appearance of this one followed the closure of Fleetway Printers' Sumner Street works where TELEVISION had been set for the last two years or so: we are glad to say that agreement has now been reached by all the parties concerned. We shall however have to ask our readers to bear with us a little while longer while we try to get back to our normal monthly publishing date.

This month we welcome to our columns a regular cartoon. Ed Pullin's ideas and drawings have amused us greatly and we hope that readers will find them equally entertaining.

With the publication this month of an article on *Synchronous Detectors* we conclude a group of three articles—the others were *PAL Chroma Detection* in the November issue and *PAL Switching Techniques* in the October one—which between them have looked in detail at the techniques used in the colour signal processing sections of a PAL colour receiver. The aim has been to examine the circuits found in practice in this crucial part of a colour TV set to find out exactly what goes on.

Lastly we regret that due to space difficulties with this issue we have had to hold over the second part of our feature on *Flashover Protection*. This will appear in the February issue which we hope to publish in about three weeks' time. W. N. STEVENS, *Editor*

## THIS MONTH



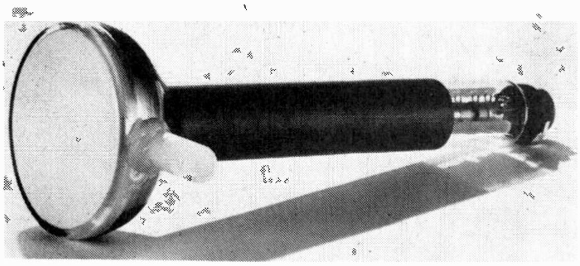
**THE NEXT ISSUE DATED FEBRUARY WILL BE PUBLISHED FEBRUARY 12**

# TELETOPICS

## APPROACH OF VIDEOCASSETTES

As the time approaches when video recordings in cassette form will be available to the public more firms are releasing information on their plans and competing systems. Rank-Bush-Murphy have now demonstrated—ahead of their original development schedule—their colour EVR video cartridge player. Full production of these players at the RBM Plymouth factory is expected to be in operation by April and the price will be around the £350 mark. The cartridges—one hour black-and-white ones and, later, colour ones—will cost between £20 and £40 and will also be available for hiring at 30/- upwards.

A key component in the RBM teleplayer, the scanning light source which illuminates the film and does away with the need for a pull-down sprocket system, is the Brimar flying-spot scanner tube type Q8-100AA. This is a high-precision 3in. c.r.t. which has been specially developed for the application by



*The Brimar Q8-100AA 3in. flying-spot scanner tube developed for use with EVR teleplayers.*

Brimar in conjunction with the EVR Partnership. The tube is available to the maintenance trade at a recommended trade price of £30.

A colour videocassette system using magnetic tape has also now been demonstrated by Sony. The system is at present designed for use with the US NTSC system but Sony intend to make their equipment compatible with the videocassette standard being established by Philips for use with the European colour television system. The Sony colour videocassette playback units are expected to cost about £200 and an adaptor to enable off-air recordings to be made will be about £50. The tape is expected to cost about £1 a minute's playing time. The Sony player can be connected to any standard television set without the need for modifications to the set and as it is fully compatible it can also be used with black-and-white sets. The videocassette has two sound channels, holding out the possibility of stereo sound. The system is expected to be available to the Japanese public this autumn and will later be available for export.

In addition the US videotape recorder giant Ampex has joined forces with a leading Japanese consumer electronics firm Toshiba to enter this market with a magnetic tape videocassette system called the "Instavision" system. The recorder/player is claimed to be the smallest to date and there will be a choice of players or recorder/players operating on batteries or mains supplies and in colour or black-and-white. Standard ½in. tape in a small circular plastic cartridge 4·6in. in diameter and 0·7in. thick is used and this is compatible with all other conventional reel-type recorders using the international type one standard of the Japanese EIA. Instavision equipment should be available in the US in mid-1971 and in Europe by the end of 1971. Prices will be approximately £333 for a monochrome player, £385 for a monochrome recorder/player or colour player and £416 for a colour recorder/player.

Thorn have announced that they intend to make videocassette players to the standards established by Philips.

The EVR Partnership have concluded licence agreements with the Japanese firms Mitsubishi Electric and Hitachi Ltd. for the manufacture and distribution of EVR teleplayers.

## NEW SETS

Several new monochrome models have been introduced in the **Marconiphone** range. These are the single standard 20in. Model 4807 at £71.14.0d., the 17in. Model 4803 at £61.1.0d. and the 24in. Model 4808 at £79.13.0d. Dual-standard versions are the 20in. Model 4649 at £83.7.0d., the 17in. Model 4661 at £77.3.0d. and the 24in. Model 4668 at £90.17.0d.

A 22in. **Korting** colour model, the 51675, is being imported by Europa Electronics Ltd., Howard Place, Shelton, Stoke-on-Trent ST1 4NW. This model, which has a recommended price of £309.19.0d., features a six push-button tuner, slider controls for colour tone and intensity, brilliance and contrast, and 4·5W audio output. **Telefusion** are also to market this set under the name "Carnival".

A new battery/mains 13in. portable model from **Hitachi** sells at £82. A 26in. colour model has been added to the Bang and Olufsen range. This, the **Beovision** Model 3200SJ, has recommended prices of £428 with teak finish and £434.10.0d. with rosewood finish.

Colour receiver deliveries rose to 48,000 last September, bringing the total for the first nine months of the year to 306,000. Monochrome set deliveries also increased in September to 169,000. For October the figures were 56,000 (colour) and 185,000 (monochrome). US set sales were down 27·2% (colour) and 10·2% (monochrome) during the first six months of last year.

## HITACHI GET PAL LICENCE

The Japanese Hitachi company has successfully completed negotiations with the West German AEG-Telefunken company—the PAL patent holders—for a licence to manufacture PAL colour sets and is planning to enter the UK market later this year.

## TRANSMITTER NEWS

BBC-1 programmes are now being transmitted at u.h.f. from four more stations. These are **Tacolneston** on channel 62 with horizontal polarisation (aerial group C), **Reigate** on channel 57 with vertical polarisation (aerial group C), **Guildford** on channel 40 with vertical polarisation (aerial group B) and **Brighton** on channel 57 with vertical polarisation (aerial group C). BBC-2 transmissions have now started from **Blaenplwyf** for West Wales on channel 27 with horizontal polarisation (aerial group A) and **Malvern** on channel 62 with vertical polarisation (aerial group D).

The ITA's **Sudbury** transmitter is now in operation on channel 41 with horizontal polarisation carrying Anglia TV (aerial group B).

The French government has decided to create a third state-run television channel. It is intended that the third channel, in colour, will start in 1972 and reach all France by 1975.

The ITA has issued a convenient new fold-out publication titled "ITA Transmitters—A Pocket Guide" which provides full data on the ITA Band III and Band IV/V networks. Copies are available on request from the ITA Engineering Information Service, 70 Brompton Road, London, SW3.

## US TV LOSES CHANNELS

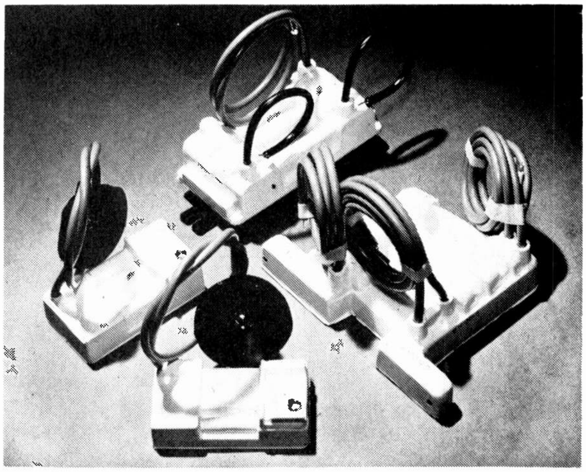
The US Federal Communications Commission (FCC) has announced that due to the expansion of two-way radiotelephone services the Band 806-947MHz is to be allocated exclusively to these services. The Band previously included TV channels 70-83 (806-890MHz). These TV channels are at present occupied by low-power translators (1kW and less) but it was expected that high-power TV transmitters would open using these frequencies when the lower channels became too crowded. As radiotelephone equipment for these frequencies is not at present available and will take some time to develop, however, the FCC has authorised as a short-term solution the sharing by these services of two lower TV channels—channels 14 (473·5MHz) and 20 (509·5MHz). This will mean changing TV station channel allocations in some areas.

## NEW PRODUCTS

The English Electric Valve Co. Ltd. has introduced a new vidicon camera tube type 7262A for closed-circuit television systems. This is a short (5·18in.) 1in. vidicon for use in compact monochrome or colour systems.

Mullard have released three new npn silicon planar transistors for use in TV receiver video output stages. They have high collector current and voltage ratings making them suitable for use in large-screen colour or monochrome receivers and can also be used as line output stage drivers. Small heatsinks are required. The BF336, BF337 and BF338 have maximum collector-emitter voltages of 180V, 200V and 225V respectively and use TO-39 encapsulation.

Clayridge Electronics Ltd. (2 Stoke Newington High Street, London, N16) are now able to supply from stock replacement e.h.t. rectifier trays for sets using semiconductor e.h.t. multiplier circuits. These are mainly Thorn/BRC sets and colour sets by the GEC, Pye and Rank-Bush-Murphy groups.



*A selection of the replacement e.h.t. rectifier trays available from Clayridge Electronics Ltd.*

## AERIALS

Antiference have introduced a new high-gain u.h.f. aerial which they claim combines the performance of a 2×18 broadside Yagi array with the advantages of single-boom mounting. The new aerial, called the Hi-Gain, has a double director chain with the pairs of directors mounted in the same plane: the idea is to avoid the "cross-polarisation effects" which Antiference say can be troublesome with some multi-director designs because of the mixture of horizontal and vertical polarisation used in the UK. The director chain is matched into a patented "Trucolour" dipole and the array is completed by a six-element angled reflector. The aerial has been designed to give even response and accurate matching with optimum directional characteristics throughout the channel groups —group A, B and CD versions are available. Recommended retail price is £6. Further details from Antiference Ltd., Aylesbury, Bucks.

Also now available from Antiference is a new set-top aerial, the Super Set-Top. This is a Yagi array with reflector, dipole and three directors and is available for the aerial groups A, B or CD.

The BBC Engineering Information Service (BBC, Broadcasting House, London, W1A 1AA) has issued an information sheet, No. 4006(2), giving a useful summary of the facts of u.h.f. TV reception and aerial requirements and installation.

## APOLOGIES TO McGRAW-HILL

We have been asked by the McGraw-Hill Publishing Co. Ltd. to make clear that the author of their recently published book *Colour Television Theory: PAL-System Principles and Receiver Circuitry* which was advertised in our last issue, dated November, 1970, is by Geoffrey H. Hutson. The author's name appeared incorrectly spelt in our advertisement.

## NEW INDEPENDENT TV COMPANY

The new company resulting from the merger of Yorkshire Television and Tyne Tees Television will be known as Trident Television. The Chairman will be Sir Richard Graham.

# 3-DIMENSIONAL DISPLAY HOLOGRAPHY

I. R. SINCLAIR

HOLOGRAPHY is a term that has suddenly become very prominent, though the basic idea has been around for some time. The attractions of holography lie in the possibilities of storing optical images in a very compressed form, a form of photography without the use of lenses, and true three-dimensional effects without the need for viewing spectacles, split screens or any of the other optical devices which we have previously associated with 3-D.

A hologram is a recording of an image—as is a photograph—but the appearance of a hologram is totally different from the appearance of a photograph just as the appearance of a piece of videotape is totally unlike the images which may be recorded on it. A hologram is a coded form of an image and it is this which makes it of such interest to workers in TV, because TV is basically concerned with methods of coding images. This is indeed what the process of scanning is.

The production of holograms has now become associated with the use of lasers, but the idea of holography goes back to before the invention of the laser and holography using sound waves has been also recently described.

### *Interference of Waves*

Before we can begin to understand holography we must know something of the waves which produce the effect, remembering first that the only difference between the light waves used in holography and the radio waves with which we may be more familiar is the difference of wavelength: the waves of light are of a much shorter wavelength. We can therefore take the information which we know about one type of wave and apply it to the other, the only differences being ones of size.

When waves of the same frequency meet each other the effect produced depends on the relative phase of the waves. To make this clearer consider Fig. 1. In Fig. 1(a), the two sets of waves coincide, the peaks of one wave occurring at exactly the same time

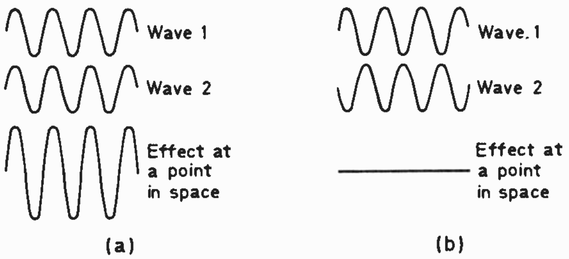



*Fig. 1: Addition of waves.*

as the peaks of the other. The total effect on any receiver—whether it be the eye for light or a radio set for its own brand of wave—is of one wave of double the amplitude, for the amplitudes of waves at any point in space add simply. In Fig. 1 (b) the two sets of waves are exactly half a wave out of step, the peak of one in the positive direction corresponding with the peak of the other in the negative direction. If the waves are of the same amplitude we can add the two together at any point in space to produce zero amplitude.

When two waves of the same frequency combine then, the resulting amplitude can vary all the way from the sum of the amplitudes to the difference between them depending on the relative phase or position of one wave as compared to the other. If the two waves have the same amplitude the resulting amplitude can be anywhere between twice the amplitude of one down to zero, depending on phase. This effect takes place with all waves, whether electromagnetic (radio, light, X-rays etc.) or mechanical (sound, ultrasonics) but cannot always easily be observed, particularly with the very short wavelengths.

Assuming that we can observe the effect though we would find that when an object is placed near a source of waves and a receiver, as shown in Fig. 2(a), so that waves can travel directly from source to receiver and indirectly to the receiver by being reflected from the object, the amplitude observed at the receiver will vary as the object is moved. This is the principle of the Doppler radar system used by the police for detecting the speed of cars, for the rise and fall in amplitude of the received wave takes place at a speed which depends on the speed of the object. Old timers may remember the "Luxembourg Effect" which was caused by Radio Luxembourg transmissions arriving here along with a reflection from the Heaviside layer in the upper atmosphere: movements of the layer caused periods of complete fadeout when the reflected wave was completely out of phase with the normally received one.

Much more important for our purposes is the effect shown in Fig. 2(b) where the detector is moved from side to side. As this is done different amplitudes are detected, because the distance travelled by one wave compared with the distance covered by the other is changing. The important quantity is the difference in path length, preferably written as a number of wavelengths, since we can easily calculate from this the phase difference between the two signals. We can then draw a "map" of these amplitudes in the region around the detector, and this is called an *interference pattern* because it represents the amount

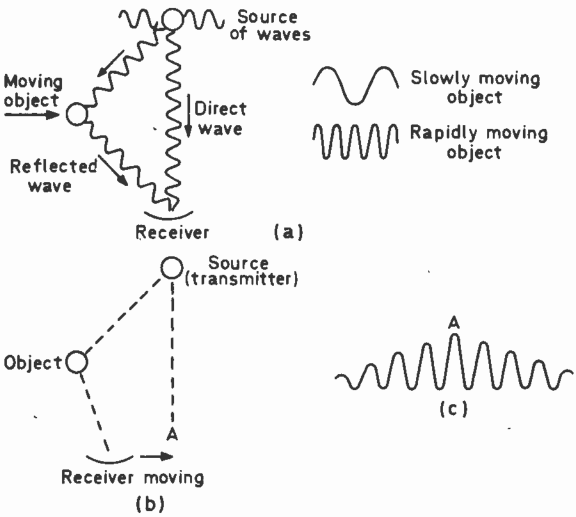
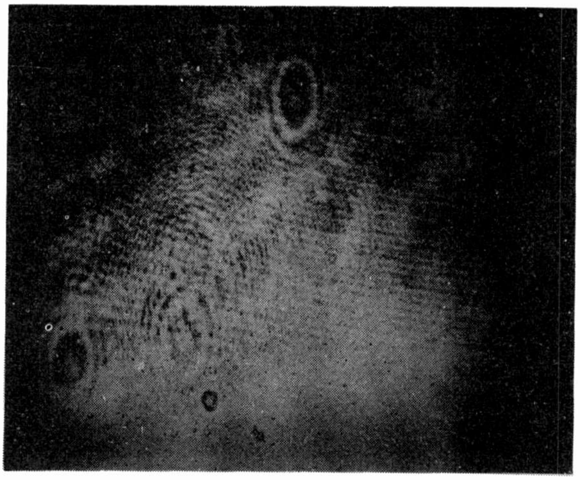



*Fig. 2: (a) A moving object gives an interference signal which varies with time—it is in fact a sinewave. (b) Fixed object but moving receiver. (c) Pattern of waves picked up by the receiver. The peak amplitude is usually at the point where the receiver and transmitter are closest.*



*Appearance of a hologram produced by a set-up as shown in Fig. 4 when viewed in daylight. (Photo courtesy The Marconi Company Ltd.)*

of interference between the waves—constructive interference where the waves add in amplitude, destructive where they substract. Fig. 2(c) shows the type of pattern which can be obtained using radio waves. Incidentally this type of pattern can be used as a means of measuring distance very accurately if the distance between two receivers whose signals are then combined is known. This process is called *radio interferometry* and is of very great use to astronomers.

## Demonstrating Interference Effects

Interference patterns can also be heard. If a stereo outfit is available the existence of interference can be convincingly heard if the channels are combined by switching to mono and a single note such as a tuning signal is fed to both speakers. As the listener's head moves from place to place, the sound becomes alternately louder and softer because of interference between the two sets of sound waves. Another feature of interference patterns can also be observed from this simple experiment. If the note used is of high pitch (short wavelength) the distance which the head has to move from a loud point to the next soft point is small; if the note is of low pitch (long wavelength) the distance between the loud and soft parts of the interference pattern is large. This indicates that there is more difficulty in detecting the interference patterns made with short wavelengths because of the very small distance between the high-amplitude points and the low-amplitude points.

This does not mean that the patterns cannot be observed with light but it does mean that the circumstances in which we can expect to find interference patterns may be more limited. One of these circumstances is well known to photographers. If colour slides are being made up by pressing the film between two plates of glass a pattern of closed loops looking at first sight like a giant fingerprint is seen. The same pattern, called Newton's Rings (Fig. 3), can also be seen when the flat glass pieces are pressed together without the film. The pattern varies as the glasses are pressed together, because the glass is bending and thus varying the distance which the reflected light ray has to move. Its visibility is greatly increased if it is viewed in the light of a single colour such as the light from a sodium lamp. This effect again has many applications in the measurement of very small distances.

