

# TELEVISION

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1973

## ASSESSING RECEIVER PERFORMANCE



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**All Lopts NEW and GUARANTEED for SIX MONTHS**

E. J. PAPWORTH AND SON Ltd.,  
80, MERTON HIGH ST., LONDON, S.W.18

01-540 3955

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## LAWSON BRAND NEW TELEVISION TUBES

**SPECIFICATION:** The Lawson range of new television tubes are designed to give superb performance, coupled with maximum reliability and very long life. All tubes are the products of Britain's major C.R.T. manufacturers, and each tube is an exact replacement. Tubes are produced to the original specifications but incorporate the very latest design improvements such as: High Brightness Maximum Contrast Silver Activated Screens, Micro-Fine Aluminising, Precision Aligned Gun Jigging, together with Ultra Hard R.F. High Vacuum Techniques.



### DIRECT REPLACEMENTS FOR MULLARD-MAZDA BRIMAR GEC, ETC.

|         |          |         |         |            |
|---------|----------|---------|---------|------------|
| A47-11W | MW43-69  | C19/AK  | CME1903 | 172K       |
| A47-13W | MW43-80  | C21/1A  | CME1905 | 173K       |
| A47-14W | MW52/20  | C21/7A  | CME1906 | 212K       |
| A47-17W | MW53/80  | C21/AA  | CME1908 | 7205A      |
| A47-18W | AW47-97  | C21/AF  | CME2101 | 7405A      |
| A47-26W | AW53-80  | C21/KM  | CME2104 | 7406A      |
| A59-11W | AW53-88  | C21/SM  | CME2301 | 7502A      |
| A59-12W | AW53-89  | C23/7A  | CME2302 | 7503A      |
| A59-13W | AW59-90  | C23/10  | CME2303 | 7504A      |
| A59-14W | AW59-91  | C23/AK  | CME2305 | 7601A      |
| A59-15W | C17/1A   | CME1601 | CME2306 | 7701A      |
| A59-14W | C17/5A   | CME1602 | CME2308 | A50-120W/R |
| AW43-80 | C17/7A   | CME1702 | CRM172  | MW36/24    |
| AW43-88 | C17/AA   | CME1703 | CRM173  | MW36/44    |
| AW43-89 | C17/AF   | CME1705 | CRM212  | CRM141     |
| AW47-90 | C17/FM   | CME1706 | CRM211  |            |
| AW47-91 | C17/SM   | CME1901 | 23SP4   |            |
| MW43-64 | C19/10AP | CME1902 | 171K    |            |

### REBUILT TUBES

LAWSON "RED LABEL" CRTS are particularly useful where cost is a vital factor, such as in older sets or rental use. Lawson "Red Label" CRTS are completely rebuilt from selected glass, direct replacements and guaranteed for two years.

|                | New Tubes<br>£ | Red Label<br>£ | Colour Tubes<br>old glass not required |
|----------------|----------------|----------------|--|
| 14"            | 3-50           | —              |  |
| 17"            | 6-25           | 4-97           | 19" £39-50                             |
| 19"            | 7-25           | 5-25           |  |
| 21"            | 8-50           | 6-95           | 22" £43-50                             |
| 23"            | 9-75           | 7-25           |  |
| 19" Twin Panel | 10-25          | 8-25           | 25" £47-50                             |
| 23" Twin Panel | 15-50          | 9-75           |  |
| 16" Panorama   | 8-50           | —              | 26" £49-50                             |
| 19" Panorama   | 9-38           | 6-95           |  |
| 20" Panorama   | 10-50          | 7-50           | carr. £1-50                            |
| 23" Panorama   | 11-95          | 8-75           |  |

### LAWSON TUBES

18 CHURCHDOWN ROAD,  
MALVERN, WORCS.  
Malvern 2100

**2 YEARS' GUARANTEE  
FULL TUBE FITTING  
INSTRUCTIONS**

Tubes are despatched day of order by passenger train, road or goods taking far too long for customers satisfaction.