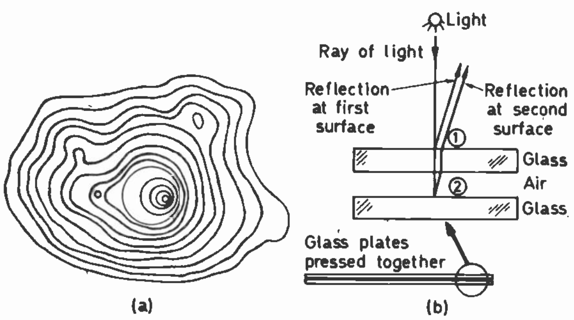



*Fig. 3: Newton's rings. (a) Typical pattern seen between glass plates. (b) The two reflected waves have travelled different distances and their phase will depend on the spacing between the plates, which are never truly flat. Perfectly flat plates would show no pattern. Each space between rings represents a change of air gap of 50 millionths of a centimetre.*

## Forming Holograms

Holography, first suggested by Professor D. Gabor of Imperial College London, is a reversible process of forming an interference pattern of an object. The process involves using a light source and a recording medium, such as a photographic plate, to form the hologram, which can then be reconverted to an image by viewing, either directly or by the use of a screen. The difference between this process and conventional photography is that no lenses are used and that the pattern on the photographic plate bears absolutely no resemblance at all to the object which has been holographed. Also unless the light source used has certain features not

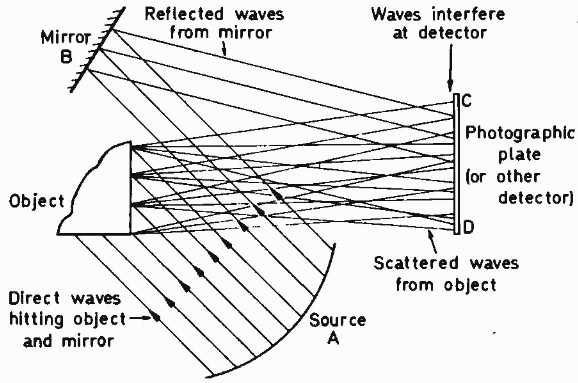



*Fig. 4: Creating a hologram.*

generally found in conventional sources of light the pattern is neither obtained nor reconverted. Incidentally it is interesting to note that Professor Gabor first suggested the process as a lensless method of recording images so that better X-ray images could be obtained since we know no way of focusing X-rays, lenses being useless at the short wavelengths of X-rays.

The basic set-up for creating a hologram is shown in Fig. 4. An object is illuminated by waves from the source A and the waves are reflected from the object on to the photographic plate CD. At the same time waves are also reflected from the mirror B towards the photographic plate. If the source of the waves is very small there will be two distinct wave rays reaching every point on the photographic plate, one reflected from the object and one reflected from the mirror. These waves will interfere so that the amplitude of the wave reaching the plate at any point depends in a complicated way on the shape of the object.

The shape of the hologram is totally unlike that of a photograph. In a photograph, light from a point on an object is focused by a lens so that it reaches a point on the photographic plate, and each point of the object focuses to a *corresponding* point on the plate. In making a hologram, each point on the object reflects (more properly, *scatters*) waves to *all* points on the photographic plate, where they interfere with a "reference wave" coming in a definite fixed direction from the mirror.

When we look at a hologram in the normal way we cannot see the image of the object but only a complicated pattern which might be a giant fingerprint or an entry at an art exhibition. The reason for this is that the "reference wave" which plays such an important part in forming the hologram is missing. A good comparison is with a single-sideband, suppressed-carrier radio transmission (or the suppressed-subcarrier colour TV chroma signal). To receive these correctly we have to supply the missing carrier in the correct phase and then detect. Similarly before we can detect a hologram with our eyes it is necessary to supply the missing "carrier" wave at the correct frequency and phase. We shall discuss some of the problems of doing this later.

## Characteristics of Holograms

Because each part of the hologram carries information about all portions of the object, a hologram can be broken up into a number of parts each of which can still be used to reconstruct the object. Something must of course be lost and in this case it is the resolution, but the difference between hologram and photograph is evident. Another striking difference is that the hologram contains information about the distance of each part of the object from the photographic plate and not merely information about the object's length and breadth so that holograms are three-dimensional in nature.

In photography we can create this 3-D effect only by taking two photographs from slightly different positions and arranging that each eye of the viewer sees a different image. This is a clumsy process compared with the holographic method where instead of different viewpoints a reference beam is directed on the hologram and, as shown in Fig. 5, the image can be viewed in the normal manner. Further if with a hologram we change the angle between our direction of viewing and the reference beam, for example by moving our position, it is as if we actually change the angle at which we viewed the original object, the image appearing to us as if we had been able to turn it. It is in fact possible to make a hologram which contains all information on all sides of an object so that rotating the angle of the reference beam enables us to view all sides of the image in turn. It is almost like the dream situation of seeing a photograph of a house and then without moving looking behind it to see what the garden is like! Another point about holograms is that the difference between positive and negative images is unimportant since one can be converted into the other by adjusting the phase of the reference wave.

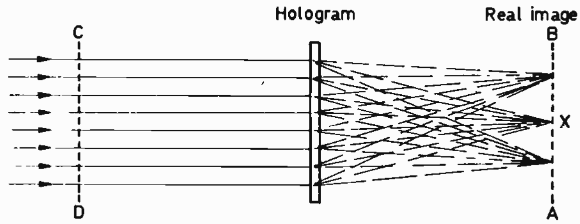
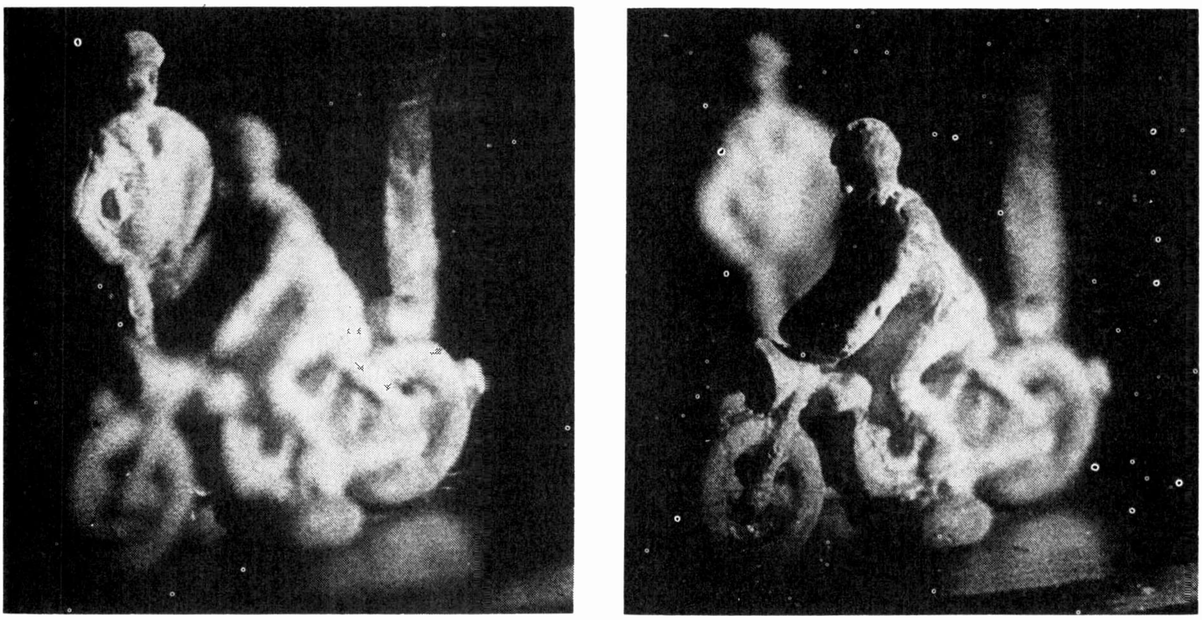



*Fig. 5: If the hologram is held in a parallel beam of suitable waves the interference of these waves caused by the hologram forms a real image which can be projected on to a screen at position AB. If instead an observer's eye is at position X he will see the image at position CD.*

It all sounds too good to be true. Take the lens away from the old Box Brownie, arrange your scene with a mirror to provide a reference beam, get a hologram which does not need printing to a positive and project your image so that moving the projector's light position enables you to see the picture at a different angle! In addition, no distorting lenses and it doesn't matter if the dog eats half the picture! It sounds too good to be true and it is, but the reasons for the impossibility of the scene just imagined are rather complicated.

## Practical Problems

Holography indeed was not a practical proposition when it was first suggested and is still not practicable with most light sources. This is the case with most inventions—the means of making them work not being available when the idea first occurs. With holography the snags are the wave sources and



*Showing the 3-D nature of a holographic display. The display of a hologram of model soldiers was photographed using a camera with a small depth of focus, the left-hand photo being made with the camera focused on to the rear plane of the display and the right-hand photo with the camera focused on the front plane of the display. (Photos courtesy The Marconi Company Ltd.)*

the detection of the waves. Since we are going to combine two sets of waves at the detector it is important that the sources of the waves should keep in step. It is equally important that we should be able to detect the holographic pattern over a reasonably large area, for though each small area contains all the information needed the resolution suffers if the area is too small while if the area is comparable in dimensions to the wavelength of the waves being used no hologram can be formed at all.

One method which seems obviously easy is to use light waves and record on a photographic plate. For reasons which we shall discuss shortly this has been possible only recently. Radio waves can be used, but we cannot conveniently "photograph" radio waves and it would be tedious to move a receiver over a large area, noting the wave amplitude and plotting it at various points, even if we took the sensible step of using short wavelengths such as 3cm. microwaves.

### Quanta and Coherence

The apparatus shown in Fig. 6(a) does not produce any interference effects with light, the apparatus shown in Fig. 6(b) does. Early physicists were puzzled by this difference but accepted that interference effects could be demonstrated only if a single beam of light was split into two parts, one being taken along a slightly longer path than the other before being recombined to give *interference fringes* as they are called. The difference in length between the paths has to be very small, only a few (up to 50 or so) wavelengths of light. As the wavelength of light is only 50 *millionths* of a centimetre this means that interference effects in light have to be demonstrated using very small distances indeed, and this accounts for the usefulness of interference in the measurement of small distances. Once again early physicists were puzzled by this: they could not see why interference effects could not be obtained using longer path lengths, and their problem was not solved until much later.

At one time, one reason for the difficulty of obtaining interference effects from two light sources was thought to be the bandwidth of the light. White light consists of a very wide band radiation extending from around 100 million MHz to 250 million MHz—the bandwith of about 150 *million* MHz makes the frequency response of your video amplifier look a bit tame and should increase your respect for the human eye. It is asking rather a lot that this huge range of frequencies from two different light sources should interfere simultaneously, so it would seem reasonable to try the experiments of Fig. 6 again with light of a more limited bandwidth or, as it is more familiarly known, light of a single colour. When we do this we find that the fringes produced by the method shown in Fig. 6(b) are very much more distinct and have a more "focused"

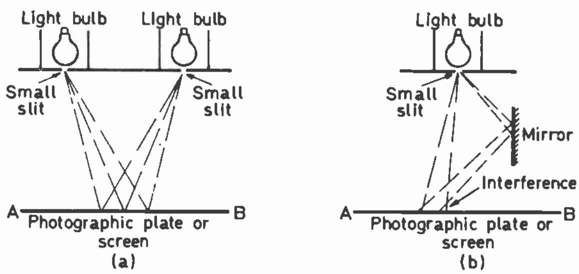



*Fig. 6: Interference is seen only when one light beam is split into two sections one of which travels farther than the other. (a) There are no interference effects seen with this set up. (b) With one bulb and one slit, interference effects are seen.*

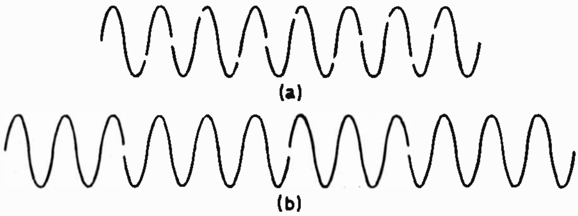



*Fig. 7: (a) Diagrammatic representation of "quanta" or "wave packets". Note that the phase usually changes after each break. (b) Effect of quantum breaks at longer wavelengths (not to scale).*

appearance, but the method shown in Fig. 6(a) still does not work. Thus another effect must be present. Though limiting the light bandwidth is not the answer to the problem it does indicate that our holograms might have to be made with light of a single colour if we are to have good resolution of fine detail.

The "other effect" was not discovered until the end of the last century. It forms the basis of the Quantum Theory of Max Planck and is probably the most far-reaching theory in all physics. What it boils down to is that no oscillation is truly continuous. Instead oscillations stop and start, giving a broken train of waves as illustrated in Fig. 7. It may seem odd that this effect was not noticed earlier, but the breaks are very small and cannot be observed directly though the effects which we have mentioned are the consequences of these breaks.

For long waves the gaps are very small compared to a wavelength and occur between a large number of wavelengths; for short wavelengths the gaps may occur several times in the course of a single wavelength. In the first case we can observe the wavelength but we cannot see the gaps bcause they are so small and infrequent. In the second case we cannot observe the waves either because we have no means of doing so. In each case however Planck's Theory predicts that the product of the energy of the wave and the time between the gaps is a constant (small) quantity now called Planck's Constant. This can be measured in a variety of different ways and appears always to have the same value.

We can now see why it is not possible to produce interference between two separate light sources. Each source is producing pieces of waves (quanta) and there is no way of ensuring that the phase of one quantum is the same as the phase of the next—in fact it is almost certain that there will be some difference. For long waves this should be less of a problem since as the gaps are so very small compared to the wavelength the phase differences must also be small.

The ability of any wave source to produce quanta whose phase is constant or at least does not vary too much from one wavelength to another is called *coherence.* The longer a wavelength the easier it is to produce coherent waves and the easier it is to maintain that coherence over long distances because these distances represent only a few waves. For this reason it is easy to demonstrate interference with two loudspeakers, for sound waves are coherent over long distances. On the other hand it is almost impossible to show coherence in normally-produced light waves because coherence extending over a few light wavelengths means that we should be reduced to an impossibly close spacing of our apparatus.

## *Enter the Laser*

One of the properties unique to the *laser* as a generator of light waves is that these are coherent over an enormous number of wavelengths amounting to a distance of several metres. This is because of the way in which the laser generates light. In an incandescent lamp of the normal type groups of atoms are oscillating due to the electrical energy with which the lamp is being fed. There is nothing to keep the individual oscillators in step, so it is not surprising that the light is not coherent. In a laser however the energy fed in (electrical, chemical or in the form of other light) is used to raise the electrons of each atom to a higher energy level. When an electron then returns to its normal energy level the light emitted can trigger the other electrons so that the portions of wave are kept in step and the light emitted is coherent. Because of this the laser is the ideal source of light for holography.

## *Applications*

Until recently the main applications of laser holography have been in the realms of metrology, the science of exact measurement. Suppose we have a manufactured object which has to be made to very close limits. By using a laser in a holographic set-up we can make a hologram on film which is a coded representation of the object. If we keep the object and its hologram in position and rearrange the laser and the mirror so that we produce an image of the object in exactly the same place as the object, then when image and object coincide exactly nothing unusual is seen. If however a slight change has occurred in the object, for example expansion due to a tiny temperature change, then the image and object are no longer identical and the object has interference bands across it. The spacing of the interference bands indicates the difference in dimensions between the object when it was holographed and when it was imaged, close spacing meaning large differences and wide spacing small differences. The words large and small here mean in comparison to a wavelength of the light used.

Using this idea we can measure very small changes in dimensions such as occur when metals are magnetised, and we can make these measurements without any physical contact with the object. We can also very rapidly check the dimensions of a copy of the object since any deviation from the dimensions of the one used to form the hologram will show up. Laser holography is in this way of enormous value to industries producing items to very fine tolerances.

## *RCA Selectavision System*

Recently an application of laser holography to TV was announced. RCA have shown the first prototypes of their colour TV recording system which uses the holographic principle as a convenient way of coding an image. RCA claim that reproduction of the image can be carried out by a player whose cost is estimated at about $400 (£170) and which plugs into the aerial terminal of an ordinary colour TV receiver. This compares very favourably with even a black-and-white magnetic videotape player and the amount of tape required for a given length of programme seems to be smaller.

Few details have been released of the Selectavision system—as it is called—at the time of writing but the whole process starts with the production of a holographic tape. A colour programme, which may be live or from tape or telecine, is used in the form of a video signal. This video signal is recorded on conventional photographic film by means of an electron-beam recorder, shown in diagrammatic form in Fig. 8. The electron beam is obtained from a conventional cathode-ray tube gun but in place of a screen there is a carrier which winds the film past the scanning beam in a vacuum. In scanning

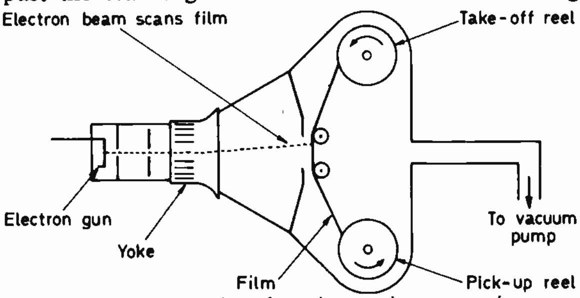


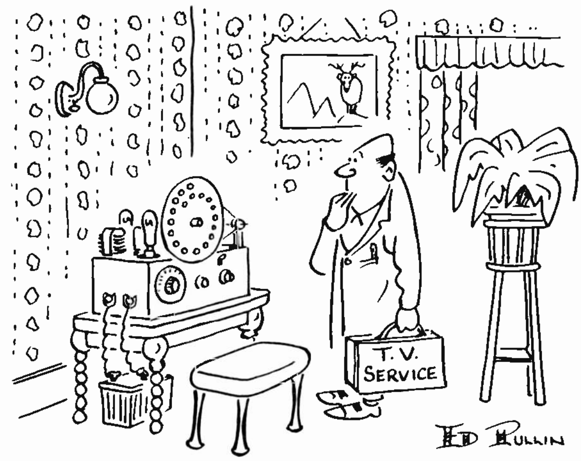

*Fig. 8: Basic outline of an electron-beam recorder.*

the film the beam exposes it with an intensity proportional to the amplitude of the signal. If a light beam scans the developed film the video signal can be recreated in conjunction with a photocell. The brightness, hue and saturation information are contained in this video signal and the tube used for recording needs only one gun and no shadowmask.

The film of the video signal could be used directly as the recording but film is expensive to copy. If this were not so it would be cheaper to film the original programme and sell copies of the film. Instead it is necessary to turn the film into a form which can be copied cheaply. To do so a hologram film is made, using the now-familiar holographic recording set-up. This hologram is made not on ordinary film but on a plastic tape coated with photoresist—the material used in the production of printed and integrated circuits. This material hardens when exposed to light but can be easily washed off where it has not been exposed. When the hologram has been made the film is washed to remove the unexposed portions.

Imagine the appearance of this film. The pattern on it is that of the typical hologram—loops and lines in perplexing order—but the loops and lines are raised portions of hard material. We have thus converted from a light-and-shade image into a high-and-low hologram in one operation. This is the holographic master tape and can be reproduced using the same techniques as used for LP records which also consist of patterns cut in a suitable material. The master tape is electroplated with nickel and the nickel carrying the exact shape of the holograms on the master tape is next stripped off. The nickel tape can then be laid on a transparent vinyl tape and the two passed between heated rollers resulting in a pressed out copy of the original. Since this is a printing process and can be made continuous, can operate at high speeds and needs no chemical processing it is relatively cheap. RCA estimated that the cost of a 30-minute tape would be about £4 which is very much less than a colour film copy would cost even in 8mm. stock. Just as with LP records thousands of copies can be made from one master.

## THE LIGHTER SIDE . . .




The problem now is to convert from the hologram tape to the video signal and this is the part of the process about which least has been revealed. If the tape is reeled past a laser and a mirror in the standard arrangement for reproducing a hologram, the image which can be detected will consist of the original recorded image, that is of light and shade corresponding to the amplitude of a colour video signal. If the reproducing beams are arranged to interfer at the photocathode of a photomultiplier then the light and shade signals will produce an electrical signal—the video signal which we want.

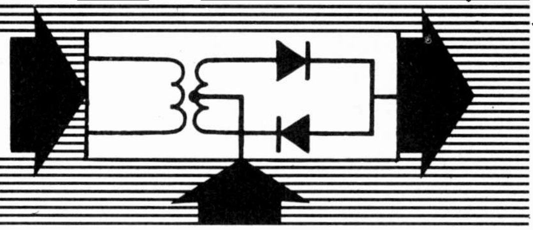
This video signal will contain all the information required to operate a colour TV set, including the sync and colour-burst signals, but it will be usable only if the rate at which it is played back is equal to the rate at which it is recorded. The playback system must therefore wind the tape at a reasonably constant speed equal to the speed with which the original recording was made, though this requirement is not so stringent as that for a videotape recorder since the hologram is tolerant of mis-positioning.

More important is the scanning of the tape. If the laser beam can be scanned the light can be focused straight into a photomultiplier, as has been assumed in this description. If the laser beam is not scanned the scanning must be done by the pick-up tube, which would presumably be of the form of the old-time Farnsworth image dissector (see *Early TV Camera Tubes*, PRACTICAL TELEVISION, June 1969). In either case some form of sync signal would be necessary so that the scanning keeps in step with the rate used at the recorder, but again we would expect this process to be very tolerant of errors.

The video signal is then amplified and modulated on to a suitable r.f. carrier so that it can be fed directly to a colour TV set aerial input socket.

This has not been the only announced application of lasers to TV. Others include large-screen colour TV and also 3-D TV. The Selectavision system however seems to be the most advanced application of lasers to TV practice and is certainly the only application so far of holographic recording. It is certain that we shall see other applications of this remarkable method of image coding and decoding. ■

# SYNCHRONOUS DETECTORS



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Most colour receivers incorporate four synchronous demodulators, one to detect the R–Y colour-difference signal, one to detect the B–Y colour-difference signal, one to detect the burst signal and one as a.f.c. discriminator in a flywheel line sync circuit. Thus the first thing to note is that synchronous demodulators are not something completely new, though the synchronous detector circuits used in colour television receiver decoders are rather different from the familiar line sync discriminator circuits. The Philips G6 single- and dual-standard chassis use in addition a further synchronous demodulator as automatic chrominance control rectifier.

### Phase-sensitive Detectors

An alternative name for synchronous demodulators is *phase-sensitive rectifier* and this brings out the important feature of synchronous detectors, that they provide an output which is proportional not only to the amplitude of the signal to be detected but also its phase at the instant of detection. This means that unlike a simple diode detector a synchronous detector will provide either a positive- or negative-going output depending on the phase of the signal being demodulated at the instant of detection—or, more accurately, to the phase relationship between the signal being demodulated and the reference signal also fed to the synchronous detector, synchronous detectors requiring as we shall see two inputs.

This phase-sensitive action is illustrated in Fig. 1. A sinewave signal is shown at (a) and a simple diode detector would pass either the positive or negative-going signal excursions depending on which way round it was connected. If a synchronous detector conducts at instants A during each cycle of the sinewave it will provide an output as shown at (b), while if it conducts at the instants marked B it will provide an output as shown at (c). These outputs of course assume that there is no load capacitance in the detector circuit.

### Timed Rectifiers

We have emphasised the instant of conduction. This is because synchronous detectors are "timed", that is unlike a simple diode detector which conducts on alternate half-cycles of the signal for a certain time a synchronous detector conducts, as illustrated in Fig. 1, for a brief, set instant each cycle or half-cycle (depending on the type of circuit). As a result of this instead of getting an output which is always either positive- or negative-going, the output of a synchronous detector is positive- *or* negative-going as shown in Fig. 1(b) and (c), depending on the phase of the signal at the instant conduction. Thus a synchronous detector rectifies either the positive- or negative-going signal excursions depending on the point during the reference signal cycle at which it conducts, the reference signal providing the timing action. Fig. 1 (d) shows a synchronous detector in block schematic form: the reference signal switches the synchronous detector on once or twice each cycle to obtain the required output.

### Need for Synchronous Detectors

But why is a phase-sensitive detector necessary for demodulating the chroma signal, that is for R–Y and B–Y colour-difference signal demodulation?

It will be recalled that in colour television the *amplitude* of the chroma signal denotes the *strength* or *saturation* of the colour—whether for example it is pale pink or deep red—while the *phase* of the chroma signal denotes the actual colour—red, green, blue and so on. So in demodulating the chroma signal we need to extract information on its ampliude and phase—which a synchronous demodulator does.

To take an example, Fig. 2 (a) shows the basic B–Y colour-difference signal for the standard colour-bar test pattern while Fig. 2 (b) shows this signal after modulation on to its subcarrier. If (b) is demodulated by a simple diode detector we get the signal shown in Fig. 1 (c). This is plainly very different to Fig. 1 (a)! And this is because the output of a simple diode detector tells us nothing about the phase of the chroma signal.

The important difference between Fig. 1 (a) and (c) is one of polarity. In Fig. 1 (a) bars 1, 3 and 5 are negative-going while bars 2, 4 and 6 are positive-going. In (c) they are all positive-going—which would give us, to take the first colour bar (we are ignoring the white and black bars of the actual test pattern since there are of course no colour-difference signals during these bars) a blue signal (compare with bar 6) on the yellow bar when the blue gun of the tube should actually be cut off, yellow resulting from a combination of red and green in colour television.

### Colour Signal Modulation

Now the modulation system used for the colour-difference signals indicates to the receiver whether the detector output should be positive- or negative-going. This is done by modulating the chroma subcarrier in both phase and amplitude, phase as previously mentioned indicating the particular colour and amplitude its saturation. The "colour clock" diagram shown in Fig. 3 makes this clear. The chroma signal can vary in

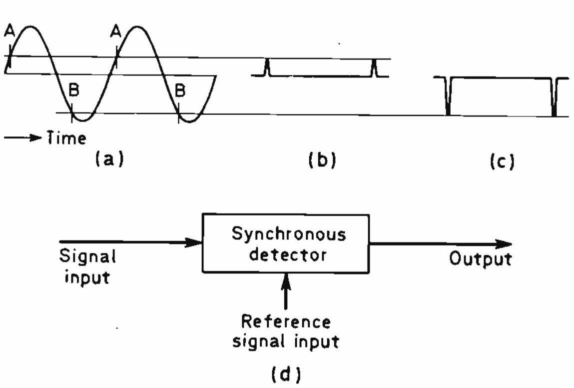



*Fig. 1 (left): Operation of a phase-sensitive rectifier. The rectifier will produce an output as shown in (b) if switched on at the points marked A during the sinewave input; if switched on at the points marked B it will produce an output as shown at (c). The polarity of the output thus depends on the instant at which the rectifier conducts during the input waveform. In (d) a block diagram of a synchronous detector is shown: the reference signal input is used to switch on the synchronous detector which then samples the signal input providing an output which depends on the phase and amplitude of the signal.*

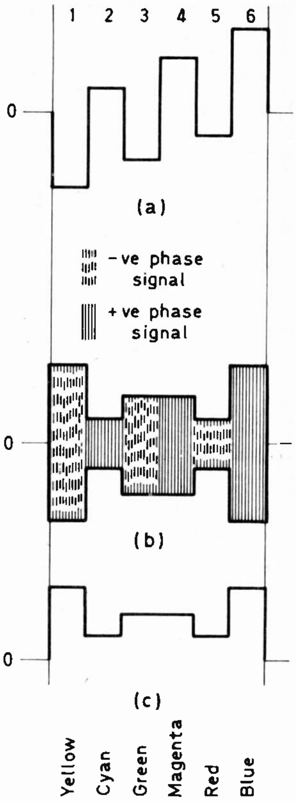



*Fig. 2 (right): (a) The B—Y colour-difference signal for the standard colour-bar test pattern. (b) The signal shown at (a) modulated on to its subcarrier. (c) Output derived from (b) by a simple diode detector.*

phase from 0°, representing red, at the top, right round to red again, the various phase positions in between (360° = one cycle of the subcarrier) representing different colours. Thus a signal at A, 10° away from R, would consist of red with a small amount of blue added, i.e. a variation away from pure red towards magenta. A signal 225° away from the reference 0° point brings us into the –B and –R regions, i.e. here the blue and red guns of the tube are biased back to give us a yellowish green colour. At C we've a mixture of equal red and blue giving magenta while at D we have blue but R is in the negative region giving us a cyan shade—shown in this case as being of low amplitude to bring out the saturation/signal amplitude aspect.

To go back to Fig. 2(b), it will be appreciated that the phase of the signal on bars 1, 3 and 5 is such that the signal moves in the –B region of the "colour clock" while on bars 2, 4 and 6 the phase of the signal is over on the right-hand side of the colour clock.

It will be clear now why a phase-sensitive detector is needed to get (a) instead of (c) in Fig. 2: if our chroma detector tells us something about the phase of the signal as well as its amplitude, then we shall be able to recover (a). And this is where the second, reference signal input to the synchronous detector comes in. This input is used to switch on the synchronous detector briefly once or twice (depending on circuit configuration) each subcarrier cycle to sample the amplitude *and phase* of the signal at that

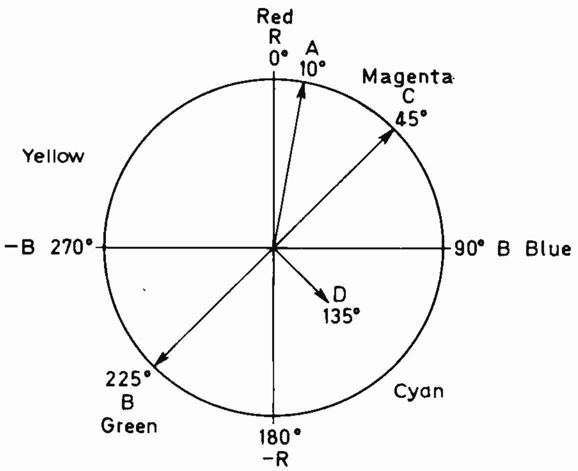


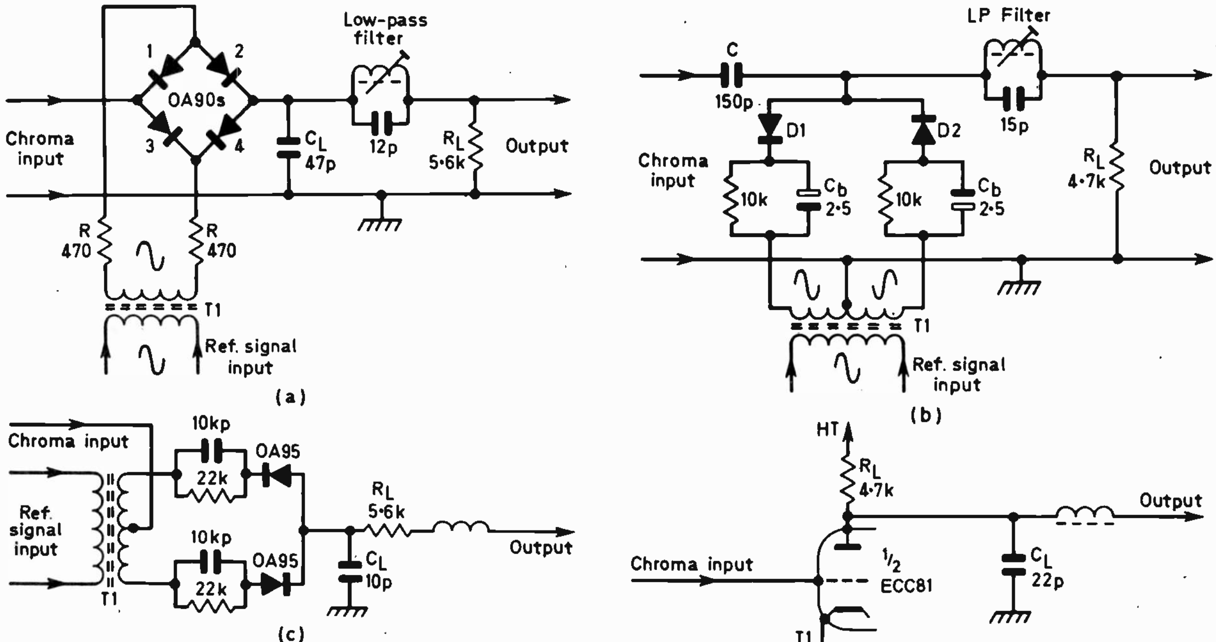

*Fig. 3: The "colour clock": the phase of the chroma subcarrier varies to indicate different colours.*

instant, the output then being of the correct amplitude *and polarity*. For this action to be accurate of course the transmitter subcarrier and receiver reference oscillator must be synchronised and for this purpose the colour burst is transmitted once each line.

To return to the B—Y colour-bar signal shown in Fig. 2 (a), to obtain correct reproduction we need to know during each bar the polarity and amplitude of the signal as indicated by the phase and amplitude of the modulation. So what we do is to arrange for our B—Y synchronous detector to conduct briefly at the 90°, or 90° and 270° points, in Fig. 3, i.e. on the B—Y axis. It will then tell us once or twice each subcarrier cycle the amplitude of the B—Y signal at that point and whether it is of negative or positive polarity. If we switch it on on every half-cycle we must of course invert the output on alternate half-cycles to get a consistent signal.

## Practical Circuits

There are many variations in detail in synchronous detector design but all those so far used in colour sets in this country fall into one of four categories: series-diode bridge, series-diode pair, shunt-diode pair and triode valve. The series-diode bridge has till now been most frequently used and was briefly introduced last month. It is shown again in Fig. 4 (a). When the diodes are non-conducting the chroma signal is isolated from the load resistor $R_L$ and its associated capacitor $C_L$. A reference signal at subcarrier frequency is also however fed to the bridge, via T1. Once each cycle the junction of diodes 1 and 2 will be sufficiently positive for them to conduct



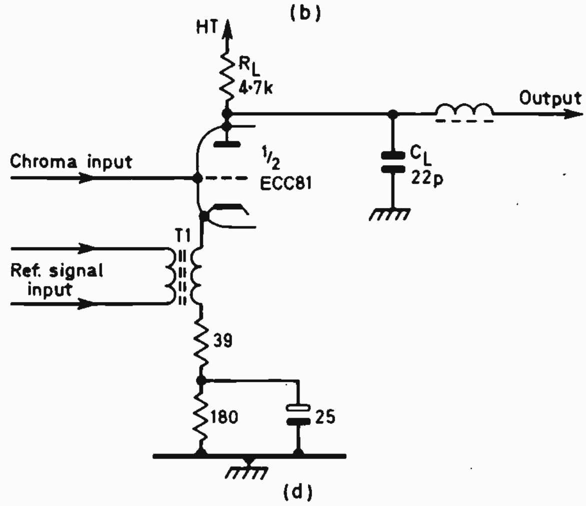




*Fig. 4: Four types of synchronous detector: (a) series diode bridge; (b) shunt diode pair; (c) series diode pair; (d) triode valve.*

and, 180° later, the junction of diodes 3 and 4 will be sufficiently negative for them to conduct. During these occasions $C_L$ charges to the chroma signal amplitude—positive or negative with respect to earth. The diodes are in opposite polarity on alternate half-cycles, giving the required signal inversion.

The bridge must of course conduct only briefly on each occasion—on the negative and positive tips of the subcarrier signal. With a peak chroma signal of about 1V a 5-7V reference signal is necessary and the resistors *R* ensure that the diodes conduct only on the peaks of the reference signal input. The reference signal itself is not wanted of course and is filtered from the output by the low-pass filter.

## Quadrature Detection

Now if there is no chroma signal, or the chroma signal is 90° out of phase with the reference signal, there is no output: the reference signal is filtered out while if the chroma signal is 90° out of phase with the reference signal it will be at zero at the instant when the diodes conduct. This latter feature enables the detector to discriminate against unwanted cross-talk between the R−Y and B−Y colour-difference signals. Although these are separated in the PAL system in the delay-line circuitry, nevertheless slight unbalance in circuit tolerances may lead to some B−Y information being present at the input to the R−Y detector and vice versa. As the R−Y and B−Y signals are 90° out of phase however unwanted cross-colour components will be ignored by the detectors since the reference signals fed to them are in quadrature—90° apart in phase—and synchronised with the transmitter's subcarrier so that the R−Y detector operates on the correct R−Y axis and the B−Y detector operates on the correct B−Y axis. A 90° phase shift network is generally incorporated in the reference oscillator feed to the B−Y detector in order to achieve the correct 90° phase displacement between the instants of conduction of the two colour-difference synchronous detectors.

## R-Y Switching

With the R−Y signal we have of course the further complication that its phase is alternated 180° from line to line in the PAL system. It will be appreciated however that this can be adjusted in the receiver either by shifting the R−Y signal back again in phase on alternate lines or by inverting on alternate lines the phase of the reference oscillator feed to the R−Y synchronous detector.

## Dual-diode Detectors

A shunt-diode pair synchronous demodulator is shown in Fig. 4(b). Here the previous system has been re-arranged, the capacitor being in series with the signal instead of shunting the output while the active elements are in shunt instead of in series with the chroma signal. The two diodes form a bridge with the centre-tapped secondary of T1. The inset waveforms show that the two diodes conduct together once each reference signal cycle—when the signal at D1 cathode is negative-going and that at D2 anode positive-going. The whole bridge is effectively at earth potential when the diodes conduct, and the capacitor then charges to the signal voltage presented to it, subsequently discharging via $R_L$. The bias capacitors $C_b$ charge up so that the diodes conduct only on the tips of the reference signal.

### *Clamp Detector*

It will be noticed that the basic circuit shown here is identical to one form of d.c. clamping circuit, and in fact this circuit is sometimes referred to as a clamp detector. The difference is purely one of frequency of operation. A black-level clamp is switched on at line frequency, i.e. once each line or 15,625 times a second, whilst a synchronous detector is switched by the reference signal at 4.43MHz. The effect is much the same: in the clamp circuit the coupling capacitor charges to the sync tip amplitude every time the clamp conducts while with the synchronous demodulator the capacitor charges to the varying chroma signal amplitude each time the detector diodes conduct.