Carriage/Insurance: 12"-19" 62p. 20"-25" 75p

|   |   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
|---|---|----------------------------------|--------------|----------------------------|-------------|-------------------------|-------------|---|------------------------|-------------|-------------|--------------|-------------|--------------|-----------|---|--------------------|------------|---|------------------------|-----------|-------------|--------------|------------|------------|-----------|------------|------------|------------------|------------|--|----------------|----------|--|----------------------------|---------|----------------------------|--|-----------------------|----------------|----------------------------|---------|-----------------|----------------------------|--|-------------------|-------------------------|--|----------------|-------------------------|------|----------------|-------|----------------|---------------|---|------------------------|-----------------|-------------|------------------|--------|------------------|----------|------------------|--------|---------------------------|--|------------------------|-------|---------------------------|-------|------------------|-------|---------------------------|-------|------------------|-----------|---------------------------------|-----------|----------------|-----------|-------------------------------|-----------|-----------|--------|------------------------|-----------|--|-----------|---------------------|---------|------------|--------|-------------------------|------------|----------|---------|---------------------|----------|-----------|------------|-----------------|-----------|---------------------|-----------|--|------------------------|-----------|------------------|------------|------------------|-----------|------------------|----------|------------------|----------|--------------------------------|-----------|----------------|-----------|-------------------------------|-----------|--------|---------|-----------|-----------|---------|-----------|----------|-----------|-----------|-----------|-----------|-----------|------------|--|-----------|----------|------------|---------|----------|-----------|---------|----------|-----------|---------|----------|-----------|---------|----------|-----------|---------|----------|-----------|----------|-----------|-------------|----------|----------|------|----------|-----------|---------|----------|-----------|--|----------|-------------|-----------|
| <p><b>Colour Television I.C.'s</b></p> <table border="0"> <tr> <td>TA500 £2.00</td> <td>TA850 £3.00</td> <td>SL436B £3.86</td> </tr> <tr> <td>TA510 £2.00</td> <td>TA860 £3.28</td> <td>SL432A-T £1.18</td> </tr> <tr> <td>TA520 £2.05</td> <td>TA750 £1.04</td> <td>SL901B £2.66</td> </tr> <tr> <td>TA530 £1.08</td> <td>TA990 £3.99</td> <td>SL35C-E</td> </tr> <tr> <td>TA540 £2.00</td> <td>SL4030 £1.50</td> <td>SL917A</td> </tr> </table> <p><b>I.C. Sockets</b><br/>Dual-in-line or Zig-Zag (Quil), 14 and 18 pin<br/>Our Price 15p</p>  | TA500 £2.00   | TA850 £3.00                      | SL436B £3.86 | TA510 £2.00                | TA860 £3.28 | SL432A-T £1.18          | TA520 £2.05 | TA750 £1.04   | SL901B £2.66           | TA530 £1.08 | TA990 £3.99 | SL35C-E      | TA540 £2.00 | SL4030 £1.50 | SL917A    | <p><b>VDR's &amp; Thermistors</b></p> <table border="0"> <tr> <td>A15B 75p</td> <td>GL23 £1.00</td> <td>VA1005 15p</td> </tr> <tr> <td>CZ1 15p</td> <td>R53 £1.32</td> <td>VA1026 13p</td> </tr> <tr> <td>CZ4 13p</td> <td>R54 £1.46</td> <td>VA1033 13p</td> </tr> <tr> <td>CZ13A 13p</td> <td></td> <td>VA1040 10p</td> </tr> <tr> <td>E298 ED/A258 10p</td> <td></td> <td>VA1053 10p</td> </tr> <tr> <td>E298 ZZ/06 10p</td> <td></td> <td>VA1055S 10p</td> </tr> <tr> <td>GL16 £1</td> <td></td> <td>VA1034 10p</td> </tr> </table> | A15B 75p           | GL23 £1.00 | VA1005 15p  | CZ1 15p                | R53 £1.32 | VA1026 13p  | CZ4 13p      | R54 £1.46  | VA1033 13p | CZ13A 13p |            | VA1040 10p | E298 ED/A258 10p |            | VA1053 10p   | E298 ZZ/06 10p |          | VA1055S 10p  | GL16 £1                    |         | VA1034 10p                 | <p><b>Potentiometers</b></p> <table border="0"> <tr> <td>5KΩ</td> <td>50KΩ</td> <td>500KΩ</td> </tr> <tr> <td>10KΩ</td> <td>100KΩ</td> <td>1MΩ</td> </tr> <tr> <td>25KΩ</td> <td>250KΩ</td> <td>2MΩ</td> </tr> </table> <p>log or lin less switch (&amp; 1KΩ lin) 12p<br/>log or lin with switch 24p<br/>dual less switch 40p<br/>dual with switch 10K, 100K &amp; 1M log only 52p<br/>10K log - 10K antilog less switch 40p</p> | 5KΩ                   | 50KΩ           | 500KΩ                      | 10KΩ    | 100KΩ           | 1MΩ                        | 25KΩ   | 250KΩ             | 2MΩ                     | <p><b>Capacitors</b></p> <p>Ceramic - plate 63V (C333)</p> <table border="0"> <tr> <td>1.8pf</td> <td>8.2pf</td> <td>33pf</td> <td>120pf</td> </tr> <tr> <td>2.2pf</td> <td>10pf</td> <td>39pf</td> <td>150pf</td> </tr> <tr> <td>3.3pf</td> <td>12pf</td> <td>47pf</td> <td>180pf</td> </tr> <tr> <td>3.9pf</td> <td>15pf</td> <td>56pf</td> <td>220pf</td> </tr> <tr> <td>4.7pf</td> <td>18pf</td> <td>68pf</td> <td>270pf</td> </tr> <tr> <td>5.6pf</td> <td>22pf</td> <td>82pf</td> <td>330pf</td> </tr> <tr> <td>6.8pf</td> <td>27pf</td> <td>100pf</td> <td></td> </tr> </table> <p>all 5p. each</p> <p>mylar film 100V</p> <table border="0"> <tr> <td>1000pf 2p</td> <td>-0.1μF 3p</td> <td>0.68μF 4p</td> </tr> <tr> <td>2000pf 2p</td> <td>-0.2μF 3p</td> <td>1μF 4p</td> </tr> <tr> <td>5000pf 2p</td> <td>-0.4μF 3p</td> <td>2μF 5p</td> </tr> <tr> <td></td> <td>-0.5μF 3p</td> <td></td> </tr> </table> <p>metallised polyester 250V (C280)</p> <table border="0"> <tr> <td>-0.1μF 3p</td> <td>0.68μF 3p</td> <td>47μF 8p</td> </tr> <tr> <td>-0.15μF 3p</td> <td>1μF 4p</td> <td>68μF 11p</td> </tr> <tr> <td>-0.22μF 3p</td> <td>1.5μF 4p</td> <td>1μF 13p</td> </tr> <tr> <td>-0.33μF 3p</td> <td>2.2μF 5p</td> <td>1.5μF 20p</td> </tr> <tr> <td>-0.47μF 3p</td> <td>3.3μF 6p</td> <td>2.2μF 24p</td> </tr> </table> <p>metallised polyester 400V (C281)</p> <table border="0"> <tr> <td>-0.1μF 4p</td> <td>0.47μF 6p</td> <td>2.2μF 14p</td> </tr> <tr> <td>-0.15μF 4p</td> <td>0.68μF 6p</td> <td>3.3μF 10p</td> </tr> <tr> <td>-0.22μF 4p</td> <td>1μF 7p</td> <td>4.7μF 15p</td> </tr> <tr> <td>-0.33μF 4p</td> <td>1.5μF 8p</td> <td></td> </tr> </table> <p>mixed dielectric 600V</p> <table border="0"> <tr> <td>0.1μF 7p</td> <td>0.47μF 7p</td> <td>2.2μF 18p</td> </tr> <tr> <td>0.22μF 7p</td> <td>0.68μF 8p</td> <td>4.7μF 24p</td> </tr> <tr> <td>0.33μF 7p</td> <td>1μF 8p</td> <td>1μF 33p</td> </tr> </table> <p>mixed dielectric 1000V</p> <table border="0"> <tr> <td>1000pf 6p</td> <td>6800pf 9p</td> <td>1μF 12p</td> </tr> <tr> <td>2200pf 6p</td> <td>0.1μF 9p</td> <td>2.2μF 20p</td> </tr> <tr> <td>3300pf 6p</td> <td>0.22μF 9p</td> <td>4.7μF 32p</td> </tr> <tr> <td>4700pf 6p</td> <td>0.47μF 12p</td> <td></td> </tr> </table> <p>Ceramic</p> <table border="0"> <tr> <td>12KV d.c.</td> <td>8KV d.c.</td> <td>HI-K 750V.</td> </tr> <tr> <td>10pf 9p</td> <td>200pf 9p</td> <td>1500pf 5p</td> </tr> <tr> <td>15pf 9p</td> <td>220pf 9p</td> <td>1500pf 5p</td> </tr> <tr> <td>22pf 9p</td> <td>250pf 9p</td> <td>2000pf 5p</td> </tr> <tr> <td>68pf 9p</td> <td>270pf 9p</td> <td>3000pf 5p</td> </tr> <tr> <td>82pf 9p</td> <td>300pf 9p</td> <td>5000pf 5p</td> </tr> <tr> <td>100pf 9p</td> <td>750V DISC</td> <td>10,000pf 5p</td> </tr> <tr> <td>120pf 9p</td> <td>470pf 5p</td> <td>feed</td> </tr> <tr> <td>140pf 9p</td> <td>1000pf 5p</td> <td>through</td> </tr> <tr> <td>150pf 9p</td> <td>5000pf 5p</td> <td></td> </tr> <tr> <td>180pf 9p</td> <td>10,000pf 5p</td> <td>1000pf 5p</td> </tr> </table> | 1.8pf          | 8.2pf                   | 33pf | 120pf          | 2.2pf | 10pf           | 39pf          | 150pf   | 3.3pf                  | 12pf            | 47pf        | 180pf            | 3.9pf  | 15pf             | 56pf     | 220pf            | 4.7pf  | 18pf                      | 68pf   | 270pf                  | 5.6pf | 22pf                      | 82pf  | 330pf            | 6.8pf | 27pf                      | 100pf |                  | 1000pf 2p | -0.1μF 3p                       | 0.68μF 4p | 2000pf 2p      | -0.2μF 3p | 1μF 4p                        | 5000pf 2p | -0.4μF 3p | 2μF 5p |                        | -0.5μF 3p |  | -0.1μF 3p | 0.68μF 3p           | 47μF 8p | -0.15μF 3p | 1μF 4p | 68μF 11p                | -0.22μF 3p | 1.5μF 4p | 1μF 13p | -0.33μF 3p          | 2.2μF 5p | 1.5μF 20p | -0.47μF 3p | 3.3μF 6p        | 2.2μF 24p | -0.1μF 4p           | 0.47μF 6p | 2.2μF 14p  | -0.15μF 4p             | 0.68μF 6p | 3.3μF 10p        | -0.22μF 4p | 1μF 7p           | 4.7μF 15p | -0.33μF 4p       | 1.5μF 8p |                  | 0.1μF 7p | 0.47μF 7p                      | 2.2μF 18p | 0.22μF 7p      | 0.68μF 8p | 4.7μF 24p                     | 0.33μF 7p | 1μF 8p | 1μF 33p | 1000pf 6p | 6800pf 9p | 1μF 12p | 2200pf 6p | 0.1μF 9p | 2.2μF 20p | 3300pf 6p | 0.22μF 9p | 4.7μF 32p | 4700pf 6p | 0.47μF 12p |  | 12KV d.c. | 8KV d.c. | HI-K 750V. | 10pf 9p | 200pf 9p | 1500pf 5p | 15pf 9p | 220pf 9p | 1500pf 5p | 22pf 9p | 250pf 9p | 2000pf 5p | 68pf 9p | 270pf 9p | 3000pf 5p | 82pf 9p | 300pf 9p | 5000pf 5p | 100pf 9p | 750V DISC | 10,000pf 5p | 120pf 9p | 470pf 5p | feed | 140pf 9p | 1000pf 5p | through | 150pf 9p | 5000pf 5p |  | 180pf 9p | 10,000pf 5p | 1000pf 5p |
| TA500 £2.00   | TA850 £3.00   | SL436B £3.86                     |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| TA510 £2.00   | TA860 £3.28   | SL432A-T £1.18                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| TA520 £2.05   | TA750 £1.04   | SL901B £2.66                     |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| TA530 £1.08   | TA990 £3.99   | SL35C-E                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| TA540 £2.00   | SL4030 £1.50  | SL917A                           |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| A15B 75p  | GL23 £1.00  | VA1005 15p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| CZ1 15p   | R53 £1.32   | VA1026 13p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| CZ4 13p   | R54 £1.46   | VA1033 13p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| CZ13A 13p   |   | VA1040 10p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| E298 ED/A258 10p  |   | VA1053 10p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| E298 ZZ/06 10p  |   | VA1055S 10p                      |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| GL16 £1   |   | VA1034 10p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 5KΩ   | 50KΩ  | 500KΩ                            |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 10KΩ  | 100KΩ   | 1MΩ                              |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 25KΩ  | 250KΩ   | 2MΩ                              |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 1.8pf   | 8.2pf   | 33pf                             | 120pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 2.2pf   | 10pf  | 39pf                             | 150pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 3.3pf   | 12pf  | 47pf                             | 180pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 3.9pf   | 15pf  | 56pf                             | 220pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 4.7pf   | 18pf  | 68pf                             | 270pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 5.6pf   | 22pf  | 82pf                             | 330pf        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6.8pf   | 27pf  | 100pf                            |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 1000pf 2p   | -0.1μF 3p   | 0.68μF 4p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 2000pf 2p   | -0.2μF 3p   | 1μF 4p                           |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 5000pf 2p   | -0.4μF 3p   | 2μF 5p                           |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