### *Series-diode Circuit*

A series-diode pair synchronous detector—as used in the Philips G6 chassis—is shown in Fig. 4(c). As in the circuit shown in (a) the diodes isolate the chroma signal from $C_L$. The diodes conduct once each reference signal cycle and $C_L$ is then charged by the chroma signal. The capacitors in the bridge ensure that the diodes conduct only on the reference signal tips.

### *Triode Synchronous Detector*

For the sake of completeness Fig. 4 (d) shows the triode synchronous detector used in early Baird colour chassis and in many US models. The cathode circuit is controlled by the reference signal and incorporates a bias network so that the triode conducts briefly on the tip of the reference signal waveform, $C_L$ then being charged by the chroma signal.

### *Burst and Flywheel Sync Detectors*

To turn finally to the burst and line a.f.c. discriminators, these of course have in common the fact that they both provide an output to control the frequency of an oscillator—the decoder reference oscillator in the former case and the line oscillator in the latter. The principle of operation is similar to that already described. In the case of the burst detector the burst signal (the 10 cycles of subcarrier transmitted during the sync pulse back porch period) is one input and the reference oscillator output the other, an output being obtained only when both signals are applied to the detector. The output is positive- or negative-going depending on whether the oscillator leads or lags the burst signal in phase, and is used after smoothing as a control potential to control the reference oscillator frequency. In the case of a flywheel sync circuit the inputs to the discriminator are of course the sync pulses and a reference waveform tapped from the line oscillator (rarely) or the line output transformer. The control action is the same as in the case of the decoder reference oscillator. We will give examples of burst phase detector circuits in a later article when we consider the entire burst gating and amplifying circuitry and the a.p.c. loop. ■

# versatile IC 'SCOPE PREAMPLIFIER PART 2

MARTIN L. MICHAELIS, M.A.

THE output at Sk4 should be connected to the oscilloscope with any convenient length of coaxial cable not exceeding about two yards. Special alignment for a particular length as for an input signal probe is not necessary here. The acceptable cable length and capacitance tolerance at Sk5 are even greater since the bandwidth restricting capacitor C17 already imposes a high basic capacitive load. Resistors R33, R34 and R32 restrict the possible currents at the respective outputs so that even prolonged short-circuits with full drive cannot damage the preamplifier. Both outputs—Sk4 and Sk5—are suitable for driving headphones of any impedance from 50Ω to 4kΩ directly. As shown in Fig. 2 last month the preamplifier may be used in this manner as a sensitive r.f., i.f., a.f. signal tracer on its own.

With the oscilloscope connected to Sk4 headphones (or any ordinary monitor amplifier with loudspeaker) may be simultaneously connected to Sk5. Alternatively, with the oscilloscope connected to Sk4 the i.c. millivoltmeter described in the Oct. issue may be connected simultaneously to Sk5. Always connect to the 5V f.s.d. range of the i.c. millivoltmeter, never to any other range, when using the instrument in this manner. The voltmeter reads according to its normal ±5V f.s.d. scale when the coarse gain switch of the preamplifier is in the centre position 2 and the 10:1 signal probe is used at input Sk1. In switch position 1 the meter then reads ±25V f.s.d. and in position 3 it reads ±2.5V f.s.d. with corresponding deflection sensitivities on the oscilloscope in each position.

The vernier gain control of the Videoscope MV3 allows for 10:1 ratio maximum discrepancy between the d.c. and a.c. components of a signal whilst remaining within the linear ranges of the equipment. Switch S2 must of course be set to d.c. whenever meter and scope displays are required simultaneously. If during a series of tests through a piece of equipment the odd test point carries an excessive d.c. potential temporarily move S2 to a.c. for such test points to mute the meter. Provided the 10:1 signal probe is always used for dual meter-and-scope readings there are no significant meter offset shifts with different source impedances at the test points touched with the signal probe.

To set up connect the signal probe, preamplifier, i.c. millivoltmeter and oscilloscope as shown in Fig. 2 and switch on the i.c. millivoltmeter *first*. After adjusting its set zero control switch on the preamplifier and then adjust its d.c. shift control to re-zero the meter. Do not touch the zero control of the i.c. millivoltmeter again. Any zero corrections of the meter are subsequently always made with the zero shift control of the preamplifier. Set the polarity switch on the i.c. millivoltmeter as required. It is equally permissible to readjust the preamplifier d.c. shift control for centre zero meter reading if repeatedly changing d.c. component polarities are encountered at successive test points. This does not affect the a.c. component display on the oscilloscope.

If the strobe-trigger timebase unit is also included in the equipment set-up always connect the preamplifier between the signal source and the strobe-trigger timebase unit, not between the latter and the oscilloscope. There are no restrictions in the logically available functional combinations and the i.c. millivoltmeter or headphones may be connected simultaneously to the second output of the preamplifier.

## First Stage

The gain factor is determined in the normal manner for an operational amplifier as the ratio of the negative feedback resistor R13 to the total $\overline{IP}$ source resistance R6+R4+R5=420kΩ. This ratio is evidently 5. The output lag capacitor C11 and the input frequency compensation C8, R14 have been given corresponding fixed values.

As usual $\overline{IP}$ is a voltage node point (virtual chassis short-circuit) with the heavy applied negative feedback via R13 so that for input signals coming via R2 or R3, R6 behaves as if it were in parallel with R4 and R5, presenting a net impedance of roughly 100kΩ between the bottom end of C3 and chassis. It is not practicable to obtain a higher impedance value here by using proportionately higher values for R4 to R6 because this would demand impossibly large values for R13 to maintain the required gain factor. The author has satisfactorily used values of up to 15MΩ in the equivalent position R13 for mathematical operations (we shall meet an example in a subsequent operational amplifier article featuring a frequency meter) where large capacitances are in parallel therewith to provide the integrator function, but the system is prone to severe instability and excessive noise if values much greater than 2MΩ are used in a.c. amplifier applications.

We are using conventional IP-side voltage offset balance with VR1 to set the d.c. operating point right through both stages. To maintain reasonable offset current symmetry and thus keep the class A operating point on the track of VR1 even in the maximum gain setting of S3 it is necessary to satisfy the usual condition that the source impedances at IP and $\overline{IP}$ should not differ too greatly. Hence the large value of R7 to match R4 to R6, which R8 alone cannot match.

We mentioned last month the fact that a differential amplifier generates at least twice as much thermal input noise as a single-ended stage because being random the noise components at IP and $\overline{IP}$ do not cancel but add quadratically and there is a current division noise contribution. C7 mitigates this additional noise by reducing the IP source impedance drastically for a.c. signals, leaving only R8 as surge safety resistor in this branch.

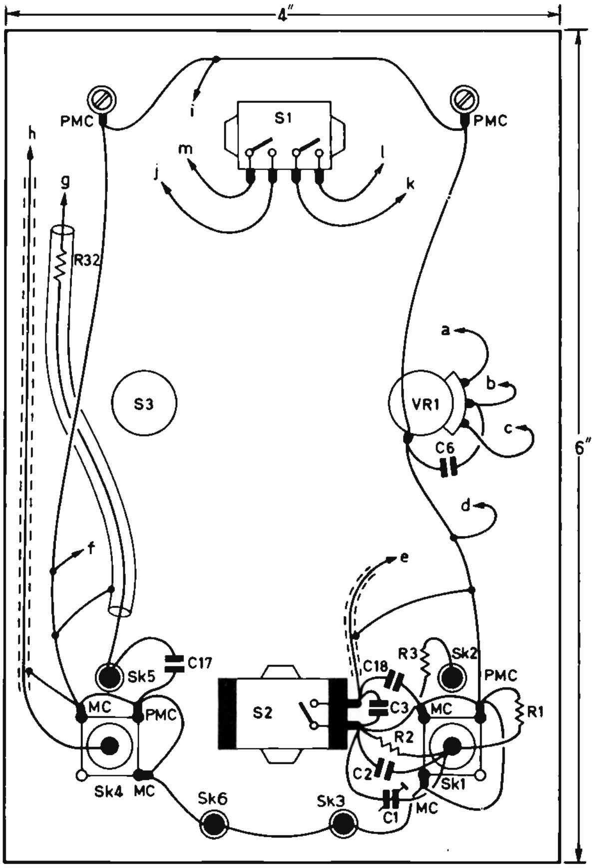
The value of R7 has been chosen sufficiently smaller than the sum of R4 to R6 to bring the class A operating point (zero d.c. voltage at outputs with inputs open-circuit) near the positive end of VR1 track in the maximum gain setting of S3. This provides class AB, B and C operating points too within the range of VR1.

Check as follows: The class A operating point (voltmeter at Sk5 reads zero) should lie about 30% of the track of VR1 from the right-hand stop with S3 in position 3. The class B operating point (amplifier just cutting off) should lie about 30% of the track of VR1 from the left-hand stop. The grass on the Videoscope MV3 at maximum gain setting, S3 in position 3, vanishes abruptly at this point leaving only the undisturbed timebase trace for all settings of VR1 further to the left. Alternatively check with headphones at Sk5; the weak background hiss vanishes abruptly at the class B point.

If the class A and class B points do not lie reasonably close to the specified settings of VR1, judiciously adjust the values of R9 and R10 after first making sure that the trouble is not due to grossly unequal voltages of the two batteries. Apart from the need of two stages for proper positioning of the gain switch and for no net inversion of signal polarity, the two-stage arrangement preserves absolutely symmetrical current drain from the two batteries regardless of d.c. operating point because when one stage is driven up the other is driven down and vice versa. Thus the total current drain is 3·5mA per fresh battery irrespective of the operating point set by the d.c. component of a signal or with VR1, and the two batteries will discharge symmetrically.

This is why the input $\overline{IP}$ has been used as signal input for both stages even though impedance problems would have been much simpler with the IP inputs and correct signal polarity would have been given just as well. If however the IP inputs had been used as signal inputs any operating point other than class A would have produced grossly unequal battery loading and consequent early exhaustion of only one battery. The resulting confusion regarding battery renewals effectively shortens the service life of a pair of batteries to less than 20 hours whereas with the guaranteed symmetrical discharge at least 48 hours non-stop operation without a rest are obtainable with any operating point, or 60 to 80 hours intermittent.

Always replace the batteries as a pair, not individually, and as far as possible use two batteries from the same batch as replacements. It is then safe to assume that the batteries will always discharge symmetrically giving optimum service life as long as they are not defective. It is not necessary to be unduly apprehensive about battery life by switching on for only brief measurements. It is normally quite economical to switch on at the start of a working session of several hours and to switch off only at the end of work—but remember to switch off before leaving the workshop!




MC Chassis soldering tag under fixing bolt for coaxial socket
PMC Chassis soldering tag under fixing bolt for coaxial socket and printed circuit board
Network MC/PMC bare tinned copper wire
Lead g/R32/Sk5 insulated wire and resistor, insulated sleeving, outside shield braid sleeving
S3 attached to printed circuit board

*Fig. 3: Wiring on rear of front panel.*

## Class B and C Operating Points

There are several very important applications of these features. To mention only two, better output swing exploitation in relation to d.c. components is obtainable with a class B or just AB operating point for highly asymmetrical pulse waveforms. If strobe or trigger is required with waveforms possessing much large-amplitude detail between the dominant pulse sections, e.g. with composite video and sync waveforms, improved stability is possible by selecting a class C operating point to effect sync pulse separation. The correct setting of VR1 for this purpose can be observed by first connecting the preamplifier output to the oscilloscope Y-input and then transferring to the external sync input.

Further consideration of non-class A operating points will be left to a following article introducing mathematical operations with the MC1709CG and featuring a frequency meter. The present preampli-

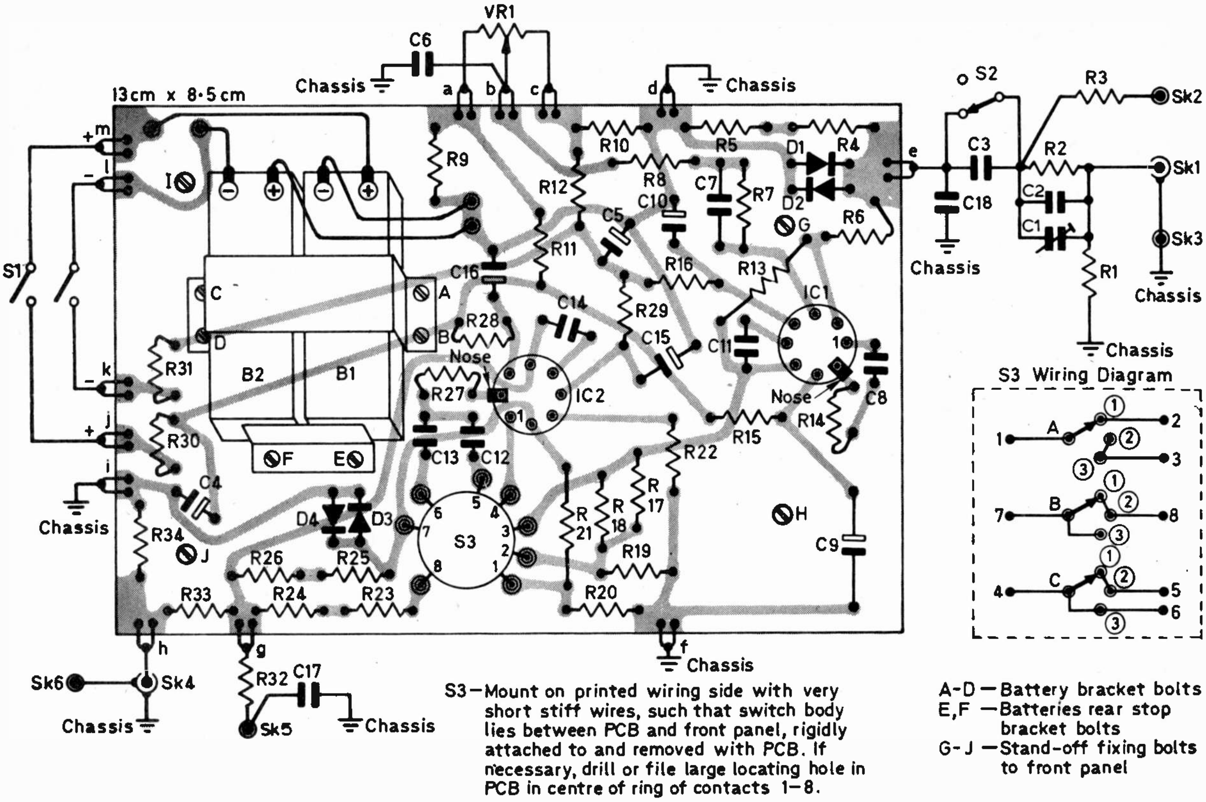



*Fig. 4: Layout of the printed board, viewed from the component side.*

fier is envisaged as drive preamplifier for this frequency meter, with threshold selection facilities similar to the sync separator function of a television receiver.

## Second Stage

The gain factor is here the ratio of R23+R24 (or R25+R26) to R21 plus R19 in setting 1 of S3A or plus the output impedance (about 150Ω) of IC1 in settings 2 and 3 of S3A. The $\overline{\text{IP}}$ source impedance is thus very nearly 2·5kΩ in all settings of S3A. S3B, switching the negative feedback resistors, establishes nominal gain factors of 20 or 40. A common output lag value for C14 suffices for this small range of gain variation, but the input frequency compensation must be switched with S3C. R22 provides the same source impedance for IP as for $\overline{\text{IP}}$ to cancel offset current. This stage possesses no offset voltage compensation of its own since by virtue of the d.c. coupling VR1 serves to control the offset for both stages and thus saves more than half a milliamp of battery current because only one bleeder network is necessary.

## Adjustments

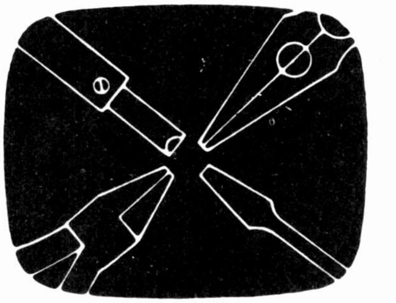
The various series or parallel combinations of two resistors serve for alignment by selection. Equivalent preset potentiometers may be used if desired.

With a signal of about 5kHz fed to Sk2 select a slightly different value for R4 or R5 (if necessary) to make the output voltage at pin 6 of IC1 exactly five times the input voltage fed to Sk2 (use oscilloscope *with* signal probe touched to respective points). Now select a different value for R17 (if necessary) to make the signal voltage across R19 exactly the same as the input voltage fed to Sk2. Next with S3 in position 1 select a different value for R23 (if necessary) to make the voltage at Sk4 ten times as great as that fed to Sk2. Finally switch S3 to position 3 and select R26 to make the voltage at Sk4 ten times as great as a signal voltage fed to Sk1.

## Bandwidth

Inject a squarewave of a few kHz repetition frequency to Sk1 *via the 10 : 1 signal probe (see Fig. 2)* after this signal probe has already had its own trimmer capacitor adjusted for dead-beat squarewave display when connected directly to the Videoscope MV3. Now adjust C1 for dead-beat squarewave flanks, without rounding-off or overshoot noses. The resulting bandwidth is as specified in Table 1 with the 6dB point lying at 350kHz for the W input and output combination if C1 is adjusted for dead-beat squarewaves. If C1 is adjusted to give about 10 to 20% overshoot noses on the squarewave display the bandwidth is boosted to approach 1MHz. This may be useful for some applications involving quasi-sinusoidal signals rather than pulse signals, but for general television work it is generally preferable to use the dead-beat pulse display alignment. A bandwidth of 350kHz is normally quite adequate at high deflection sensitivity and it is usual to restrict bandwidth when boosting deflection sensitivity.

*—continued on page 129*



# SERVICING television receivers

L. LAWRY-JOHNS

## BAIRD 620-640 SERIES

THIS group of models was developed from the 600 series which had many similar features. Some of these notes will therefore be found to apply to this previous series but the correct service information should be used if any involved servicing is undertaken on these earlier models.

These are quite reliable receivers, suffering mainly from width circuit problems or trouble with the u.h.f. tuning drive. The latter trouble takes the form of distortion of the drum on which the nylon drive cord is wound or breakage of the drum at the centre boss. Modified drums were used during production and the serial number of the set should be quoted when ordering replacements. The diagrams which accompany this article should render further comment on restringing unnecessary.

### Width Modification

Modification was also made to the width circuit to increase the range of the control. This it undoubtedly did but it also resulted in the possibility of quite a nasty burn-out, as with the modified arrangement the control was connected directly from the boost line to chassis. The absence of a series resistor means that as the control changes value (which they do) the current increases to a point where the control burns out with the possibility of damage to the panel or nearby components. It is the writer's practice to include a 1MΩ resistor from the low end of the replacement control to chassis to prevent a recurrence of the trouble.

### Access

Whilst servicing the main deck is quite easy since it swings down when the two top side screws are removed (support the chassis when removing the screws or it may swing down quicker than you want it to!) access to the tuners is not so easy in some models as the space is very limited.

The top fixing screws of the side assembly are obvious but the two bottom ones are situated in a very restricted space requiring the use of a long screwdriver or a very small coal miner. The front knobs pull off—even if they do not appear to—as far as the tuners are concerned, but the volume and brightness knobs may have grub screws. Some models have a small cover at the bottom of the cabinet: this allows the v.h.f. turret contacts to be cleaned easily, an operation which is necessary when v.h.f. switching becomes troublesome.

Servicing of the larger and rather handsome 23in. models with folding doors is much easier but the temptation to lift these by the top overhang of the cabinet should for obvious reasons be resisted.

### Common Faults

Mention has already been made of the boost line supply to the width control where some trouble can be expected. Attention is also directed to the boost line supply to the tube first anode and field oscillator. From the circuit it will be seen that this is a common supply point from the top of the focus control R103, the other end of which connects to chassis. As with the width control, so with the focus control: it can and does change value. As it does so the height of the picture is reduced with a perhaps not so obvious darkening of the picture as the first anode voltage at pin 3 of the tube base also falls.

It is not always necessary to replace the focus control if the value has only fallen to say 1MΩ or thereabouts. The optimum position of the slider is usually at the top end and therefore the introduction of a 1MΩ resistor between the bottom end and chassis will often restore normal conditions with no further change of working value. This type of improvisation may cause a frown to appear upon the brow of some engineers who are used to the cosy confines of a workshop, but when one is out in the depths of the Yukon on a cold wet night it has a certain appeal!

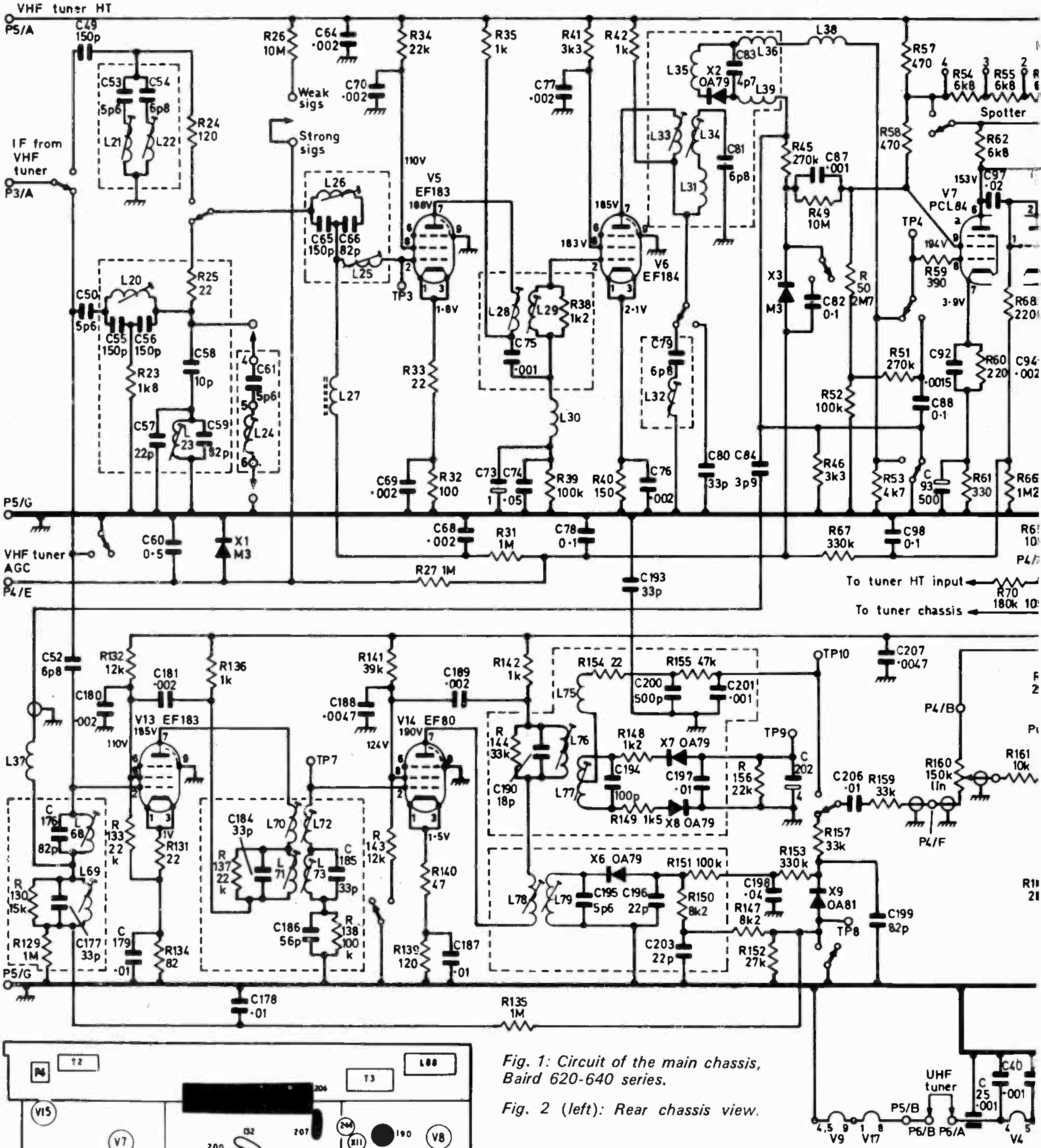
### Field Timebase

Quite often the symptoms of lack of height are due to a failing PCL85 (PCL805) and this is the valve to change when one is faced with a reduced scan, no vertical scan at all, vertical hold troubles or a jittery picture. If a new valve does not clear the trouble or new troubles present themselves try another new one (not all new valves are good).

In the event of lack of height, after this try checking the value of R195 (820kΩ) and C238 for leakage. Then check R187 and R188 if necessary.

In the event of bottom compression check C234 by shunting a 100μF capacitor across it and see that the colours of R178 are bright and clear. This 330Ω resistor does not often change value in this model but it can be damaged by a faulty PCL85.

If field roll is the trouble note whether the control is at one end of its travel or not. If it is check R183 and C235 and also the control itself (remember that the PCL85 has already been checked). If the rolling is up or down with no secure locking point try squeezing the M3 interlace diode X10 with a pair of pliers (to improve the internal contact) before measuring its back-to-front resistance. If the fault is not due to the interlace diode check back to the sync separator screen feed resistor (R78) 100kΩ and the video cath-



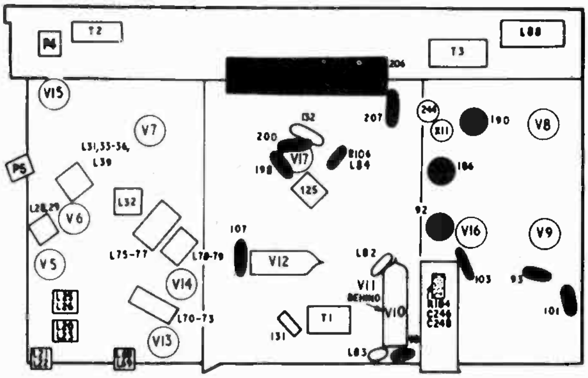
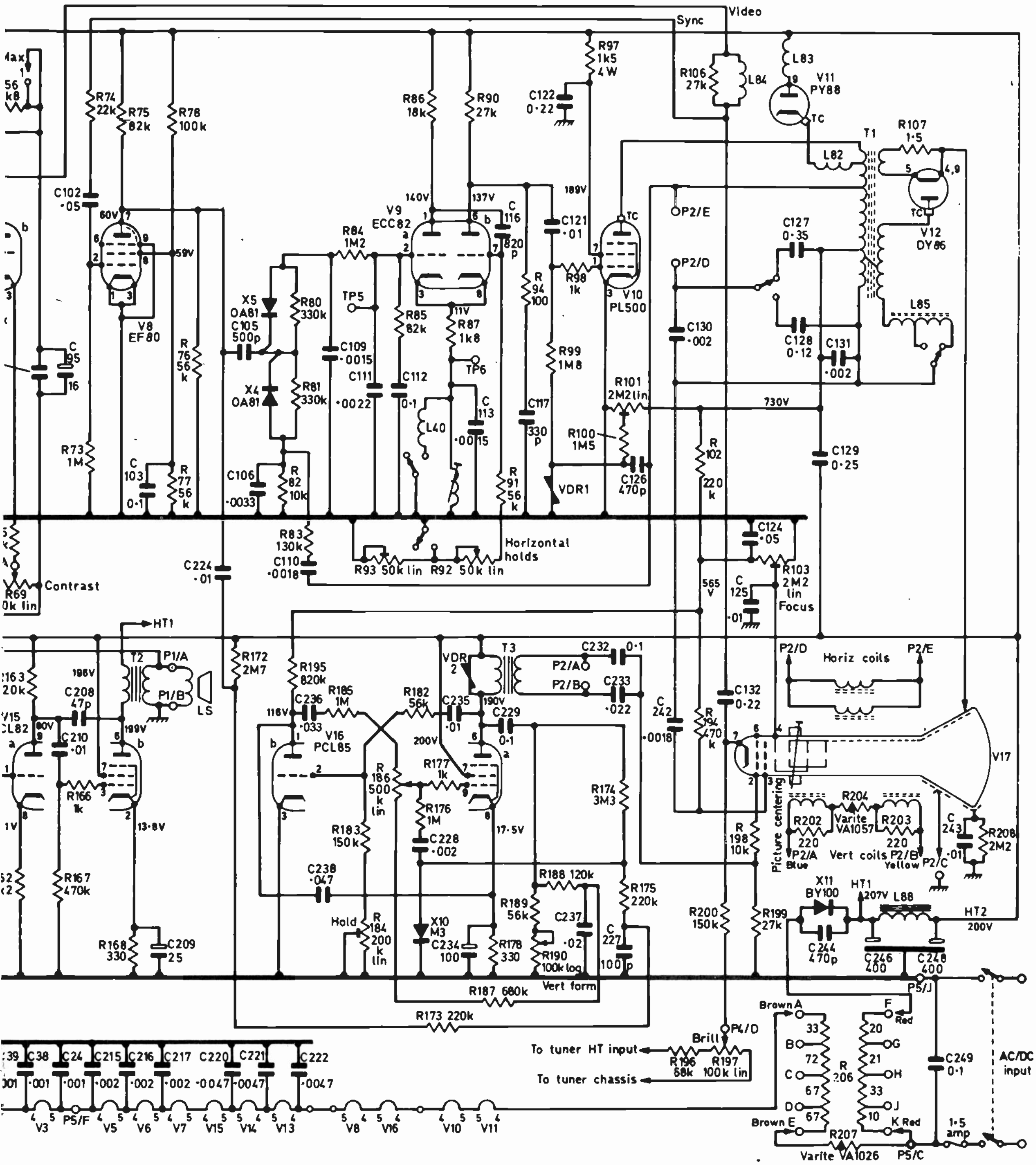



*Fig. 1: Circuit of the main chassis, Baird 620-640 series.*

*Fig. 2 (left): Rear chassis view.*

ode 500$\mu$F electrolytic C93 which may be open-circuit.

On occasions the symptom of no scan at all will present itself—evidenced by a narrow line across the screen. If the PCL85 is not responsible (it nearly always is) it will be necessary to check the voltages at the base. If there is no voltage at pin 6 but pin 7 shows normal h.t. this will generally indicate an open-circuit in the primary winding of the field output




transformer (the v.d.r. will allow a little voltage to appear at pin 6 but not a lot).

## The Video Stage

The PCL84 video amplifier stage can be the source of a few troubles, some obvious and some not so obvious. The obvious troubles cause loss of picture content, leaving a blank raster, a weak picture lacking in contrast or what appears to be a normal picture with very poor sync.

Probably the fault which gives most trouble is when the PCL84 develops an internal short and the set is being used on 405. On this system the vision detector diode X2 is directly connected to the PCL84 control grid and the sudden appearance of h.t. at this point ruins the diode. On 625 there is a series capacitor C88 which blocks the d.c. and saves the diode. So the lesson here is that if there is a cook-up in the video stage necessitating replacement of the PCL84 and some resistors (check the screen, grid and cathode resistors) and the set was being used on 405 lines the detector diode will also have suffered and a picture will not be obtained until this is replaced.

The video cathode capacitor C93 has a habit of going open-circuit. This leads to weak sync and a slightly smeared picture. Check by bridging another electrolytic across it.

The writer keeps a multisection electrolytic to hand with a pair of flyleads. One lead is permanently clipped to the common negative tag and is terminated in a crocodile clip. The other can be clipped to any other tag and terminates in a probe. Since the capacitor is rated at 275V and has 100, 300 and 16μF sections it provides a quick method of checking capacitors suspected of being open-circuit in most situations, be they h.t. electrolytics or low-voltage bias capacitors.

When checking for various faults in the video or any other section always ensure that the system switch contacts are making where they should. This is more or less a visual examination and any adjustment is mechanical requiring no explanation.

## The Audio-output Stage

A PCL82 is used in the audio stage. The fault most often encountered is weak and distorted output. This is most often due to a faulty valve but other points should be checked as these may have contributed to the valve's failure.

C210 can have leakage which will cause the valve to draw excess current with the possibility of damage to the bias resistor R168. Therefore a check on this stage should include voltage readings at the cathode pin 2 and the control grid pin 3. The latter should record no voltage and the former about 14V. The presence of a voltage at pin 3 and a higher voltage than 14V at pin 2 will indicate a faulty PCL82 or a leaky C210.

Another worthwhile check is on the value of R163 (220kΩ). This can go high-resistance, resulting in low and distorted sound.

**CONTINUED NEXT MONTH**

# DX AMATEUR TV ON THE 70cm. BAND


*Transmission from GW6JGA/T Prestatyn received portable by GD6FDZ/T on the Isle of Man, path 79 miles.*

*John Lawrence GW6JGA/T at Prestatyn (Photo: Rhyl Journal).*

FOLLOWING a series of local /T tests between John Lawrence GW6JGA/T Prestatyn and Derek Whitehead GW6FDZ/T Llandudno and after obtaining the necessary special permission from the Ministry of Posts and Telecommunications, Derek Whitehead went /T portable to the Isle of Man for the first GD-GW Amateur Television QSO. The crossing from Liverpool was made on Tuesday 15th of September and by 17.30 hours two-way 'phone contact was established followed by two-way video.

The first video signals were around strength 2 (British Amateur Television Club TV Signal Strength Reporting System) but after some tweaking at both stations this improved to strength 3-4 and very good pictures were received in each direction. The weather conditions were good but unfortunately there was very little lift in propagation conditions.

The following day an almost continuous series of tests were made to evaluate the performance of various parts of the gear. Some lift was noticeable shortly after 12.00 hours but weather conditions deteriorated rapidly during the afternoon with dense low cloud and rainstorms. During this time very deep slow fading was experienced.

Valuable help was received from Jack Elliott, David Williams, Alan Antley GW3UTG and George Moorfield GW3DIX who kindly loaned the Honda generator used.

| | | |
|---|---|---|
| Location | Prestatyn N. Wales | Nr. Laxley Isle of Man |
| Call | GW6JGA/T | GD6FDZ/T GW6FDZ/T/A (GD) |
| Height a.s.l. | 350ft. | 1000ft. |
| Signal source | Vidicon camera 405 line | Vidicon camera 405 line |
| Tx | QQVO6/40 Grid mod. by 6CL6 40W pk white | QQVO6/40 Grid mod. by 5763 40W pk white |
| Rx | BF180 converter and Ekco Model TMB272 | BF180 r.f. TV tuner and Sony TV receiver |
| Aerial | J-Beam 70/MBM46 | J-Beam 70/MBM46 |
| Distance | 79 miles | |

# COLOUR RECEIVER CIRCUITS

GORDON J. KING

## I.F. CHANNEL—1

The tuner(s) provide sound and vision i.f. outputs and on colour of course the vision signal also embodies the chroma subchannel components. Dual-standard sets not only have the complication of two tuners but also that of vision i.f. channel response switching. Usually the vision i.f. passband is fundamentally tailored to suit the 625-line signal, filters being switched in on the 405-line standard to narrow the response and to provide the necessary rejector characteristics. Sets of this kind generally employ the mixer stage of the v.h.f. tuner as an extra i.f. amplifier stage on the 625-line standard. This is achieved by taking the i.f. output of the u.h.f. tuner not to the i.f. channel direct but to the input of the v.h.f. mixer stage. To some extent this simplifies the system switching as it means that the output of the v.h.f. tuner can be permanently coupled to the dual-standard i.f. channel. Filter switching commonly takes place at the input of the i.f. channel.

The extra i.f. amplifier stage provided by the v.h.f. tuner mixer on the 625-line standard is useful in making good the gain lost in the u.h.f. tuner, for the overall gain of a u.h.f. tuner is generally below that of a v.h.f. tuner. Single-standard sets have therefore to be designed with a greater i.f. channel gain than dual-standard models and the trend is to provide this by using a cascode stage in the i.f. channel. Pye and Rank-Bush-Murphy sets are two examples which adopt this scheme (see PRACTICAL TELEVISION July 1970, pages 438-440).

Dual-standard sets also have to feature a sound i.f. channel which will respond to both the 405-line i.f. signal and the 6MHz intercarrier signal on the 625-line standard. This is achieved by the use of dual transformers and filters in the channel, one lot responding to the sound i.f. on 405 lines and the other to the 6MHz intercarrier signal on 625 lines. Owing to the substantial difference between the 405-line sound and the 625-line intercarrier frequencies, filter and transformer switching is not necessary. It is of course necessary to switch at the input from the sound i.f. takeoff on 405 lines to the inter-carrier take-off on 625 lines and to incorporate audio switching to change from the 405-line a.m. detector output to the 625-line f.m. detector output.

### Carrier Positions

Figure 1 shows the video-frequency spectrum of a 625-line PAL colour television signal. It can be seen that the chroma subcarrier is approximately 4.43MHz and the sound carrier 6MHz from the vision carrier. The u.h.f. tuner delivers this spectrum at i.f. and the placement of the three carriers on the i.f. response curve in a typical receiver is shown in Fig. 2. Typical alignment frequencies

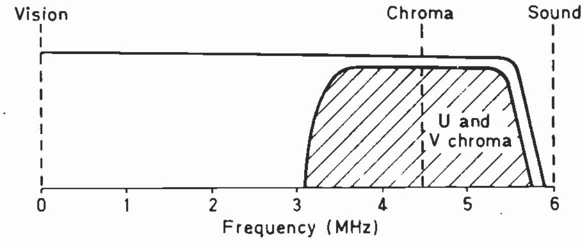



*Fig. 1: Video frequency spectrum of the PAL colour television signal.*

are vision i.f. 39.5MHz, 625 sound i.f. 33.5MHz and chroma i.f. about 35.07MHz. For correct vestigial-sideband detection the vision carrier normally has to fall about 6dB down the response curve. It is also common for the chroma subcarrier response to be a little down—on the other side of the response curve—by an amount depending on the design of the receiver's i.f. channel and chroma bandpass amplifier.