|   | -0.5μF 3p   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.1μF 3p   | 0.68μF 3p   | 47μF 8p                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.15μF 3p  | 1μF 4p  | 68μF 11p                         |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.22μF 3p  | 1.5μF 4p  | 1μF 13p                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.33μF 3p  | 2.2μF 5p  | 1.5μF 20p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.47μF 3p  | 3.3μF 6p  | 2.2μF 24p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.1μF 4p   | 0.47μF 6p   | 2.2μF 14p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.15μF 4p  | 0.68μF 6p   | 3.3μF 10p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.22μF 4p  | 1μF 7p  | 4.7μF 15p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| -0.33μF 4p  | 1.5μF 8p  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 0.1μF 7p  | 0.47μF 7p   | 2.2μF 18p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 0.22μF 7p   | 0.68μF 8p   | 4.7μF 24p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 0.33μF 7p   | 1μF 8p  | 1μF 33p                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 1000pf 6p   | 6800pf 9p   | 1μF 12p                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 2200pf 6p   | 0.1μF 9p  | 2.2μF 20p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 3300pf 6p   | 0.22μF 9p   | 4.7μF 32p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 4700pf 6p   | 0.47μF 12p  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 12KV d.c.   | 8KV d.c.  | HI-K 750V.                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 10pf 9p   | 200pf 9p  | 1500pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 15pf 9p   | 220pf 9p  | 1500pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 22pf 9p   | 250pf 9p  | 2000pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 68pf 9p   | 270pf 9p  | 3000pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 82pf 9p   | 300pf 9p  | 5000pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100pf 9p  | 750V DISC   | 10,000pf 5p                      |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 120pf 9p  | 470pf 5p  | feed                             |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 140pf 9p  | 1000pf 5p   | through                          |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 150pf 9p  | 5000pf 5p   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 180pf 9p  | 10,000pf 5p   | 1000pf 5p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| <p><b>Transistors</b></p> <table border="0"> <tr> <td>AC128 15p</td> <td>BC172 18p</td> <td>BF184 25p</td> </tr> <tr> <td>AC176 15p</td> <td>BD115 67p</td> <td>BF185 25p</td> </tr> <tr> <td>AF139 28p</td> <td>BD124 £1.01</td> <td>BF194 15p</td> </tr> <tr> <td>AF239 30p</td> <td>BD131 70p</td> <td>BF195 15p</td> </tr> <tr> <td>BC107 10p</td> <td>BD132 70p</td> <td>BF196 15p</td> </tr> <tr> <td>BC108 10p</td> <td>BD131/Z.M.P. £1.48</td> <td>BF197 15p</td> </tr> <tr> <td>BC109 10p</td> <td>BF115 25p</td> <td>BF272 53p</td> </tr> <tr> <td>BC147 10p</td> <td>BF167 20p</td> <td>BFY50 24p</td> </tr> <tr> <td>BC148 10p</td> <td>BF173 20p</td> <td>BRY39 36p</td> </tr> <tr> <td>BC149 10p</td> <td>BF180 25p</td> <td>BSX21 26p</td> </tr> <tr> <td>BC171 21p</td> <td>BF181 30p</td> <td>BU105 £2</td> </tr> </table> | AC128 15p   | BC172 18p                        | BF184 25p    | AC176 15p                  | BD115 67p   | BF185 25p               | AF139 28p   | BD124 £1.01   | BF194 15p              | AF239 30p   | BD131 70p   | BF195 15p    | BC107 10p   | BD132 70p    | BF196 15p | BC108 10p   | BD131/Z.M.P. £1.48 | BF197 15p  | BC109 10p   | BF115 25p              | BF272 53p | BC147 10p   | BF167 20p    | BFY50 24p  | BC148 10p  | BF173 20p | BRY39 36p  | BC149 10p  | BF180 25p        | BSX21 26p  | BC171 21p  | BF181 30p      | BU105 £2 | <p><b>Resistors</b></p> <p>½ watt 5% Carbon Film - low noise Hi-Stabs</p> <p>All E24 values 1p each plus p. &amp; p. 7p for up to 50 Resistors and a further 2p for each additional 50. Deduct 33¼% for 100 of one type or 25% for mixed orders over £1 in value.</p> <table border="0"> <tr> <td>1 W 10% Carbon Composition</td> <td>3p each</td> </tr> <tr> <td>2 W 10% Carbon Composition</td> <td>8p each</td> </tr> <tr> <td>2 1/2 W 5% Wire wound</td> <td>9p each</td> </tr> <tr> <td>5 W Wire wound</td> <td>9p each</td> </tr> <tr> <td>10 W Wire wound</td> <td>10p each</td> </tr> </table> <p>plus p. &amp; p. 7p for up to 25 resistors plus 1p for each additional 25.</p> | 1 W 10% Carbon Composition | 3p each | 2 W 10% Carbon Composition | 8p each  | 2 1/2 W 5% Wire wound | 9p each        | 5 W Wire wound             | 9p each | 10 W Wire wound | 10p each                   | <p><b>TV Electrolytics</b></p> <table border="0"> <tr> <td>1.2 : 4; 8μF 450V</td> <td>14p</td> <td>32μF 450V</td> <td>20p</td> </tr> <tr> <td>16μF 450V</td> <td>15p</td> <td>50μF 350V</td> <td>20p</td> </tr> <tr> <td>8-8μF; 450 V.W</td> <td>18p</td> <td>32-32μF; 350 V.W</td> <td>25p</td> </tr> <tr> <td>8-18μF; 450 V.W</td> <td>20p</td> <td>32-32μF; 450 V.W</td> <td>43p</td> </tr> <tr> <td>18-18μF; 450 V.W</td> <td>25p</td> <td>50-50μF; 350 V.W</td> <td>35p</td> </tr> <tr> <td>18+100+100+300μF; 275 V.W</td> <td></td> <td></td> <td>£1.23</td> </tr> <tr> <td>32-100+125+200μF; 275 V.W</td> <td></td> <td></td> <td>£1.23</td> </tr> <tr> <td>32+100+200+200μF; 300 V.W</td> <td></td> <td></td> <td>£1.23</td> </tr> <tr> <td>100+100+150+150-150μF; 320 V.W.</td> <td></td> <td></td> <td>£1.66</td> </tr> <tr> <td>100+100+200+300μF; 275 V.W.</td> <td></td> <td></td> <td>£1.23</td> </tr> <tr> <td>60+100+200μF; 300 V.W.</td> <td></td> <td></td> <td>43p</td> </tr> <tr> <td>100+200μF; 275 V.W.</td> <td></td> <td></td> <td>75p</td> </tr> <tr> <td>100+200+200μF; 300 V.W.</td> <td></td> <td></td> <td>£1</td> </tr> <tr> <td>100+400μF; 275 V.W.</td> <td></td> <td></td> <td>£1.15</td> </tr> <tr> <td>200μF; 275 V.W.</td> <td>50p</td> <td>300-300μF; 300 V.W.</td> <td>£1.90</td> </tr> </table> | 1.2 : 4; 8μF 450V | 14p                     | 32μF 450V  | 20p            | 16μF 450V               | 15p  | 50μF 350V      | 20p   | 8-8μF; 450 V.W | 18p           | 32-32μF; 350 V.W  | 25p                    | 8-18μF; 450 V.W | 20p         | 32-32μF; 450 V.W | 43p    | 18-18μF; 450 V.W | 25p      | 50-50μF; 350 V.W | 35p    | 18+100+100+300μF; 275 V.W |  |                        | £1.23 | 32-100+125+200μF; 275 V.W |       |                  | £1.23 | 32+100+200+200μF; 300 V.W |       |                  | £1.23     | 100+100+150+150-150μF; 320 V.W. |           |                | £1.66     | 100+100+200+300μF; 275 V.W.   |           |           | £1.23  | 60+100+200μF; 300 V.W. |           |  | 43p       | 100+200μF; 275 V.W. |         |            | 75p    | 100+200+200μF; 300 V.W. |            |          | £1      | 100+400μF; 275 V.W. |          |           | £1.15      | 200μF; 275 V.W. | 50p       | 300-300μF; 300 V.W. | £1.90     | <p><b>Eliminators</b></p> <table border="0"> <tr> <td>9 volt (or 20mA (PP3))</td> <td>£1.25</td> </tr> <tr> <td>6 volt (or 50mA)</td> <td>£1.50</td> </tr> <tr> <td>9 volt (or 50mA)</td> <td>£1.50</td> </tr> <tr> <td>6 + 6 volt, 50mA</td> <td>£2.50</td> </tr> <tr> <td>9 + 9 volt, 50mA</td> <td>£2.50</td> </tr> <tr> <td>7½ volt for cassette recorders</td> <td>£2.00</td> </tr> <tr> <td>6.75 or 9 volt</td> <td>£3.00</td> </tr> <tr> <td>3, 4.5, 6, 7½, 9, 12 or 500mA</td> <td>£3.99</td> </tr> </table> <p>Car Battery Converter fully stabilised to provide 6.75 or 9 volts £4.99 (p. &amp; p. 15p on all types)</p> | 9 volt (or 20mA (PP3)) | £1.25     | 6 volt (or 50mA) | £1.50      | 9 volt (or 50mA) | £1.50     | 6 + 6 volt, 50mA | £2.50    | 9 + 9 volt, 50mA | £2.50    | 7½ volt for cassette recorders | £2.00     | 6.75 or 9 volt | £3.00     | 3, 4.5, 6, 7½, 9, 12 or 500mA | £3.99     |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AC128 15p   | BC172 18p   | BF184 25p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AC176 15p   | BD115 67p   | BF185 25p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AF139 28p   | BD124 £1.01   | BF194 15p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AF239 30p   | BD131 70p   | BF195 15p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC107 10p   | BD132 70p   | BF196 15p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC108 10p   | BD131/Z.M.P. £1.48  | BF197 15p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC109 10p   | BF115 25p   | BF272 53p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC147 10p   | BF167 20p   | BFY50 24p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC148 10p   | BF173 20p   | BRY39 36p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC149 10p   | BF180 25p   | BSX21 26p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BC171 21p   | BF181 30p   | BU105 £2                         |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 1 W 10% Carbon Composition  | 3p each   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 2 W 10% Carbon Composition  | 8p each   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 2 1/2 W 5% Wire wound   | 9p each   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 5 W Wire wound  | 9p each   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 10 W Wire wound   | 10p each  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 1.2 : 4; 8μF 450V   | 14p   | 32μF 450V                        | 20p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 16μF 450V   | 15p   | 50μF 350V                        | 20p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 8-8μF; 450 V.W  | 18p   | 32-32μF; 350 V.W                 | 25p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 8-18μF; 450 V.W   | 20p   | 32-32μF; 450 V.W                 | 43p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 18-18μF; 450 V.W  | 25p   | 50-50μF; 350 V.W                 | 35p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 18+100+100+300μF; 275 V.W   |   |                                  | £1.23        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 32-100+125+200μF; 275 V.W   |   |                                  | £1.23        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 32+100+200+200μF; 300 V.W   |   |                                  | £1.23        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100+100+150+150-150μF; 320 V.W.   |   |                                  | £1.66        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100+100+200+300μF; 275 V.W.   |   |                                  | £1.23        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 60+100+200μF; 300 V.W.  |   |                                  | 43p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100+200μF; 275 V.W.   |   |                                  | 75p          |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100+200+200μF; 300 V.W.   |   |                                  | £1           |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100+400μF; 275 V.W.   |   |                                  | £1.15        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 200μF; 275 V.W.   | 50p   | 300-300μF; 300 V.W.              | £1.90        |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 volt (or 20mA (PP3))  | £1.25   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6 volt (or 50mA)  | £1.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 volt (or 50mA)  | £1.