The chroma subchannel uses double-sideband suppressed-carrier modulation. This means that—depending on the position of the chroma subcarrier on the i.f. response characteristic—one chroma sideband could be amplified more than the other and thus result in chroma distortion. In some designs this is compensated by purposely introduced 'roll-off' or asymmetry in the chroma bandpass amplifier response characteristic. The chroma channel input high-pass filter alone may provide the necessary compensation in some designs while in others the alignment of the chroma bandpass amplifier is

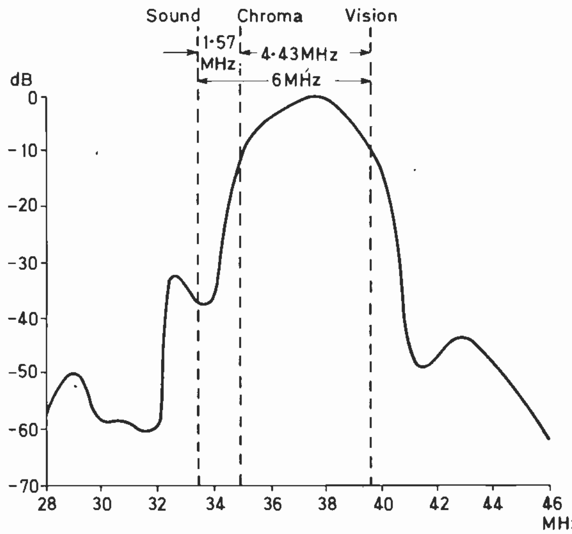



*Fig. 2: Typical colour receiver response curve.*

geared to that of the i.f. channel. Most of this however concerns the chroma bandpass amplifier which I shall be investigating in subsequent articles.

Returning now to Fig. 2 it will be seen that the sound carrier coincides with a rejector trough approaching −40dB. This corresponds to the 625-line sound attenuator found in all dual-standard and single-standard sets of the 625-line variety. It will be recalled that the vision i.f. channel on this standard passes the f.m. sound signal as well as the vision information and that the non-linear characteristic of the vision detector results in a beat frequency equal to the difference between the vision and sound carriers being produced. This is of course the intercarrier signal at 6MHz which carries the f.m. sound information. The vision a.m. signal which it may also carry is mostly limited in the intercarrier channel either by the amplifier stages or the ratio detector (or both).

## Sound-chroma Beat

A point worth noting at this juncture is the beat between the sound and chroma signals. Fig. 2 shows that this works out to about 1.57MHz. The design of the i.f./detector channel has to take this into account so that the beat signal amplitude is kept as low as possible. Clearly, as the vision detector produces the intercarrier signal it will by exactly the same process also give rise to a 1.57MHz sound-chroma beat signal and if this is allowed into the luminance channel the picture display can be badly affected by herring-bone pattern interference. Some designers solve the problem by using separate sound and vision detectors. The sound detector must of course receive both the vision and sound i.f. signals to yield the intercarrier signal, but when two detectors are employed that dealing with the vision signal need only receive the vision i.f. signal, meaning that a rejector can be included at this point to delete the sound i.f. signal and hence also the chroma-sound beat signal.

There is hardly any point in this series in delving too deeply into the signals appropriate to the 405-line standard since these are now very well known. On this standard we have seen that the vision and sound signals are handled by separate i.f. channels. The intercarrier sound system cannot be adopted of course because the sound signal is amplitude-modulated the same as the vision signal. To clear the vision i.f. channel of sound signal, rejectors resonated to the sound i.f. are incorporated and one of these is employed to extract the sound i.f. signal from an early stage. These rejectors are not quite the same as those used in the i.f. channel on the 625-line standard for the plan in this latter case is not to delete the sound signal altogether but merely to reduce its amplitude to a rather critical lowish value to ensure the best intercarrier sound performance and the least intercarrier buzz in the sound channel.

If the rejector which puts the trough at the sound i.f. in the response curve shown in Fig. 2 is incorrectly tuned for example the sound signal will not be properly attenuated and the vision detector will receive more sound signal than required for correct intercarrier operation. The symptom is commonly that of buzz on sound caused by the interaction of the vision signal—this is generally called "intercarrier buzz". The rejector dip could also if mistuned lie somewhere in the vision passband and on colour this could severely affect both the amplification and the phasing of the chroma subchannel signal.

## Phase Aspects

So far we have considered mainly the amplitude/frequency characteristic of the i.f. channel, sometimes loosely referred to as its "frequency response". There is another equally important characteristic, the delay/frequency characteristic. This characteristic is indeed of major importance in colour receivers since if the signal delay through the i.f. channel varies over the frequency spectrum the various components of the vision signal will fail to pass through the channel at the same rate. This means that some frequency components will arrive at the output before others. On monochrome this produces the typical "echo" effects, giving overshoot symptoms like black-after-white etc., but on colour the effect can be even more severe owing to the phase-sensitive nature of the chroma signal. With the PAL system however, the phase sensitivity is significantly diminshed, but if the chroma phasing is badly distorted there will be a reduction in colour saturation if not in hue error.

Thus the design of the i.f. channel in a colour set has to take into consideration the delay/frequency characteristic more critically than a monochrome set does. The switched i.f. channel of a dual-standard set can certainly aggravate the problems involved, and all told it is rather amazing that such good results on colour are achieved from most receivers of this kind. Happily the design problems are eased by the recent single-standard approach. From the circuit point of view one may not be aware of the detailed attention that has been paid to the delay/frequency characteristic since this is related mainly to the design of the tuned circuits and rejectors and to the overall alignment of these circuits.

## Circuit Analysis

Now let us have a look at a representative circuit. The complete i.f./detector channel of the dual-standard Rank-Bush-Murphy CTV25-CV2510 is shown in Fig. 3. The vision i.f. stages consist of transistors Tr1, Tr2 and Tr3 and the i.f. signal from the tuner is directed to the base of Tr1 via the input filters. The sections of switch 2S1 are involved with standard changing and are all shown in the 625-line position.

The first 2S1a merely introduces an extra filter on 405 lines to assist with the tailoring of the 405 response in the manner already explained. On the 625-line standard the filter is inactive of course. The bandpass transformer in Tr1 collector circuit couples the signal to Tr2 via a rejector. Alternative bandpass coupling circuits on 405 and 625 selected by 2S1b and 2S1d link the signal from Tr2 to Tr3 base. On 625 the output from a bandpass transformer is by way of a tapping on the secondary and a capacitor to 2S1d and then to Tr3 base.

The collector of this transistor feeds two detectors. The top one D1 provides the intercarrier signal only. Here the signal is tuned by a 6MHz transformer and extracted from a tapping on the secondary. It is then conveyed through a screened lead and fed to the base of Tr10 via 2S1h. The bottom

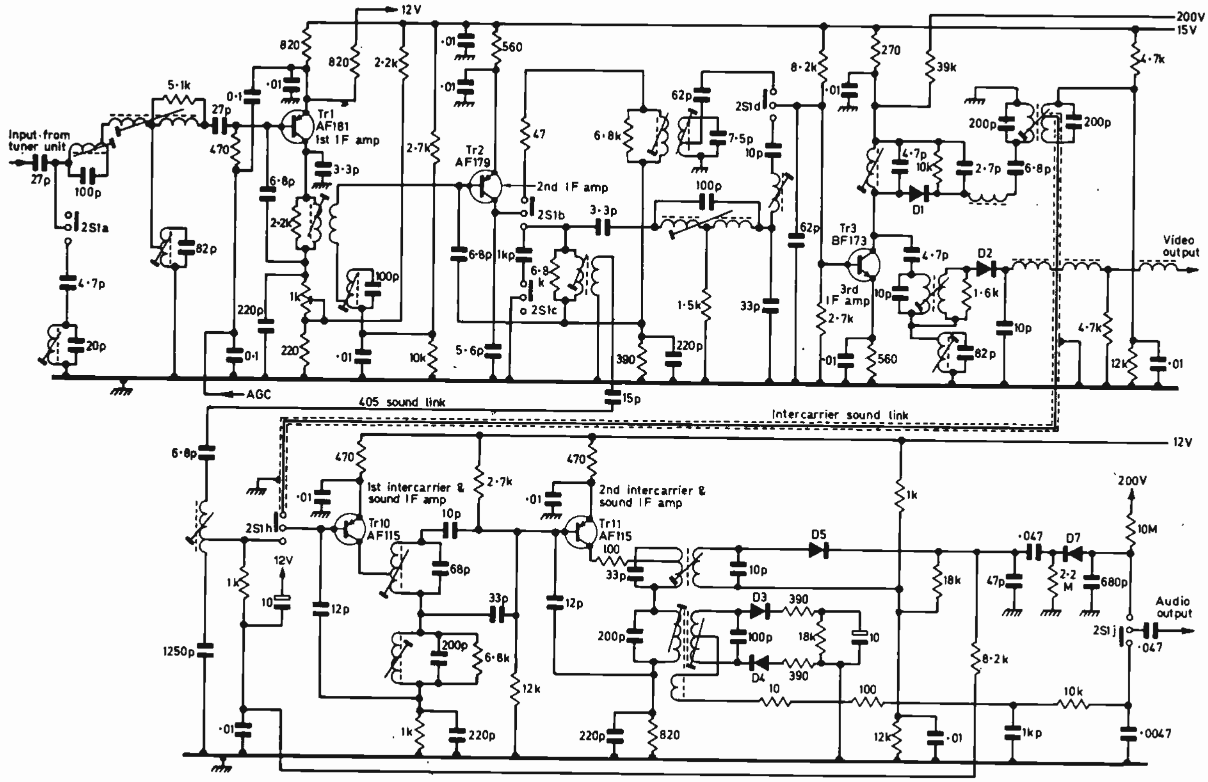



*Fig. 3: Sound and vision i.f. circuits and detectors of the Rank-Bush-Murphy CTV25 chassis.*

detector D2 yields the video signal. In this circuit is also included a sound i.f. rejector which neatly deletes the chroma-sound beat.

The first intercarrier transistor Tr10 is coupled via its collector load to the base of the second transistor Tr11 and the collector of this transistor also feeds two detectors. The lower one with D3 and D4 is an f.m. ratio detector while the upper one D5 is the a.m. detector. The detector which is active depends on whether Tr10 is receiving intercarrier signal by the route just mentioned or 405-line sound i.f. signal via switch 2S1h and the 405 sound link marked on the diagram. 2S1j selects the load of whichever detector is active and communicates the signal to the audio circuits. Stages Tr10 and Tr11 thus constitute the intercarrier sound channel on the 625-line standard and the ordinary sound i.f. channel on the 405-line standard. The 405 sound i.f. in this model is at 38.15MHz.

Diode D7 is a series-connected sound interference limiter and is active only on the 405-line standard since adequate limiting is provided by the ratio detector on the 625-line standard. Under normal signal conditions D7 is biased by the 10MΩ resistor between its anode and the h.t. positive rail so that audio signal passes through it. In the event of a burst of impulsive interference however its cathode swings positively with the peaks and the diode is switched off for a period governed by the time-constant of the load circuit including the 680pF capacitor connected to the diode anode.

We have already seen what happens when some of the switches change from the 625 to the 405 position, but to recap: 2S1a introduces an input filter on 405; 2S1b selects the 405- or 625-line coupling between Tr2 collector and Tr3 base, an action assisted by 2S1c which earths the 405 sound take-off circuit via the 1kpF capacitor on 625; while 2S1d selects the appropriate Tr3 base input, which on 405 is via a bridged-T type sound rejector. In the sound channel the input is selected by 2S1h while 2S1j couples the load of the active sound detector to the audio channel.

Most i.f. channels incorporate some kind of vision a.g.c. and in Fig. 3 this is applied to Tr1 base via the 470Ω resistor. The forward a.g.c. system is generally used. With this technique stage gain is *reduced* by the a.g.c. bias causing an *increase* in base-emitter current, and hence collector current, rather than a decrease which results from reverse a.g.c. action. Forward a.g.c. pushes the controlled stage more towards saturation than cut-off, thereby making it somewhat less prone to overloading—depending on the nature of the transistors. Some transistors are specially designed for forward a.g.c. operation but others rely in this mode of operation on the fall in collector voltage when the forward bias is increased. This fall generally occurs across a resistive load in the collector circuit and it is this which then reduces the stage gain. I shall be having more to say about vision a.g.c. in subsequent articles. Sound a.g.c. in the circuit shown in Fig. 3 is used on the 405-line standard only. It is fed from the a.m. detector via the 8.2kΩ resistor to the base of Tr10 only when 2S1h is in the 405-line position. The stage operates at full gain on 625 lines, and under this condition the transistors of the intercarrier sound channel are encouraged to bottom to provide a degree of amplitude limiting.

**TO BE CONTINUED**

# INTERNATIONAL BROADCASTING CONVENTION IBC-70

J. I. SIM

THE International Broadcasting Convention combined a large broadcasting exhibition with a programme of technical sessions covering techniques and developments since the last Convention—in 1968. It was opened by Christopher Chataway who made it clear to the Broadcasting authorities that they had a duty to supply a television service to every person who wanted it: those living in the remote areas of Wales, Scotland, the Lake District and the South West must be considered and not all engineering resources channelled into the u.h.f. duplication of services. However, the cost per viewer of giving a television service to the really remote areas of the United Kingdom is so enormous that had it been the prime aim the u.h.f. programmes might never have started. The answer perhaps lies with satellite transmission.

The problems of coverage were also brought up by Howard Steele, Chief Engineer of the ITA, in the opening technical session. "In 1969 alone we in the Authority installed more r.f. transmitter power than in all our fourteen previous years taken together. Today we have in operation twelve main u.h.f. transmitters with a total e.r.p. of over 7MW and over 500kW of r.f. power." Mr. Steele went on to say that the ITA's v.h.f. coverage of 98·7% of the population of the UK was achieved with 47 transmitting stations including low-power relays. The BBC have nearly twice as many v.h.f. transmitting stations to obtain their higher percentage coverage. "For u.h.f. the BBC and ourselves speak hopefully of providing roughly comparable coverage with perhaps 60 main stations and 500 relays. We must be clear that to attempt full national coverage on Bands IV and V even in a country as compact as the UK will be a truly Herculean task. And not only is it going to be difficult, it's going to be damned expensive."

### *Technical Sessions*

Automation of equipment was a predominant topic of both opening addresses and the technical sessions during the week: automation of transmitter operations, of measurements of standard parameters, of trade test transmissions, of videotape editing and so on. These things may not appear of much significance but in fact will result in programme pictures of more consistent quality. As Howard Steele put it, "They (*automation and digitalisation*) are probably the most important words at this Convention and those that will follow. From knob twiddling we went to 'hands-off'. We are now progressing to feet-up operation. Digital, or no-go, go, no-go techniques mean that we are gradually moving away from the era of graduated colour quality towards an era of either perfect quality or a totally unrecognisable blur."

Automation in the programme chains overcomes some of the deficiencies of the human operator and permits manpower reductions which with the training of television staff becoming more and more expensive is increasingly important. Unmanned stations are becoming the rule rather than the exception and whereas three years ago only a relay station was unattended now even the largest stations can be made reliably automatic. The biggest example is the new 1MW unattended u.h.f. ITA station at Crystal Palace. But to control the wide number of unattended stations a network of fourteen regional colour control centres has been set up at existing ITA v.h.f. manned stations: a fault at an unattended site monitored by one of these centres results in a maintenance team being sent out. Naturally with more unattended stations more members are required on the mobile maintenance teams and the installations of these stations will therefore result in some increase in transmitter personnel. A great deal of cooperation has always existed between the engineering staffs of the BBC and the ITA—sometimes very unofficially—and it is therefore rather surprising that no official arrangements have been suggested for the staff of one authority to engineer equipment of the other authority, even if only under emergency fault conditions.

Other technical sessions at the Convention included papers on developments in colour cameras, colour coders and telecines in the origination sector; on videotape copying by thermal contact and colour-film operations in the recording and films section; and on developments in the distribution of signals and in transmitting and transposing equipment.

Most of the technical sessions were fairly well balanced in their content and it was generally felt that the Programme Committee had made the best choice of papers possible. In the session on receivers however only four papers were offered. Three of these dealt with the broadcast-quality receivers used for pick-up of transmissions intended for rebroadcasting at a different frequency—as at a relay station—with the minimum possible distortion. The only paper directly about receivers was that by T. L. Harcombe of Glamorgan Polytechnic who described a hybrid, thick-film, capacitance diode tuned u.h.f. tuner for receivers. Mr. Harcombe's tuner adopts the present-day view that tuning should be independent of mechanical intricacies. He therefore follows the trend towards the use of varicaps as the tuning capacitors—the capacitance being simply controlled by a d.c. bias from a preset potentiometer.

The tuner is constructed on a substrate with the transmission (lecher) lines laid by solder dipped palladium silver. Mr. Harcombe explained that the problem of oscillator drift was more severe on a varicap tuned system because of the dependence of frequency on supply rail voltage and temperature. The former is easily solved with the use of a zener diode stabilising the supply rail voltage. The zener is thermally bonded on to the tuner substrate so that it is all at the same temperature.

Temperature compensation was considered by Mr. Harcombe in two alternative ways—either by heating the substrate with a thick-film heating element controlled by a bi-metallic strip or by using a power transistor as the heating element driven by an amplified reference voltage derived from across the zener. Both systems therefore depend on the substrate operating at above ambient temperature. The second method is to be preferred because the heating control is smooth and continuous and not an on-off mode as provided by the first method. It was rather unclear as to how long it would take in either case for the substrate to reach its operating temperature: it was also unclear whether the tuner described would meet the rather severe image-frequency rejection specification suggested by BREMA.

Apart from the mechanical simplification of the tuner the use of varicaps has a secondary advantage which is not immediately obvious: as the tuner frequency depends on a d.c. control potential a great deal of the circuitry necessary for a.f.c. in a conventional tuner is made redundant.

This paper then was the only one connected directly with the commercial receiver and this was rather surprising. After all, whatever skill goes into the production of television programmes and their provision and transmission by engineering expertise the final link is the most important one—the receiver. Bernard Rogers of Rank-Bush-Murphy was to have presented a paper reviewing colour television receiver trends but this paper very unfortunately missed the closing dateline. This paper might have broken the unhealthy view held by the majority of the television manufacturers that their work is top-secret. This viewpoint is outdated. Sufficient details of new developments could quite happily be released to give the industry an idea of the direction in which progress lies without giving away "secret" details of particular circuits or manufacturing techniques. Perhaps it would shake up the manufacturers to know that those who really want to find out do so anyway.

One of the papers on professional receivers—by F. H. Wise of the ITA—did however touch on an area which might be of future interest in the commercial receiver. Present receivers use diode envelope detectors for video and because of the nature of the vestigial sideband transmissions this results in a form of distortion known as *quadrature distortion*. This shows up as a narrowing or expanding of horizontal picture detail. The professional receiver is now beginning to use synchronous detectors (a similar arrangement to that used for detection of the U and V signals in a colour receiver) and this overcomes quadrature distortion. A secondary advantage is found to be an inherently linear detection characteristic which cannot be obtained with an envelope detector.

### The Exhibition

A complete review of the exhibits at IBC-70 would take up a not inconsiderable space. We must therefore confine ourselves to the new, the novel and the exhibits of most interest to the majority of readers.