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6 + 6 volt, 50mA  | £2.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 + 9 volt, 50mA  | £2.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 7½ volt for cassette recorders  | £2.00   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6.75 or 9 volt  | £3.00   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 3, 4.5, 6, 7½, 9, 12 or 500mA   | £3.99   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| <p><b>Diodes &amp; Rectifiers</b></p> <table border="0"> <tr> <td>AA119 9p</td> <td>BA156 15p</td> <td>BY176 £1.50</td> </tr> <tr> <td>AA120 9p</td> <td>BA243 56p</td> <td>BY182 £1.50</td> </tr> <tr> <td>AA129 9p</td> <td>OA47 10p</td> <td>BY250 23p</td> </tr> <tr> <td>BA102 25p</td> <td>OA79 9p</td> <td>IN4001 6p</td> </tr> <tr> <td>BA115 17p</td> <td>OA90 7p</td> <td>IN4002 7p</td> </tr> <tr> <td>BA130 10p</td> <td>OA91 7p</td> <td>IN4003 8p</td> </tr> <tr> <td>BA145 20p</td> <td>OA200 10p</td> <td>IN4004 8p</td> </tr> <tr> <td>BA148 20p</td> <td>BY100 15p</td> <td>IN4005 10p</td> </tr> <tr> <td>BA154 13p</td> <td>BY126 15p</td> <td>IN4006 12p</td> </tr> <tr> <td>BA156 14p</td> <td>BY127 15p</td> <td>IN4007 15p</td> </tr> </table>  | AA119 9p  | BA156 15p                        | BY176 £1.50  | AA120 9p                   | BA243 56p   | BY182 £1.50             | AA129 9p    | OA47 10p  | BY250 23p              | BA102 25p   | OA79 9p     | IN4001 6p    | BA115 17p   | OA90 7p      | IN4002 7p | BA130 10p   | OA91 7p            | IN4003 8p  | BA145 20p   | OA200 10p              | IN4004 8p | BA148 20p   | BY100 15p    | IN4005 10p | BA154 13p  | BY126 15p | IN4006 12p | BA156 14p  | BY127 15p        | IN4007 15p | <p><b>Power Sections</b></p> <table border="0"> <tr> <td>ohms</td> <td></td> <td>(or 700mA 20p)</td> </tr> <tr> <td>7, 9, 10, 12, 14, 17.5, 20</td> <td></td> <td>(or 700mA 25p)</td> </tr> <tr> <td>22, 25, 28, 30, 33, 36</td> <td></td> <td>(or 300mA 20p)</td> </tr> <tr> <td>40, 47, 52, 56, 60, 63, 66</td> <td></td> <td>(or 300mA 25p)</td> </tr> <tr> <td>75, 87, 100, 120, 140, 160</td> <td></td> <td>(or 120 mA 20p)</td> </tr> <tr> <td>180, 200, 220, 250, 270</td> <td></td> <td>(or 150mA 25p)</td> </tr> <tr> <td>300, 350, 400, 470, 560</td> <td></td> <td>(or 100mA 20p)</td> </tr> <tr> <td></td> <td></td> <td>(or 70mA 25p)</td> </tr> </table> <p>plus p. &amp; p. 7p per section.</p> | ohms           |          | (or 700mA 20p)   | 7, 9, 10, 12, 14, 17.5, 20 |         | (or 700mA 25p)             | 22, 25, 28, 30, 33, 36   |                       | (or 300mA 20p) | 40, 47, 52, 56, 60, 63, 66 |         | (or 300mA 25p)  | 75, 87, 100, 120, 140, 160 |  | (or 120 mA 20p)   | 180, 200, 220, 250, 270 |  | (or 150mA 25p) | 300, 350, 400, 470, 560 |      | (or 100mA 20p) |       |                | (or 70mA 25p) | <p><b>Presets</b></p> <table border="0"> <tr> <td>Vertical or Horizontal</td> <td></td> </tr> <tr> <td>0-1 watt 5p</td> <td>0.25 watt 7p</td> </tr> <tr> <td>100 1K</td> <td>10K 100K</td> </tr> <tr> <td>250 2.5K</td> <td>25K 250K</td> </tr> <tr> <td>500 5K</td> <td>50K 500K</td> </tr> </table> | Vertical or Horizontal |                 | 0-1 watt 5p | 0.25 watt 7p     | 100 1K | 10K 100K         | 250 2.5K | 25K 250K         | 500 5K | 50K 500K                  | <p><b>Eliminators</b></p> <table border="0"> <tr> <td>9 volt (or 20mA (PP3))</td> <td>£1.25</td> </tr> <tr> <td>6 volt (or 50mA)</td> <td>£1.50</td> </tr> <tr> <td>9 volt (or 50mA)</td> <td>£1.50</td> </tr> <tr> <td>6 + 6 volt, 50mA</td> <td>£2.50</td> </tr> <tr> <td>9 + 9 volt, 50mA</td> <td>£2.50</td> </tr> <tr> <td>7½ volt for cassette recorders</td> <td>£2.00</td> </tr> <tr> <td>6.75 or 9 volt</td> <td>£3.00</td> </tr> <tr> <td>3, 4.5, 6, 7½, 9, 12 or 500mA</td> <td>£3.99</td> </tr> </table> <p>Car Battery Converter fully stabilised to provide 6.75 or 9 volts £4.99 (p. &amp; p. 15p on all types)</p> | 9 volt (or 20mA (PP3)) | £1.25 | 6 volt (or 50mA)          | £1.50 | 9 volt (or 50mA) | £1.50 | 6 + 6 volt, 50mA          | £2.50 | 9 + 9 volt, 50mA | £2.50     | 7½ volt for cassette recorders  | £2.00     | 6.75 or 9 volt | £3.00     | 3, 4.5, 6, 7½, 9, 12 or 500mA | £3.99     |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AA119 9p  | BA156 15p   | BY176 £1.50                      |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AA120 9p  | BA243 56p   | BY182 £1.50                      |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| AA129 9p  | OA47 10p  | BY250 23p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA102 25p   | OA79 9p   | IN4001 6p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA115 17p   | OA90 7p   | IN4002 7p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA130 10p   | OA91 7p   | IN4003 8p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA145 20p   | OA200 10p   | IN4004 8p                        |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA148 20p   | BY100 15p   | IN4005 10p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA154 13p   | BY126 15p   | IN4006 12p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| BA156 14p   | BY127 15p   | IN4007 15p                       |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| ohms  |   | (or 700mA 20p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 7, 9, 10, 12, 14, 17.5, 20  |   | (or 700mA 25p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 22, 25, 28, 30, 33, 36  |   | (or 300mA 20p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 40, 47, 52, 56, 60, 63, 66  |   | (or 300mA 25p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 75, 87, 100, 120, 140, 160  |   | (or 120 mA 20p)                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 180, 200, 220, 250, 270   |   | (or 150mA 25p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 300, 350, 400, 470, 560   |   | (or 100mA 20p)                   |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
|   |   | (or 70mA 25p)                    |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| Vertical or Horizontal  |   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 0-1 watt 5p   | 0.25 watt 7p  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100 1K  | 10K 100K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 250 2.5K  | 25K 250K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 500 5K  | 50K 500K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 volt (or 20mA (PP3))  | £1.25   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6 volt (or 50mA)  | £1.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 volt (or 50mA)  | £1.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6 + 6 volt, 50mA  | £2.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 9 + 9 volt, 50mA  | £2.50   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 7½ volt for cassette recorders  | £2.00   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 6.75 or 9 volt  | £3.00   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 3, 4.5, 6, 7½, 9, 12 or 500mA   | £3.99   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| <p><b>EHT Rectifier Trays</b></p> <p>(5 stick version) for BRC Chassis i.e. Ferguson, Ultra, Marconiphone &amp; HMV - 950 Mk II, 960, 970 &amp; 1400 chassis.<br/>Our Price £3.50 plus p. &amp; p. 20p</p>  | <p><b>Mains Droppers</b></p> <table border="0"> <tr> <td>(1) 37Ω + 31Ω + 97Ω - 26Ω + 168Ω</td> <td>50p</td> </tr> <tr> <td>(2) 14Ω - 26Ω + 97Ω - 173Ω</td> <td>50p</td> </tr> <tr> <td>(3) 30Ω + 125Ω - 2.85KΩ</td> <td>50p</td> </tr> </table> <p>plus p. &amp; p. 7p per dropper.</p> | (1) 37Ω + 31Ω + 97Ω - 26Ω + 168Ω | 50p          | (2) 14Ω - 26Ω + 97Ω - 173Ω | 50p         | (3) 30Ω + 125Ω - 2.85KΩ | 50p         | <p><b>Presets</b></p> <table border="0"> <tr> <td>Vertical or Horizontal</td> <td></td> </tr> <tr> <td>0-1 watt 5p</td> <td>0.25 watt 7p</td> </tr> <tr> <td>100 1K</td> <td>10K 100K</td> </tr> <tr> <td>250 2.5K</td> <td>25K 250K</td> </tr> <tr> <td>500 5K</td> <td>50K 500K</td> </tr> </table> | Vertical or Horizontal |             | 0-1 watt 5p | 0.25 watt 7p | 100 1K      | 10K 100K     | 250 2.5K  | 25K 250K  | 500 5K             | 50K 500K   | <p><b>Presets</b></p> <table border="0"> <tr> <td>Vertical or Horizontal</td> <td></td> </tr> <tr> <td>0-1 watt 5p</td> <td>0.25 watt 7p</td> </tr> <tr> <td>100 1K</td> <td>10K 100K</td> </tr> <tr> <td>250 2.5K</td> <td>25K 250K</td> </tr> <tr> <td>500 5K</td> <td>50K 500K</td> </tr> </table> | Vertical or Horizontal |           | 0-1 watt 5p | 0.25 watt 7p | 100 1K     | 10K 100K   | 250 2.5K  | 25K 250K   | 500 5K     | 50K 500K         |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| (1) 37Ω + 31Ω + 97Ω - 26Ω + 168Ω  | 50p   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
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| 0-1 watt 5p   | 0.25 watt 7p  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100 1K  | 10K 100K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 250 2.5K  | 25K 250K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 500 5K  | 50K 500K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| Vertical or Horizontal  |   |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 0-1 watt 5p   | 0.25 watt 7p  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 100 1K  | 10K 100K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 250 2.5K  | 25K 250K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |
| 500 5K  | 50K 500K  |                                  |              |                            |             |                         |             |   |                        |             |             |              |             |              |           |   |                    |            |   |                        |           |             |              |            |            |           |            |            |                  |            |  |                |          |  |                            |         |                            |  |                       |                |                            |         |                 |                            |  |                   |                         |  |                |                         |      |                |       |                |               |   |                        |                 |             |                  |        |                  |          |                  |        |                           |  |                        |       |                           |       |                  |       |                           |       |                  |           |                                 |           |                |           |                               |           |           |        |                        |           |  |           |                     |         |            |        |                         |            |          |         |                     |          |           |            |                 |           |                     |           |  |                        |           |                  |            |                  |           |                  |          |                  |          |                                |           |                |           |                               |           |        |         |           |           |         |           |          |           |           |           |           |           |            |  |           |          |            |         |          |           |         |          |           |         |          |           |         |          |           |         |          |           |          |           |             |          |          |      |          |           |         |          |           |  |          |             |           |

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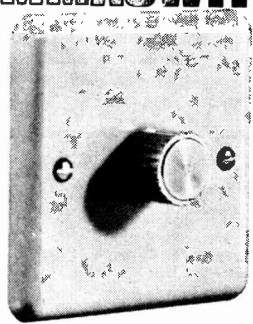
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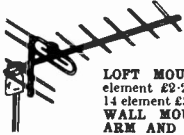
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# TELEVISION

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## IMPORTS AND EXPORTS

In 1936 the world's first regular high-definition public TV broadcast service was started by the BBC. It was the culmination of an extraordinary phase in the technical history of TV. Video and pulse circuitry, TV standards, cameras and transmission techniques were all developed in a comparatively brief, even by modern R and D standards, period of time. The UK electronics industry was a world leader and the outlook seemed good.

The war set the industry back of course. Development effort was concentrated on radar and military requirements and TV closed down. While this was going on the US adopted 525 lines and, during the late forties, put in most of the development work on colour TV as we know it today. Nevertheless the UK TV industry was back on its feet when Europe was only beginning to recover from the effects of the war and the Japanese electronics industry had hardly been thought of.

So in spite of being lumbered with the 405-line system you might have expected the UK TV industry to have been in a leading international position. You would, of course, be wrong. With a few very commendable exceptions—such as EMI's colour cameras—the export performance of the UK TV industry has been lamentable. Especially on the set side.

In 1971 the entire UK TV setmaking industry managed to export a grand total of 53,000 sets. At the rate things have been going recently this will soon be less than the monthly rate of set imports. We have at the moment this extraordinary boom, triggered off by inept government action, which has put UK setmakers in an impossible position. Production capacity has increased dramatically in the past 18 months but with dealers constantly at them it is not surprising that the setmakers have little over for export purposes.

It is not we hope too much to expect that once home demand has levelled out our setmakers will go after a reasonable chunk of the international market. Set prices in the UK have remained remarkably stable over the years, so the industry should be competitive. There are welcome signs that some setmakers are now looking to a prosperous export market, in Europe at least. It is about time—but will it be too late?

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**Cover:** Our cover photographs show good colour reproduction (top) and two fault conditions (below), severe 1.57MHz sound-chrominance beat patterning (left) and lack of h.f. response (right) resulting in poor definition and cogging. Test Card F is the joint copyright of the BBC, IBA, BREMA and EEA.

THE NEXT ISSUE DATED MARCH  
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# TELETOPICS



## TV SET RELIABILITY

Papers on the reliability of domestic TV sets given during a seminar organised by the Society of Electronic and Radio Technicians and published in the November issue of the Society's Journal provide a fascinating insight in considerable depth into this absorbing topic—from the setmakers' point of view, the dealers' point of view and the viewpoint of the rental organisations.

In presenting the experience and views of the dealer S. Hetherington commented first on a significant increase in set reliability though he went on to say, somewhat surprisingly perhaps, that at present colour sets are in general more reliable than monochrome sets. Our first reaction to this was that perhaps fear that the whole trade would become a complete shambles, with a consequent hard to live down public reputation, had made the setmakers take a great deal of trouble to ensure the reliability of current colour models. Some further comments by Mr. Hetherington, based on over twenty years' experience in the trade, threw a rather different light on matters however. Briefly, he had found that during boom periods for the setmakers reliability increased whilst during periods of diminishing sales a fall in the standard of reliability became evident. We had tended to think that a boom meant an attitude of anything goes to get as many sets out to meet the demand, with consequent corner-cutting and use of whatever alternative components could be got hold of if necessary. The over-riding point seems to be however that in boom conditions with a seller's market prices can be maintained and quality standards kept up whilst in flat market conditions there is overwhelming pressure on prices and reliability tends to fall. It is difficult to be too sure about this since the worst trading period coincided with the era of dual-standard TV sets which were inevitably less reliable than the single-standard chassis which preceded and succeeded them. It would however tie up with Mr. Hetherington's findings about the comparative reliability of colour and monochrome sets, since the present colour boom coincides with a very flat period in monochrome set production and sales.

Mr. Hetherington stressed that in talking about reliability he meant overall dependability rather than initial statistics for unboxed set condition. Here he said that approximately 20% of new monochrome receivers required attention when unpacked while approximately 30% of colour receivers required such attention. He also found that during the first three months of the life of a set approximately 20% of monochrome receivers required attention while

approximately 35% of colour receivers required attention. It is interesting to note Mr. Hetherington's list of typical receiver faults. First monochrome: maladjusted tuning; open-circuit thermal fuses; faulty e.h.t. trays; faulty tuning capacitor earthing springs; open-circuit dropper resistors; poor smoothing capacitor earth connections; dry joints; incorrect or under-rated resistor tolerances; substandard miniature capacitors. Colour: tuner drift; convergence controls intermittent; trip-circuits operating under no fault conditions; substandard capacitors; capacitors mounted too close to power resistors; faulty e.h.t. triplers; defective transistors in the video output, field output and line driver and output stages; inferior screened leads; dry joints; under-rated resistors. He commented that there was no marked difference between the reliability of UK-produced and imported sets. It is a fact of course that as far as colour is concerned most imported sets sell at the top end of the market, which tends to confirm Mr. Hetherington's earlier points about reliability.

In summing up, Mr. Hetherington suggested that existing colour chassis should be retained by setmakers and up-graded as necessary. This would certainly be best from the reliability viewpoint. Unfortunately however all too many customers fall for and demand "the latest", and it seems likely that this year will see a sudden swing by UK setmakers to 110° colour sets with all their additional problems. Mr. Hetherington also recommended the support of a healthy home components industry "to remove the prevalent irritating shortages of vital replacements when breakdowns occur"—many readers will appreciate why we highlight this point! He also suggested that if servicing costs rise significantly the setmakers will be forced to shift the emphasis from initial set cost towards reliability. He concluded by pointing out, very rightly we feel, that any industry that could keep its charges to the public as stable as the radio and television industry has done over the years is surely soundly based.

One would have expected the rental concerns to put great pressure on setmakers to ensure set reliability. There are other aspects however. In another paper it was suggested that the intervals between service calls should not be so great that gradual set deterioration resulted in performance that gave the rental organisation a poor reputation. This is something that the pure sales organisation with its reduced contact with customers can do little about unless a great effort is made to encourage customers to call in and discuss the performance of their purchases from time to time. It puts a nice glow on the



operations of rental organisations, the thought that they are continually monitoring the performance of their stocks in the field. This perhaps is not all that untrue in view of the long life they get from sets—and this certainly pays since a long set life is highly profitable once the initial costs have been met.