Both the BBC and the ITA had stands at IBC-70. Members of the ITA's Engineering Information Service handled a large number of enquiries on ITV engineering and the stand relayed a special programme of colour television throughout the Convention. The BBC showed off their mobile colour demonstration unit which has toured Great Britain showing quality colour pictures to the general public. Both authorities also illustrated on their stands some of the engineering work taking place; from the proposed colour distortion correction unit developed by London Weekend Television's engineering subsidiary—Dynamic Technology Ltd.—to the automatic monitoring and control systems developed by the BBC for its u.h.f. transmitting stations.

### New Colour Cameras

Two completely new colour cameras were shown for the first time at the Convention. The one to attract most attention was the Marconi Mark VIII camera channel. The Mark VIII is a three-tube camera as is the new EMI camera channel type 2005. So after years of arguments between the supporters of the three-tube and those of the four-tube colour camera all the suppliers to the British market—EMI, Pye and Marconi—are now producing three-tube cameras.

The Marconi Mark VIII is decribed as "the world's first automatic colour television camera". And automatic it is—at least in the engineering sense—with a unique sequential line-up system which starts with a push-button. A special line-up pattern is displayed and the camera sets up its channel gains to give similar outputs on red, green and blue, aligns the three electron guns in the Plumbicon tubes and then automatically registers one upon the other. With the diascope pattern switched off the colour balance then sets itself up to give accurate white from the scene being transmitted.

Automation is taken a stage further by the use of an automatic test display allowing diagnostic checks to be made on the camera throughout the video channels and in the power supplies and scanning sections. The display is made on a monochrome picture monitor and the absence of a white patch in the display pattern indicates a fault in the appropriate section of the camera. The implications of time saving are enormous not only for the time saved in an operator lining up each channel manually but by the fact that one unskilled operator can simultaneously start the line-up sequence on any number of cameras without assistance. There is also the extra ease afforded by the channel in outside broadcast use and the known repeatable quality of camera pictures.

The flexibility and size of the cable connecting the camera to the camera control unit has always been a problem because of the very large number of signals passed. Both Marconi and EMI use time-division multiplex to code signals together for cable passage and have been able to reduce the size of the camera cable to the same proportions as those used for monochrome cameras.

The EMI 2005 colour camera seemed not to attract the same engineering attention as the Marconi camera and this was perhaps reflected best in the announced EMI orders, the majority of which were for the existing EMI 2001, already established as a camera capable of giving superb colour pictures.

### Videotape Recorders

One of the great difficulties over the years in the use of videotape recorders has been their relatively slow lock-up time—the time needed for the machine picture to lock to the local source of line and field sync pulses and subcarrier in both frequency and phase. This is necessary if the machine is to produce pictures capable of being faded, superimposed or inlayed with others. This time delay has resulted in having to cue a VTR at least three seconds, normally more, before it is required. Ampex showed their latest videotape recorder—the AVR-1—which gives a lock-up in 200 milliseconds (1/5th second). This is more or less the time needed to come off the back-stop of a video fader so that the AVR-1 can be programme cued instantaneously. To achieve this remarkable lock-up Ampex have had to improve the speed of tape run-up, reduce the tension on the tape to prevent stretch and considerably speed up the electronic servos. The result is a space-age looking machine with an amount of logic circuitry that is quite frightening.

The only contender to Ampex in the British market is RCA. This year they showed their latest TR70-C machine with its improved colour performance over previous models. During the show it was announced that Westward Television had ordered two such machines for the start of their colour operations next April.

It has often been said by VTR engineers that the helical-scan machine will never achieve broadcast standard requirements. Those who support that view must have been sorely disappointed to see the International Video Corporation's IVC-900 machine which offers really superb colour performance at a price of about a fifth that of a quadruplex machine.

Whilst in the area of videotape recordings, the FAM system (see page 4, October, 1970, TELEVISION) was seen demonstrated by a German firm, Vitrionic, in use on a Sony ½in. videotape recorder. The colour pictures from this rather narrow-bandwidth machine were quite acceptable from a closed-circuit viewpoint. The video disc from Teldec (Telefunken-Decca) was again on show and it is hoped to examine this in more detail in an article in TELEVISION at a later date.

### The Unusual

Probably the smallest IBC exhibit was a cassette audio recorder by Data-Vision. This single-track machine is fitted with synchronous drive and end-of-tape and broken-tape sensing. The smallest stand was that of Plymouth Polytechnic, but an enormous amount of interest was shown in its Television Engineering courses. The largest stand was the EMI one—they built a small studio on the floor of the exhibition hall. The most fascinating demonstration—shared between Thorn with their Q-File memory lighting system and Michael Cox Electronics with their three-level colour caption synthesisers—was the production of three coloured captions from a monochrome

*—continued on page 133*


DESPITE the ever-expanding u.h.f. network in the UK there are still many areas that are unable to obtain a satisfactory colour service from all three networks. Consequently in parts of the country viewers will have to rely on the existing v.h.f. services for some years yet. Generally the Band III service is less favourably received over long distances than Band I and the amplifier described here may prove useful in such areas. The DXer will also find this amplifier of interest.

### *Circuit*

The unit itself is a simple basic circuit covering Band III with a relatively flat response and having an average miniumum gain of 12—14dB. The input signal is coupled to the emitter of the BF180 via C1, L1 serving as a static discharge path and as a bypass for any m.f. and h.f. radio breakthrough from any strong local transmissions. Emitter bias is via R1 and a ferrite bead is fitted at the signal end of the resistor. The use of this bead is optional. The base

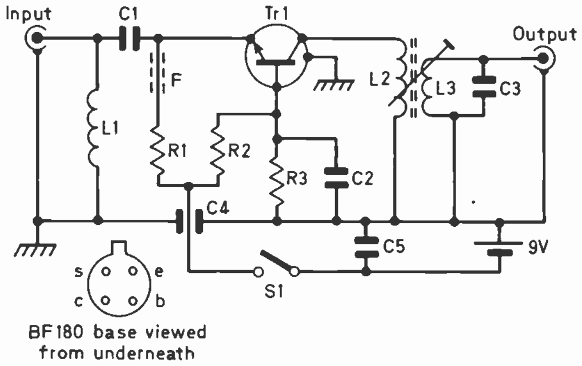



*Fig. 1: Circuit of the Band III preamplifier.*

is biased by R2 and R3, decoupled to r.f. by C2.

The collector load L2 develops the appropriate signals across it, these being coupled to the output by the secondary tuned circuit L3, C3. The dust core on this coil former is a high-*Q* type available from Home Radio Ltd., Mitcham, listed in their catalogue under catalogue number Z82A, iron dust slug, high-*Q* (50-300 MHz). Circular tagrings to fit the coil former will facilitate construction.

### *Construction*

The amplifier is mounted on a tin subchassis within an Eddystone diecast box, though any other metal container will suffice. Most of the com-

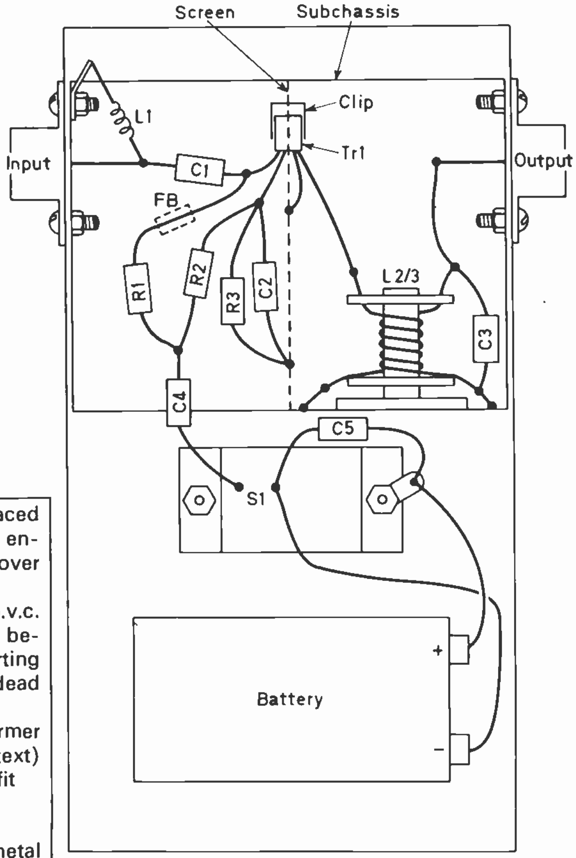



*Fig. 2: Physical layout.*

## components list

**Capacitors:**

| | | |
|---|---|---|
| C1 | 39pF | Silver mica 20% |
| C2 | 820pF | Silver mica 20% |
| C3 | 10pF | Silver mica 5% |
| C4 | 1,000pF | Feedthrough |
| C5 | 820pF | Silver mica 20% |

**Resistors:**

| | |
|---|---|
| R1 | 1k Ω |
| R2 | 3·3k Ω |
| R3 | 10k Ω |

All 5% $\frac{1}{2}$W

**Other components:**

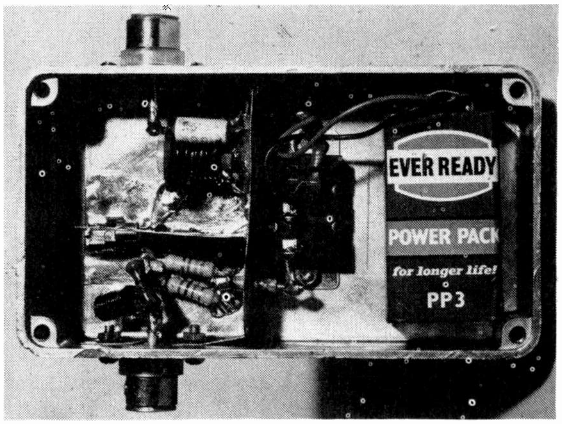
Tr1 BF180
L1 V.H.F. choke. 12 turns. 26 s.w.g. enamelled wire $\frac{3}{16}$in. diameter close spaced
L2 5 turns. 20 s.w.g. enamelled wire spaced over $\frac{1}{2}$in.
L3 2 turns. 26 s.w.g. p.v.c. covered wire wound between L2 turns, starting one turn in from "dead end"
L2 and L3 on $\frac{1}{4}$in. coil former with high-*Q* dust core (see text) and two circular tagrings to fit
F Ferrite bead
S1 S.P.S.T. slide switch
Two coaxial sockets, metal case, etc.

ponent wiring was completed on the subchassis which is secured in the case by the nuts and bolts holding the input and output sockets.

The transistor was the last component fitted on the subchassis before it was mounted in the case. As usual the normal precautions should be taken when soldering the transistor into circuit and all wiring should be kept to the minimum length possible. In the interests of stability the emitter and base circuits should be screened from the collector circuit and for this purpose the transistor is mounted on the chassis with a clip and a metal screen is inserted between the above mentioned connections.

The response of this amplifier is extremely broad and therefore the alignment is extremely simple. The receiver should be tuned to a mid-frequency in Band III and the dust core then adjusted to give maximum performance. It should be noticed that only a slight peaking effect occurs. Check the unit on other weak signals to ensure correct performance. The amplifier should be completely stable either loaded or unloaded at the input or output. If instability is found at any point over the band a slight adjustment to the dust core should overcome this.

The Mullard npn silicon transistor type BF180 has a quoted gain of 24dB at 200MHz and a typical noise figure of 4.5dB. With the wide bandwidth of this amplifier the gain obviously drops but should be about 12-14dB. In practical terms the amplifier can lift a weak Cherbourg signal on channel F12 from weak traces of line sync pulses to a locked, noisy picture (212.85MHz).



*Inside view of the Band III preamplifier.*

The current consumption is approximately 2.5mA. Transistor voltages relative to the chassis (positive side of the supply) are as follows: collector 0V; base 7V: emitter 7.7V.

## IC 'SCOPE PREAMPLIFIER

*—continued from page 118*

The frequency compensation components C8, R14 and the network on S3C, which are necessary to stabilise the operational amplifiers, inherently restrict the maximum bandwidth to about 1MHz. These reasonably priced operational amplifiers are normally incapable of giving significantly greater bandwidth.

### Conclusion

We may conclude this feature by pausing a moment to consider why the vast majority of ordinary oscilloscopes provide maximum Y-input sensitivities of some 50 to 100mV/cm., occasionally as high as 20mV/cm., but seldom more. The detailed discussion of this preamplifier, which has been presented so as to illustrate the general principles involved, has shown that any attempts to boost deflection sensitivity to a value greater than 20mV/cm. must be accompanied by careful consideration of the bandwidth-impedance product.

There is a tendency for grass to grow on the timebase trace at higher deflection sensitivities unless bandwidth and/or impedance are restricted below the figures commonly found in general-purpose oscilloscopes. This means that the actual input ratings become ambiguous, depending on the type of signal source. A general-purpose oscilloscope is no longer feasible under these conditions because it would be producing an unnecessarily large amplitude of grass for many applications where much lower input impedances and smaller bandwidths would suffice with greatly superior signal-to-noise ratio.

Our approach to this problem has been to provide a logical selection of input/output combinations on our preamplifier. We make no claim to have taken the noise performance to its ultimate, indeed certain sacrifices in noise performance have been deliberately made in favour of other outstanding advantages of using i.c. operational amplifiers. Practical circuits are readily realisable with very much greater deflection sensitivities if we drastically restrict both bandwidth and impedance.

For example, the basic thermal noise level in 200Ω with a 20kHz bandwidth is about 0.6μV peak-peak. An optimum noise-matched amplifier input stage readily achieves a noise figure of 6dB so that the actual peak-peak equivalent input noise level would be some 1.2μV. If once again we choose to tolerate a maximum grass amplitude of 2mm. on the oscilloscope screen we could use this system for deflection sensitivities as high as 6μV/cm. This is nearly a hundred times greater than the maximum available deflection sensitivity with our preamplifier—but only for signal sources whose impedance is 200Ω or less, which is such a serious restriction that it does not merit further consideration except for special requirements which individual readers may encounter. The maximum audio signal resolution of 50μV r.m.s. from source impedances up to 100kΩ provided with our general-purpose preamplifier is considered to be of more general appeal.

One final remark: if the noise source is truly white, which implies quite uniform spectral energy distribution throughout all frequency ranges of interest, the thermal noise voltage generated in a given impedance is independent of frequency. In other words the noise voltage is the same for a band from zero to 20kHz a.f. and for a bandwidth of 20kHz around any h.f. carrier. Practical circuits are not always strictly white noise sources throughout all the frequency bands up to and including u.h.f., but they may be treated as such to a first approximation. Thus we have to face an inevitable thermal noise level of about 5μV peak-peak in a 60Ω television feeder line with 5MHz channel bandwidth. ■

# DX-TV

CHARLES RAFAREL

As a result of our losing the December issue we have two months to report on this time. For most of September we have reports from Roger Bunney and Maurice Opie, since I was on holiday during this period. My September log covers only 1-4/9/70 and 29-30/9/70, and as expected the SpE activity was not very good:

1/9/70 Austria E2a, Pol/MT test card Poland or Hungary R1.
2/9/70 USSR R1, Czechoslovakia R1.
3/9/70 Czechoslovakia R1, Pol/MT test card Poland or Hungary R1.
4/9/70 USSR R1, Pol/MT test card Poland or Hungary R1, Austria E2a.
29/9/70 Pol/MT test card Poland or Hungary R1, Sweden E2.
30/9/70 USSR R1.

Roger Bunney reports as follows:

5/9/70 Czechoslovakia R1, Spain E3.
6/9/70 USSR R1 and R2, Hungary R1.
7/9/70 Sweden E2, Italy IB.
8/9/70 East Germany E4, Italy IA and IB.
10/9/70 USSR R1, Poland R1.
11/9/70 West Germany E4.
12/9/70 Italy IA.
13/9/70 East Germany E4, Norway E2 and E4, Sweden E2, Italy IB.
14/9/70 West Germany E4, Italy IB.
15/9/70 Poland R1, Czechoslovakia R1.
16/9/70 Italy IB.
26/9/70 East Germany E4, Italy IB.
27/9/70 Czechoslovakia R1, West Germany E4, Sweden E2.

His m.s. (meteor-shower reflection) experiments were rewarded with Austria E5 on the 12th, nice work!

Maurice Opie too managed some SpE:

8/9/70 Czechoslovakia R1, USSR R1 and R2, Austria E2a, and the old type "Telefunken" test card on R1 (this is a mystery).
9/9/70 Poland R1.
17/9/70 Spain E4.

You will recall that we published details recently of the possibilities of m.s. (meteor-shower reflection) in Band III as well as in Band I. This idea appealed to me but I must confess that after only limited success by R. Bunney and myself I felt that when we asked other DXers to cooperate I was not too hopeful that any startling reports would come in. I was a little too pessimistic however. It can be done and Dennis Boniface has done it in a big way. I quote from his letter:

"SpE and Trops are 'old hat' for me now, the thing with me is m.s. on Band III. On August 10 at 11.00 I switched on and the log speaks for itself: E5 Sweden test card at 12.40 and Denmark test card at 12.44. On the 11th I tried E6 and joy of joys E6 Denmark on test card at 12.14 then E6 Sweden on test card at 12.33. Back to E5 for the 12th August—E5 Sweden test card at 11.20 and E5 Denmark test card at 11.26. Sweden E5 was seen again at 12.15, 13.00, 13.04, 13.30 and 13.40. Then on August 13th E5 EBU test card at 09.55 ? location, E5 Sweden test card at 10.09, E5 Denmark test card at 10.09."

He goes on to say that having tried two different TV receivers he concluded that a narrow bandwidth set gave the better results—his old 3·5MHz Bush TV56 was better than a more modern 5·5MHz set, so now you know! His aerial was an 11-element array at 20ft. with a three-transistor preamplifier. R. Bunney suggests, quite correctly I feel, that Dennis might do even better if he canted his array upwards between 5° and 20°. This achievement is magnificent and we wish him every success with his future m.s. efforts.

Whilst on holiday I saw Gibraltar E6 on test card. It is test card G with no other lettering. The opening caption is "GBC" in white letters for Gibraltar Broadcasting Co. We went to Gibraltar for the day via the back door from Tangier as the Spanish frontier is of course closed. The 200kW transmitter is high on the Rock, on E6, and I can't help wondering if there is after all just a chance of reception here by m.s. after what has already been achieved.

Once back in France again I had the opportunity of taking a closer look at SECAM colour TV and after having seen a lot of PAL here I would say that the differences in the results of the two systems are only marginal. But SECAM sets really are very expensive. Having duly noted this we took the plunge on our return and got a Decca CS2520 25in. colour set. So watch out you CDXers, all I want now are some good Trop u.h.f. openings! I have had the u.h.f. Mendip Forest station in colour already at some 90 odd miles.