In a paper putting forward the setmakers' point of view A. T. V. Bourke, B.Sc., M.I.E.R.E., of Combined Electronic Services Ltd. (Philips group) gave much insight into the extraordinary degree to which it is possible for setmakers to assess their aims, balancing production and after-sales costs so as to maintain all-round profitability and a reputation for reliable products. He defined "market dissatisfaction" as the situation where the percentage of customers experiencing more than one failure a year exceeds 10%. This corresponds to a service call rate of 0.5 per annum. Starting from this point it is possible to work out the failure rate of the components, soldered joints and assembly work that goes into a set—assuming that the design has first been produced—and to balance the cost of improved production against subsequent servicing. As an example he quoted changing a component that increased production costs by 30p: if this resulted in a saving of service calls of 0.15 per annum at £3, i.e. 45p, an overall saving is obtained. In fact in modern sets a great deal of development work is devoted to the precise costing of each and every component. Mr. Bourke commented however that in some factories the pressure on keeping down prime costs is very great, which seems to confirm what Mr. Hetherington had to say on the way in which "reliability fluctuates with trading climate".

Conclusions from all this seem to be that to buy a model that has been in production for some time during a period when the trade is doing well is best, while to pay a bit over the odds to get a well-established product from a reputable organisation is worthwhile.

### UHF SERVICE EXTENSIONS

Both BBC services from the **Midhurst** (Sussex) main station are now in operation, BBC-1 on channel 61 and BBC-2 on channel 55. Horizontally polarised group D receiving aerials are required. In addition the BBC-1 service from the **Rosemarkie** station is now in operation, on channel 39 (horizontally polarised group B receiving aerials required). The following relay services are now in operation.

**Aldeburgh** (Suffolk) carrying Anglia Television programmes on channel 23 (receiving aerial group A).

**Whitehaven** (Cumberland) BBC-1 on channel 40 and BBC-2 on channel 46 (receiving aerial group B).

**Merthyr Tydfil** BBC-Wales on channel 22 (receiving aerial group A).

All these relay transmissions are vertically polarised.

### TRADE SCENE

The latest BREMA set delivery figures, for September, continue to show just how well the trade is doing at present. Colour set deliveries for the month rose to 186,000, the highest monthly figure yet, and during the first nine months of 1972 colour set deliveries were over twice the total for the equivalent

nine months of 1971. Monochrome set deliveries (177,000) were also up on the month though down in comparison to the same month last year. Colour set imports in September rose from 14,000 to 42,000, representing about 23% of the total—this large jump in imports is accounted for to some extent by bunching as a result of the July/August dock strike.

Estimates for colour set sales in 1973 range between two and two and a half million. With an expected home production capacity of around two million, imports could account for quite a large slice of total sales. Most setmakers now consider that it will be well into 1974 before production meets demand. An RBM spokesman commented that recent production hold-ups due to component and tube shortages had resulted in a 10-15% reduction in output. A Pye representative also spoke of component shortages: the tubes for their new 18in. model are being supplied by Toshiba.

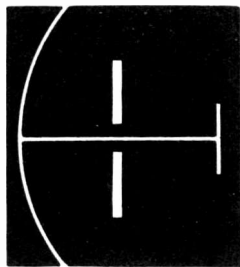
A new mains-battery portable has been introduced by **Crown**: the 12TV-5 is fitted with a 12in. tube and has a recommended price of £69.55. Extreme sensitivity is claimed as a feature, with effective operation in fringe areas.

### COMPONENT NEWS

ITT have introduced a group of i.c.s for use in TV sets, both colour and monochrome. The TCA270 incorporates a synchronous video demodulator, video amplifier, buffer output stages and noise invertors and provides a video output in either polarity plus a.g.c. and a.f.c. outputs. The TDA1330 is a low-level video demodulator providing either polarity video outputs and an a.f.c. output, designed to replace the third i.f. stage, detector and video and a.f.c. buffer stages. The TDA1352 is an i.f. amplifier incorporating its own gated a.g.c. circuit. The TDA1330 and TDA1352 together provide a complete vision i.f. gypsy—such a combination is used in the Decca Gipsy mains-battery portable. The TDA1327 for use in colour sets provides chrominance signal synchronous demodulation, PAL switching and RGB matrixing. Since similar devices are available in the ranges from other i.c. manufacturers it looks as if there is going to be standardisation in i.c.s for TV sets.

Mullard have adopted silicone plastic as the standard encapsulation for their BD131/132 transistors and this together with other improvements in manufacture has enabled them to up-rate these devices. The maximum junction temperature is conservatively raised from 125°C to 150°C with a corresponding increase in Ptot rating from 11W to 15W at 60°C. Mullard say that the new ratings for these transistors—which are widely used in the field output stages of TV sets—are particularly relevant to an expected set life of some 10 years with a cumulative viewing time of 20,000 hours and some 10,000 switching cycles.

Motorola in increasing the price of their plastic-encapsulated small-signal transistors comment that these are now in a difficult supply situation, largely as a result of the boom conditions in the TV industry. Motorola mention "the voracious appetites of the major TV setmakers" and say that as a result of most setmakers intending to introduce new chassis later this year the market for consumer i.c.s is likely to be multiplied by a factor of six times in 1973.



# The SHORT BACK-FIRE AERIAL

**REG ROPER**

THE principle of the back-fire aerial was first suggested some 12 years ago. The basic idea was to use a form of parabolic reflector and point a Yagi array at it—hence “back-fire”. The short back-fire aerial uses two reflectors between which the dipole sits—see Fig. 1. A large reflector with the characteristics of a parabolic dish is used behind the dipole with a small reflector in front of it.

The short back-fire aerial design I have been trying out recently was adapted from a design published in W. Germany and originally used for space reception. I have scaled it for the reception of the lower u.h.f. channels and get coverage over channels 21 to 41—the response falls off above channel 44—with a gain roughly equivalent to a 22-element Yagi in spite of there being only three elements. For higher channels it is only necessary of course to adjust the dimensions.

### Practical Details

The practical details of the aerial I made are shown in Fig. 2. The rear reflector consists of

chicken-wire meshing (not larger than  $\frac{1}{4}$ in.) and has an edge about 3in. deep all round. The centre beam on which the dipole and front reflector are mounted is made of plastic, about  $\frac{3}{8}$ in. diameter—I used p.v.c. water piping which is strong and costs about 7p a foot. The dipole is mounted 5in. in front of the rear reflector and the front reflector 5in. in front of the dipole. The dipole and front reflector are both made of sheet aluminium, the dipole being in the form of a cross with overall dimensions 12 × 6in. and the front reflector circular with a diameter of 10in. The two halves of the dipole are mounted on a Perspex insulator which is drilled out with a circular  $\frac{7}{8}$ in. hole so as to fit on the beam.

I made the rear reflector an oblong shape, 2ft. × 2ft. 6in., and built it on a light wooden frame. The edge was also made of wire-mesh but with the edges strengthened using aluminium wire.

When making the dipole I found it easiest to make a thin cardboard pattern of one half and use this to mark out the aluminium sheet—this saves mistakes and aluminium. For the dipole insulator I used  $\frac{1}{2}$ in. Perspex but any other type of insulating material could of course be used provided it is strong enough. For cutting the  $\frac{7}{8}$ in. hole I found the flat-bladed type of wood bit used in carpentry work to be just the job, giving a perfectly clean hole. The dipole halves were secured to the insulator by four small nuts and bolts, two of these with tag washers to which the downlead was soldered.

The method used to fix the centre plastic tube to the rear reflector is a matter of experiment: if a metal fixing plate is used it should not be larger than 1 $\frac{1}{2}$ in. The dipole insulator and the front reflector are cemented to the centre beam.

So much for the basic aerial. There are a number of variations including a double or twin back-fire with two dipoles and two small reflectors mounted side-by-side in front of a common oval-shaped rear reflector. This gives extra gain but there are problems with matching. Extra gain can also be obtained by adding normal directors in front of the basic version: the beam could be extended and a couple of directors say 9in. long and spaced 5in. apart added.

### Tests

My tests were conducted using a version with two directors. I used the Redruth transmitter for testing because it cannot normally be received in this location at Torpoint, Cornwall using a conventional Yagi array. Redruth has an e.r.p. of 100kW and is about 50 miles away over hilly country. The only times I have received this station

—continued on page 173

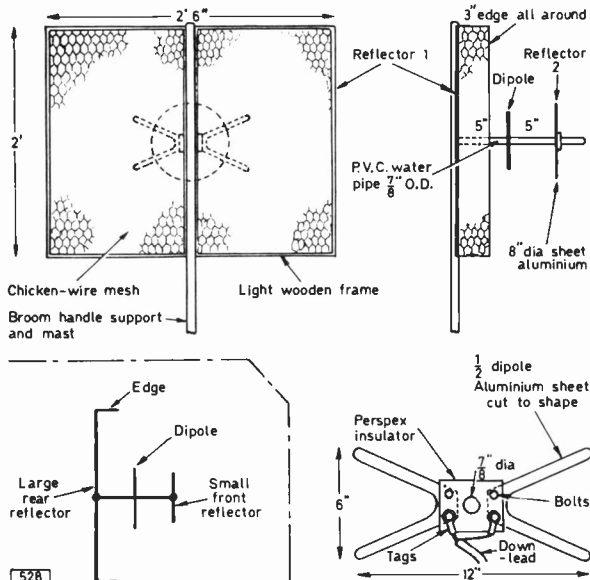
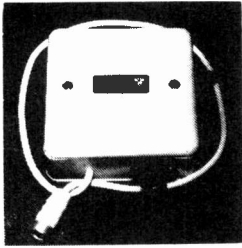


Fig. 1 (bottom left): Basic short back-fire aerial element configuration.