## OCTOBER REPORT

During October the SpE activity declined to an even lower level than in previous months. This does not mean that there is no SpE DX about: it means that we must double our efforts, be even more patient than previously and above all be prepared to accept short-duration bursts of signals. This short-duration reception was very evident during October and a further point noticed is that the direction of reception has been East-West rather than North-South. Now for the log for the period 1-31/10/70:

1/10/70 USSR R1, Spain E2.
2/10/70 Spain E2.
3/10/70 Sweden E2.
4/10/70 Spain E2, Sweden E2.
5/10/70 Spain E2.
6/10/70 USSR R1, Poland R1.
7/10/70 USSR R1, Czechoslovakia R1, Poland R1.
8/10/70 USSR R1, Poland R1, Austria E2a.
9/10/70 USSR R1.
10/10/70 USSR R1, Czechoslovakia R1.
11/10/70 USSR R1.
12/10/70 Czechoslovakia R1, Austria E2a.
13/10/70 USSR R1, Czechoslovakia R1, Spain E2.
14/10/70 USSR R1, Poland R1.
15/10/70 USSR R1, Poland R1.
16/10/70 Czechoslovakia R1.

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| A59-12W (P) | AW59-90 (M) | C23/AK (M) | CME2308 (M) | |
| A59-13W (T) | AW59-91 (M) | C23/AKT (T) | CRM173 (M) | |
| A59-14W (T) | C17/1A (M) | CME1402 (M) | CRM212 (M) | |
| A59-15W (M) | C17/5A (M) | CME1702 (M) | CRM211 (M) | |
| A59-16W (T) | C17/7A (M) | CME1703 (M) | 23SP4 (M) | |
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| AW43-89 (M) | C17/5M (M) | CME1902 (M) | 212K (M) | |
| AW47-90 (M) | MW/53-80 (M) | CME1903 (M) | 7205A (M) | |
| AW47-91 (M) | C19/10AP (T) | CME1905 (P) | 7405A (M) | |
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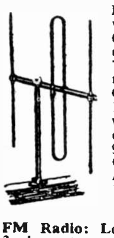

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22/10/70 Czechoslovakia R1, Hungary R1, Austria E2a, Spain E2.
23/10/70 Sweden E2.
24/10/70 USSR R1, Austria E2a.
25/10/70 Czechoslovakia R1.
26/10/70 Poland R1, Spain E2.
27/10/70 Austria E2a.
28/10/70 Poland R1, Sweden E2.
29/10/70 USSR R1.
30/10/70 Czechoslovakia R1.
31/10/70 Czechoslovakia R1.

I have been receiving bursts of the EBU bar on several occasions on Ch. R1 during the past month and have not as yet been able to identify its source. The only suggestion I can offer is that Bacau Rumania R1 has increased its power. This seems to be very much a shot in the dark, has anybody any other ideas?

The Trops have been pretty poor with only a moderate opening to France on 17/10/70. There was however a big Trop opening on 20-26/9/70. Roger Bunney had eight new West German stations and Ian Beckett had "a whale of a time". In addition to W. Germany Rimberg Ch.39, Hohen Meissen Ch.53 and Lingen Ch.59 as new ones identified on caption he had France Sarrebourg? Ch.53 and Limoges? Ch.50 and it appears that Bands III and u.h.f. were wide open to W. and E. Germany during this period. The best effort however was by M. Bluck of Scarborough—brought to my notice by D. Boniface —who had Czechoslovakia Prague Ch.24 on test card on 18/6/70 and received their confirmation. His communication with Czechoslovakian TV brought the following list of u.h.f. stations: Prague Ch.24 70kW H; Bratislava Ch.27 15kW H; Ostrava Ch.31 14kW H; Brno Ch.35 25kW H. In view of this we may all have a chance given some good Trop conditions.

I am delighted to report further Meteor Shower success, further confirming its possibilities. We have received confirmation from an old DX friend Frank Smales of Pontefract, Yorks. His meteor-shower report for August 1970 is:

10/8/70 Poland R7 at 21.10 on caption.
11/8/70 Sweden E6 at 10.15 on test card.
Sweden E5 at 12.35 on test card.
Poland R7 at 14.10 on test card.
Denmark E5 at 18.52 on test pattern.
12/8/70 Sweden E6 at 12.15 on test card.
Poland R7 at 12.24 on test card.
Denmark E6 at 19.27 on test card.

The receiver used was an American 23in. model converted to CCIR standards. He also has an excellent Trop log for the September opening. In Band III he had Austria E5 and Luxembourg E7. Amongst the multitude of u.h.f. stations he received (getting like Band III now!) he got Austria on Chs. 21, 22, 23 and 24 on 25/9/70. He thought at first these were W. Germany but as the signals improved he recognised the ORF test card and later the test pattern with the word "Oesterreicher" on it. He also had (reverting to Band III) East Germany Brocken E6, Marlow E8, Leipzig E9 and Schwerin E11 (very good).

These results should encourage us all. With the "new" meteor shower possibilities now proved and some good future Trop openings in Band III and u.h.f. the future does not seem so black after all, even during the winter SpE lull. I for one am embarking on a reorganisation. Since the arrival of the Decca colour TV set there has been a general rearrangement of sets and in future the DX ones will be on shorter coaxial leads which should help a lot.

## IBC-70

*—continued from page 127*

camera. The biggest possible money-spinner was the Gates automated radio equipment, allowing virtually automatic programming and transmission of radio—a great possibility for commercial local radio stations.

### *Summary*

If prizes were to be given we would have to award Ampex a gold medal for their development of the AVR-1 videotape recorder and another gold to D. A. Tilsley of Granada Television who in describing his company's new colour outside broadcast unit made what could have been a very boring description into a presentation to be remembered. With a slickness of slides, his Northern humour dominated all the delegates. Mr. Tilsley has what it takes to make a star comedian. A gold medal too to Marconi Communications Systems for their beautifully engineered one valve f.m. broadcast transmitter.

Silver medals should go firstly to Dr. Boris Townsend of Thames Television for his kindly good naturedness to all and sundry (including yours truly) during the week and his unique blandishment when he was either chairman or one of the rapporteurs at the technical sessions, and secondly to the poor girl who danced herself to a perspired globule day after day in front of the new Marconi colour camera.

Some of the booby prizes must go to those technical papers which had no place at IBC-70 either because of their complete lack of technical content or because they were rehashes of papers already published by the same authors or because they were nominally presented by persons *under whom* the work was undertaken and not *by whom*. Fortunately these papers were few in number. Although we have congratulated Ampex on the AVR-1 we must also criticise them on their closed-circuit stand where the colour-capable helical-scan VTRs they were to demonstrate were non-operational for a good portion of the week.

IBC must be the success it is for a variety of reasons. By no means unimportant is the opportunity it gives for a relatively small network of people to meet again and to meet new faces. The exhibition is undoubtedly important—not so much in terms of direct sales for the exhibiting companies but as an enlightening opportunity for making comparisons, for having arguments which one might not care to start on ones own premises, and for meeting the designers rather than just the salesmen.

Most of all though IBC-70 was the time for broadcasting engineers to assess the results of PAL colour and its major introduction into transmission. Certainly a large proportion of the US engineers who attended must have gone home wondering whether it was too late for them to change to PAL. It was a great pity therefore that some of the exhibitors did not wave the flag both for PAL and themselves by having their colour monitors set up properly. Only one Bloclight (BBC/Fisher Bloclight for setting up Illuminant D and grey scale) was seen in use and that was on the BBC stand.

IBC-70 was a resounding success for all. If the odd *faux pas* has been noted by the organising sponsors the Fourth Convention in 1972 should be even better. But it will be difficult over two years to remember the name that goes with the face and who owes who that drink! ■

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## MASTERADIO 4018

**There was picture rolling and the vertical hold control could not be adjusted to cure this. R102 in series with the hold control was increased in value and this temporarily corrected the fault. The fault occurred again, so the PCL85 was replaced and R102 further increased to 1MΩ. The trouble now is that there is a series of white lines across the top of the picture, which is also ½in. short at the bottom. These faults occur on 405, 625 line operation being perfect.—G. Wainwright (Dorchester).**

First check the 0·05μF capacitor C156 in the field sync feed circuit. Then check C147 (field charging capacitor) and the two capacitors C150 and C148 to the grid of the triode section of the field timebase valve. If necessary replace C151 and C155 (both 0·01μF) in the field linearity feedback circuit and check P8 the field linearity control.

## BUSH TV148U

**The trouble is buzz of varying intensity on BBC-2, depending on picture content. This buzz is worse when the picture is darkened by adjusting the contrast control. It is only when the contrast control setting is reduced to an unacceptable level that the buzzing stops. The detector balance control has been carefully adjusted and the coils tuned. The picture itself is very good and the correct aerial is installed. —E. N. Paynter (St. Austell).**

No amount of detector balance control adjustment will tune out the buzz if the OA79 detector diodes are not matched. So check the back-to-front resistance of these (2MR2 and 2MR3) and replace as necessary. Also check the 5μF capacitor 2C46.

## FERGUSON 3602

**The PL36, U193, PCL85 and ECC82 valves have been replaced, also the width control and boost reservoir capacitor, but still there is insufficient width —it is about ½in. short at each side. Do you think the width stabilising varistor is at fault?—N. Ratcliffe (Birmingham).**

The varistor Z1 is not likely to be at fault but the high-value resistors in the width circuit are inclined to change value. Check R100 1·8MΩ and R101 2·2MΩ.

## DECCA DM45

**When the gain is set at minimum a full field can be held but the picture is washy. When the gain is increased by moving the aerial or adjusting the sensitivity control the field blinks rapidly, alternating from a full field to a thin white horizontal line about twice a second. There is at the same time a loud synchronous clicking. The PL84 field output valve has been replaced.—F. McLaughlin (Devonport).**

In Decca receivers of this vintage a novel control called the interlace control was fitted. On the DM45 it is situated immediately below the mains tag panel. The setting of this control is often overlooked and leads to hours of wasted time. To set it, rotate fully anti-clockwise then rotate the field hold control to the fully anti-clockwise position. Lock the field with the interlace control, if necessary slightly adjusting the hold control. Then adjust both controls for good interlace over the complete range of locked field and so that there is no field folding at the bottom of the picture.

## COSSOR CT1700U

**There is reduced picture size all round with this 17in. receiver and the sound is very soft and distorted.—A. G. Chambers (Gt. Yarmouth).**

First check the h.t. voltage. If low check both PY82 rectifiers and the a.c. input to pin 9 at both bases. If the h.t. is not low check the PL81 and PY81 valves and the value of the focus control (2MΩ), and also the value of the 2.7MΩ triode audio amplifier anode load resistor (to pin 1) which on these models is fed from the boost rail.

## MURPHY V149U

**The trouble is field slip. This is very bad on 625, and the field slips once or twice an evening on 405. The signal strength is as good on each system and I have fitted a new PCL85 and PFL200—L. R. Harris (Portsmouth).**

Your problem could be due to aerial trouble or a faulty sync diode block 3MR1-2-3 to the right of the system switch on the timebase unit.

### BUSH TV139U

**The picture flicks from a normal to a slightly fainter one, this occurring roughly every three minutes. The tube and video amplifier have been replaced.—G. H. Clapperton (Colchester).**

The "set A.G.C. 405" control could be at fault and often is. In fact the setting of the preset controls can be very critical on these models, including the bottom left-hand 15V transistor voltage adjustment. We suggest you set the 405 preset contrast control and take voltage readings in the i.f. strip.

### EKCO T344

**The timebase valves and the c.r.t. have been replaced on this set, also R59, R66, R68 and C51. However when either the contrast or brilliance are increased the picture swells and then disappears, leaving a blank screen.—H. J. Bennett (Marlow).**

Your symptoms could be due to inadequate e.h.t. rectifier heater voltage. This is often caused by a faulty 2V winding on the line output transformer. This can be readily rewound using a length of coaxial cable inner conductor.

### GEC BT302

**The picture suddenly lost all brilliance and is almost non-existent, being only dimly discernible in a dark room. The raster is otherwise quite normally bright but has flyback lines superimposed.—S. Newcombe (Lincoln).**

The usual cause of a large loss of contrast on the picture together with superimposed flyback lines is the ageing of the video amplifier valve. This is V6, Z339. Also check the D77 interference limiter and 120kΩ resistor in the feed to the c.r.t. cathode.

### BUSH TV148U

**The width is inadequate although the height and sound are OK. Replacing the PL504 and PY800 had little effect, but reducing the brilliance control increases the width though unfortunately this introduces a circular area in the centre of the picture which is fainter than the rest.—R. A. Crawford (Ayr).**

We feel that the problem is in the line set stabilising circuit. Check the 750kΩ feed resistor 3R24, the 680kΩ resistor 3R21 to the slider and the 1·8MΩ grid resistor 3R20. Also check the line set stabilisation control itself.

### 405-625 CONVERSION

**I am about to convert a 17in. KB Royal Star receiver to 625-line operation and plan to use as a basis the "Constructor's 625-line Receiver" circuit along with a surplus transistorised i.f. strip and tuner unit. As I shall be using only seven valves plus the c.r.t. in the circuit, what will the value of the mains dropper R90, at present 130Ω, need to be changed to?—J. N. Brown (Edinburgh).**

The dropper resistor R90 in your Royal Star model will have to be increased to about 200Ω—then check that the heater current on test is about 300mA.

### BUSH TV77

**The spacing between the lines of the raster varies continually, giving the effect of the picture stretching and shrinking all the time. I have changed the valves and most of the components in the field timebase without effecting a cure.—S. A. Blyth (Watford).**

Check that the values of the smoothing resistors behind the voltage adjustment panel are correct—it is quite often that they are replaced with ones of incorrect value and if the value is too low the smoothing efficiency is reduced—it is poor smoothing that is causing your trouble. If the smoothing resistors are of the correct value, change the main smoothing capacitor block.

### PYE V700D

**The fault is that the picture creeps up from the bottom after about half an hour leaving a 2in. gap which cannot be opened out. The PCL85 field timebase valve and 200μF cathode decoupler have been replaced.—S. W. Naylor (Bridgewater).**

Check the 100μF decoupler in the h.t. feed to the field timebase—this is part of the main smoothing block. Then check the 0.1μF capacitor coupling the triode blocking oscillator section (pin 1) of the valve to the pentode output section.

### EKCO T344

**The picture is difficult to keep steady. There is a pulsing to and fro movement accompanied by a sympathic note as this occurs from the line output transformer. On increasing the contrast this stops and the picture steadies but goes negative, whilst on reducing the contrast again the picture is momentarily perfect but then resumes its pulsing.—A. L. Brown (Bolton).**

Check the value of the 27kΩ stabilising resistor connected between the h.t. line and the cathode of the 30FL1 video amplifier valve. This resistor often changes value to give the symptoms you describe.

### PHILCO 1021

**There are about four to five white vertical columns consisting of diagonal lines about ¼in. long in the centre of the screen. Sometimes these multiply to the left of the screen making this half much lighter than the other.—J. Brook (Wakefield).**

The line output transformer is fixed in position on a grooved carriage, the contacts being made by bow-springs underneath. Check the contact of these springs and clean them. Then check the 1kΩ resistor across the line linearity coil. Check the scan coils plug and socket and all connections to the line output transformer.

### RANK TV154

**The field hold control setting is very critical and there is an annoying bounce at times. There is also sound-on-vision.—F. Samuels (Botley).**

This set is fitted with the same chassis as the Bush TV161 series. For the field fault we suggest you change the interlace diode 3MR3 and check the associated components. For the sound-on-vision adjust the preset a.g.c. control 2RV1.

### FERGUSON 406T

**The scanning is satisfactory when first switched on but after about a quarter of an hour begins to slip at the top and bottom. The picture can be locked by adjusting the hold control but eventually the control is at the end of its range. Finally the picture is about 7-8in. high. The height and linearity controls work satisfactorily and the field timebase valves have been changed. Also the picture is of rather poor quality with what appears to be line smearing.—E. A. Trouse (Brighton).**

The field timebase trouble is almost certainly caused by the field oscillator cross-coupling capacitor C101 (0·01μF) from pin 2 of the PCL84 to pin 1 of the PCL82 becoming leaky. Also check R112 (220kΩ) which is in series with the field hold control. The poor picture quality is probably due to a component defect in the video amplifier stage. Check the stabilising resistor R51 (47kΩ) connected between pins 9 and 7. All the components in this circuit however should be checked, including the 0·1μF coupler (C61) to the c.r.t.

### McMICHAEL MP17

**There is no sound or vision on BBC1 or ITA on this 17in. portable model. All I get is white lines across the screen on switching on. The valves have been replaced.—I. Hannay (Woking).**

A frequent cause of the trouble you describe with these receivers is the failure of the 10kΩ 1W resistor under the tuner unit (across the PCF80 valvebase)—the grid resistor of the triode oscillator section. The original colours, brown black and orange, will be found faded.

### MARCONIPHONE 4619B

**There is a 3in. black band at the bottom of the screen and the height control only makes the picture roll. As the top of the picture is good I've not checked the PCL85.—C. Lethbridge (Preston).**

The PCL85 may well be the cause of the trouble and should be replaced. If this does not cure the fault check the 0·01μF capacitor C88 in the field linearity feedback loop.

### BUSH TV161GU

**The fault is hum on video, a dark bar going up or sometimes down the screen and distorting the picture. This is very pronounced on 625 and at the same time there is intermittent field judder and the hold control setting becomes critical. I have checked by substitution the PFL200 and PCL85, and the smoothing electrolytics.—S. Hale (Battersea).**

We have always found that the smaller electrolytics associated with the PFL200 are at fault when this type of trouble is experienced. The 8μF screen decoupler 2C48 of the sync separator section should in particular be checked.


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**TELEVISION, JANUARY, 1971**


# TEST CASE 97

*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 CTV25 colour set exhibited a gradual reduction in colour intensity with increasing temperature from switch-on. Tests in the colour-difference stages indicated that all was well here and that the fault must lie in the chroma parts of the circuit. Subsequent tests however proved that the chroma amplifier gain remained fairly steady during the condition of the symptom. A clue was provided by the saturation returning to normal after readjustment of the line lock control, but such readjustment was not necessary from the point of view of the line lock which remained solid at all times.*

*What was the most likely cause of this symptom and why could it be corrected by readjusting the line lock control even though this was not necessary for correct line synchronising? See next month's* TELEVISION *for the solution to this problem and for a further item in the Test Case series.*

### SOLUTION TO TEST CASE 96
### Page 90 (November 1970)

Since there was no distortion on the 405-line sound trouble in the audio amplifier could be discounted. Moreover the accompanying effect of intercarrier buzz almost always indicates poor a.m. rejection in the f.m. detector, assuming that the intercarrier channel and the appropriate rejectors in the vision i.f. channel are in correct alignment.

The service technician should have concentrated a little longer on the f.m. detector, for apart from making sure that the diodes are in good condition a check should also have been made to establish the d.c. conditions. The set in question employs a small preset potentiometer for balancing the ratio detector (adjusted for the least a.m. breakthrough and intercarrier buzz) and it was subsequently discovered that the slider connection to the track was impaired.

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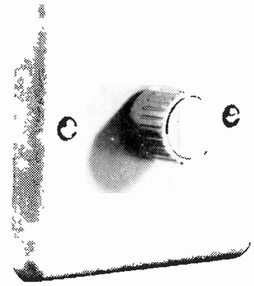

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| 400 | 2/6 | 5/6 | 7/6 | 25/– |
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