Fig. 2: Practical details of Reg Roper's short backfire aerial. The dipole "arms" are approximately  $\frac{1}{2}$ in. wide. The p.v.c. beam is mounted on the light wooden frame (which is bolted to the broom handle) using the type of metal mounting used to mount loft aerials on to loft beams, but other types can be used.

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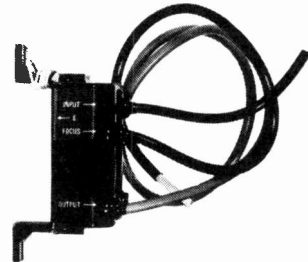
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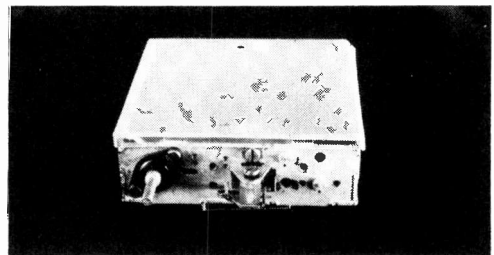
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# Assessing

# RECEIVER PERFORMANCE

## PART 1

E.J. HOARE

ANYONE with even the smallest experience of television engineering is bound to come up against that embarrassing question which is always so difficult to answer—"which TV shall I get?" The questioner is usually concerned about obtaining the cheapest and most reliable receiver that is available, and this same approach generally governs the choice between buying and renting. This is perfectly reasonable and often applies to other consumer products apart from TV. What does seem a little strange however is that no one ever seems to ask "which TV set gives the best picture?" Why not? Doesn't anyone care, or is the question too complicated to discuss? Yet the average person spends five and a half hours a day, every day, watching TV: so the quality of the picture must be important. It is high time that people began to realise this simple fact, and to take an interest in the quality of the product that absorbs so much of their spare time.

There are of course plenty of people who are genuinely interested in good picture quality. It is unlikely for example that so many readers of this journal would be taking part in the magnificent TELEVISION colour receiver project, building new monochrome receivers or adapting old ones, if they were indifferent to the quality of the picture obtained at the end of the day. Good picture quality cannot however be achieved merely by connecting together the appropriate groups of circuits. Sometimes in fact even well established designs can present problems if they are assembled in a different way to the original or with non-standard components. So what constitutes good picture quality and what do you do when things go wrong? It is not much use delving into the textbooks because they are strangely unhelpful about this sort of thing.

In this present series of articles we are going to take a look at many different aspects of picture quality in its broadest sense. In a later series we will be discussing some of the causes of the various difficulties that occur and how to tackle them. Obviously we shall not be able to go into detail about individual circuits since there are so many variations. At least however we can establish some basic principles to use as a starting point.

There is a difference between the kind of picture quality defects that you would expect to find in a manufactured receiver compared to one made by a home constructor. A manufactured receiver usually has only minor faults and one wants to assess how

well it compares with the products of other set-makers. A home-built receiver however is liable to show all sorts of peculiarities when it is first switched on—just as the first laboratory model made by a setmaker usually does.

### Preparation for Testing

In order to bring in as many interesting features as space permits we will assume that you have just completed a home-built model. You have debugged it to the point where a reasonable picture is obtained and there are no obvious circuit faults—only the peculiarities typical of a receiver which has not been completely engineered. Where do you start?

First, in case you have not already done so, make sure that it is plugged into the mains the right way round so that the chassis is earthy. Better still use an isolating transformer. If the h.t. supply circuit incorporates a bridge rectifier with four diodes be careful: the chassis will be floating and always live. Next make sure that you have a good aerial. This should be a multi-element array mounted well clear of obstacles and pointing directly at the transmitter (unless you are sure that you get a better picture by orientating it differently). It is obviously little use trying to assess picture quality with a signal full of ghost reflections and noise and perhaps with a heavily attenuated sound carrier as well.

It is axiomatic in television engineering that it is a waste of time to pay much attention to the colour characteristics of a receiver until a proper black and white picture has been obtained. It is putting the cart before the horse. We will assume to start with therefore that your receiver is a monochrome one. Later we can look into colour reproduction.

You switch on and up comes the picture—with that characteristic sigh as the e.h.t. charges the c.r.t. capacitance. If possible switch to a channel displaying a test card—this has frequency bars for assessing tuning and bandwidth, squares for checking linearity and several other useful features. You feel a sense of pride and excitement as you gaze at the picture but this initial reaction will be blunted as you begin to notice a number of things that are not quite right.

Adjust the brightness, contrast and tuning to give the best possible picture and check that the sound is present. Now concentrate on the c.r.t. display, i.e. the raster as distinct from the picture. There is not

much point in worrying about the signal circuits—however tempting they may be—until the timebases and c.r.t. are working properly.

### The CRT Display

Check the field height and linearity, the line width and linearity and the picture centring. Adjust all the relevant controls to get the best possible line and field scans. If the edges of the raster are distorted—usually bending inwards to form pincushion distortion—look for adjusting magnets on the deflection coils and see if you can improve the raster shape; do not over correct however or the cure will be worse than the initial trouble. Colour deflection coils are not normally adjustable in this way. With a raster of the right size turn up the brightness until the picture begins to defocus and then adjust the focus control (if one is provided). If you can obtain a properly focused picture turn up the brightness a bit more and readjust.

If all has gone according to plan you should now have a test card displayed with about one third of the castellations showing at all four edges of the picture. If the castellations are just about disappearing at each side of the c.r.t. you will lose a bit more of the picture but the overall linearity will probably be better: the circle will be more circular.

If you want to check the linearity more accurately display a test card or better still a crosshatch pattern if you have a suitable pattern generator and measure the size of each square across the picture along the middle line. The biggest square should not be more than about 10% larger than the smallest. Then do the same measurement on the middle vertical line of the picture. The advantage of actually measuring the size of each square lies in the fact that you can assess more accurately where the non-linearity occurs. From this you can usually deduce the cause of any error and this makes it easier to carry out readjustments or to alter the circuit. This applies particularly to the field scan, but we will discuss this later.

Raster distortion is caused primarily by the design and construction of the deflection coils. To a lesser extent it is an indirect result of the c.r.t. Fig. 1(b) shows typical pincushion distortion caused by the fact that while the electron beam in the c.r.t. is deflected in an arc about a fixed point it has at the screen to sweep across an almost flat surface—both across and up and down—see Fig. 1(a). As the beam moves away from the centre a given change of scanning current causes a larger deflection of the spot, the maximum deflection occurring at the corners. It is this extra deflection at the corners compared to the centre of the edges that produces the pincushion shape. The scan coils can be designed to compensate for this effect by distorting the magnetic deflection field. In doing so the picture is made more nearly rectangular but the distorted field also changes the shape of the electron beam, resulting in an oval spot. This “astigmatism”—a common eye defect—causes defocusing in the corners of the picture. In practice deflection coils are usually designed to give a suitable compromise between raster shape and spot quality and a small amount of defocusing can usually be seen near the edges of the picture as shown in Fig. 1(b).

Before leaving for the time being the subject of

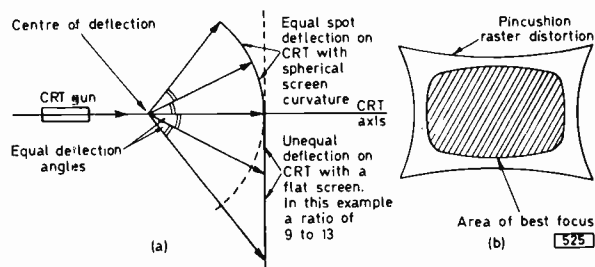


Fig. 1: (a) The basic cause of pincushion distortion: it can be corrected along the centre horizontal and vertical lines of the raster but not in the corners by “S” correction circuits. (b) A rather bad case of pincushion distortion: slight defocusing occurs near the edges of the raster.

raster quality get out a pen and plenty of paper: you are going to have a long list of comments before you have finished and in order to avoid forgetting what you have already done—and for easy reference later—start making careful notes of every item as you go along. So far you have checked and adjusted and perhaps measured the line and field scan sizes and linearity, raster distortion and focus.

There are two further items which do not depend upon the presence of a picture and so can be regarded as part of the basic display. These are field and line flyback blanking. If the c.r.t. is not turned off during the field flyback interval by a field frequency pulse of adequate amplitude you will see sloping white lines on the picture similar to those shown in Fig. 2. You should with a low contrast control setting be able to turn the brightness up to the maximum usable level with no more than a faint trace of white flyback lines visible on the picture. If you can see the lines clearly then the field blanking is inadequate and a larger pulse is needed at the c.r.t.

Any defect in line blanking can be seen at either the left-hand or right-hand edges of the picture or occasionally both together; i.e. at the beginning and/or the end of each line scan. It shows up as a white blur or foldover—see Fig. 2. The effect may be quite small and in a mild case visible for perhaps only a quarter of an inch or so at the edge of the picture.

If there is no line blanking at all and the flyback time is rather long the foldover may be quite severe however and extend for one or two inches. This occurs when the line flyback takes too long and is not completed before the picture information for the next line begins to arrive and modulate the beam. Thus the electron beam begins to brighten up with picture information whilst the spot is still travelling from right to left and has not yet reached

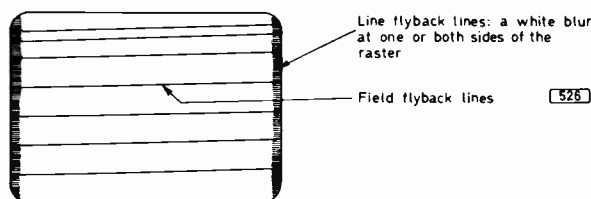


Fig. 2: Inadequate field and line flyback blanking will cause the effects shown here.

the left-hand edge of the raster. The spot is also beginning to slow down preparatory to stopping at the left-hand edge and this makes the flyback sweep even more visible. If a flywheel line oscillator is used and its phase is incorrectly adjusted the same defect can occur at the end of the scan instead of at the beginning. In this case the picture information continues after the spot has reached the right-hand edge of the picture and has started to fly back.

To check the line blanking properly it is necessary either to reduce the line scan amplitude, move the picture off-centre or rotate the deflection coils by 45° in order to be able to see the edges of the picture clearly. Vary the brightness control and use a high contrast setting. There should be no more than a trace of line flyback showing.

### Customer Controls

You have now established how well the timebases are working in terms of scanning characteristics and whether the c.r.t. is properly blanked and focused. The next step in our systematic sequence of checking is to assess the operation of the customer controls. Begin with the brightness control, turning it from minimum to maximum. Is the range and centring adequate? In other words can you go from an almost all-black picture to one that is too bright in the dark areas? Note that we are concerned primarily with changes in the picture black level, i.e. those areas of the picture that the broadcasters intend to be just and only just black.

In some receivers the black level of the picture changes as the contrast control is varied. This is usually due to the signal being wholly or partially a.c. coupled to the video output stage but in some cases it is caused by changes in d.c. bias as the contrast control is adjusted. The brightness control should be checked therefore at both minimum and maximum contrast settings. Note the results as before.

Now try the contrast control, making sure that each time you adjust it the brightness control is properly set in order to maintain the black parts of the picture at just black level. Is the minimum contrast obtainable low enough when the receiver is used in a very dimly lit room (very low ambient lighting)? Conversely is the maximum contrast adequate in high ambient lighting such as ordinary daylight? Note that whereas the brightness control is intended to move the black level up and down the contrast control alters the maximum amplitude of the signal drive to the c.r.t., determining the brightness of the picture highlights. You need a high contrast control setting under conditions of high ambient lighting therefore and a much lower setting with subdued lighting. Incidentally when checking any controls on a newly-constructed receiver always note whether they operate in the right sense—clockwise for maximum effect.

At this stage of our testing the volume control needs only a cursory twiddle. Is the maximum volume—sound output—adequate and not too obviously distorted? Is the sound turned off completely at the minimum setting?

Now tuning. There are all sorts of tuner controls but they fall into two categories—mechanical and electrical. Whatever their mode of operation we are interested in three characteristics: stability (fre-

quency drift with time); reset accuracy; and the usable tuning range on the picture. In the case of continuously variable tuning we are also interested in the mechanical ease of adjustment—some controls are too stiff for elderly people to operate with comfort.

You check the stability of the tuning by first adjusting it very carefully on a test card immediately after switching on. Then notice whether the resolution—or clarity—of the frequency bars changes as the receiver warms up. It takes about a couple of hours for a receiver to reach its maximum internal temperature but most of the temperature rise takes place during the first half hour or so. If the clarity of the fine picture detail represented by the higher frequency bars changes appreciably the tuner stability is not good. A further test along the same lines is to leave the tuning completely untouched for several evenings' viewing and then check the frequency bars again. Any additional change in resolution indicates a long-term frequency drift of the tuner oscillator not directly related to operating temperature—just an ageing effect in a new receiver or random drift in an older one.

Reset accuracy is another important characteristic of a tuner and the channel selector gear. Try changing channels a good many times and then go back to the test card and see if the tuning has changed. Any significant tuning change means that the reset accuracy is not very good. It is only fair to say that mechanical push-button tuning systems are called upon to achieve a remarkable degree of precision. Even a quarter of a MHz of detuning is fairly easily visible on a test card and yet the overall tuning range is about 470-890MHz. Thus a reset accuracy of better than 0.25/890 — 470 or one part in 1,680 is required every time a push-button is operated throughout the life of the receiver!

With varicap tuners the need for mechanical stability is exchanged for that of electrical stability. The stabilised 30V l.t. line supplying the varicap tuning potentiometers must not drift by more than about 10-20mV and this is very difficult to achieve without using an integrated circuit, some sophisticated circuitry or a very good-quality zener diode in a cool part of the cabinet or provided with temperature compensation.

Our last job on the tuner is to assess the usable tuning range on both sound and vision. This is of course primarily a function of the design of the sound and vision i.f. circuits and is affected by the tuner only if its i.f. output or r.f. circuits have inadequate bandwidth or its response curve is tilted. Nevertheless it is useful and interesting to make a preliminary assessment at this stage in your checking although we shall be returning to the subject again later.

Tune for best resolution on a test card and then detune, first in one direction and then in the other, observing what happens on the picture. Does it change gradually from clear to blurred, or do peculiar things happen to vertical lines and other picture transitions? Is the tuning control too coarse for easy adjustment, or do you have to adjust it so much that control is vague?

Now turn up the sound and adjust for best picture again. We will assume that there is plenty of volume. Detune as before and check that the sound volume does not change appreciably over the range of tuning that gives an acceptable picture. It is quite

in order for the sound to fall off or even to fade out at the point where you get the most blurred picture: tuning in the other direction however should give good sound even when the picture has broken up and slipped out of synchronisation.

We are beginning to build up quite a clear assessment of the performance of this receiver. There are still a lot of checks to carry out however so we will leave the customer controls and move on to the next group of tests.

### Synchronisation

What we want to do now is to assess the synchronisation quality of the field and line timebases under strong-signal conditions. By a strong signal we mean one which gives a clear picture with only a very small amount of noise visible in the light grey areas. In case you are surprised at the choice of a strong signal instead of a weak noisy one for testing synchronisation the point is that there is a variety of possible synchronisation defects and these are more easily seen on a clean picture. They may in fact be almost completely obscured on a very noisy picture or where timebase synchronisation is beginning to break down and the picture is tearing or slipping. We shall be testing weak-signal performance later on.

First of all check the line and field hold controls if fitted. These adjust the free-running frequency of the line and field oscillators. Turn the controls from end to end of their travel. Is the range of control over which the picture remains synchronised properly centred about the full travel of the control? Is the range of synchronisation adequate in terms of ease of adjustment and freedom from line tearing or field slipping? Take care to avoid being deceived by a smooth control action which gives only a small range of synchronisation compared with the case where the control is very critical to adjust and yet gives a good range of synchronisation. It is not always easy to distinguish which of the two is in fact giving the better performance.

Having assessed whether the controls have the right range and are properly centred look more closely at the picture. Using a test card again, look for signs of "squaring" or "cogging" as shown in Fig. 3(a). This is caused by defective sync separation, the picture information at the end of one line affecting the sync pulse and causing timing errors at the beginning of the next line. You will notice it particularly on pictures with alternate black and white areas at the right-hand side, for example the castellations of the test card.

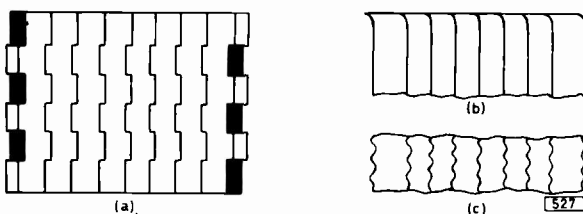


Fig. 3: (a) Squaring or cogging: note how vertical lines get displaced. (b) Hooking—this occurs at the top of the picture only. (c) Oscillations on the line sync can occur all over the picture.

The next defect to look for is signs of vertical line bowing at the top of the picture—usually called hooking: see Fig. 3(b). Line synchronisation errors at the top of the picture, i.e. just after the beginning of a new field, are nearly always caused by field sync pulses or field flyback pulses getting into the line sync channel.

Another fault that shows up very plainly is a wavy effect on vertical lines, see Fig. 3(c). The lines follow a sinewave pattern instead of being straight and the disturbance usually corresponds to a fairly high interfering frequency so that there is a large number of complete cycles of the wave between the top and bottom of the picture. If there are 10 complete cycles spread over one field for example then the interfering frequency is  $10 \times 50 = 500\text{Hz}$ .

Now look more closely at the picture and adjust the field hold control over its synchronising range. Is the picture completely stationary or does it jitter up and down slightly? Sometimes horizontal lines appear to be duplicated with a small space between them, indicating instability in the field sync. In bad cases the field slips completely and rolls over from time to time for no apparent reason.

### Interlace

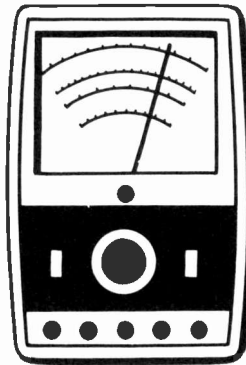
Our last item under the heading of strange signal synchronising performance is interlace. Adjust the brightness and contrast controls to give a picture with good tonal gradation and then choose an area, preferably stationary, of even mid-grey tone. If you cannot see the individual lines clearly check the focusing and try a darker part of the picture. To make things easier use the old dodge of tearing a hole about an inch in diameter in a piece of paper. Place the paper on the screen of the c.r.t. with the hole over the part you wish to inspect and leave it there: electrostatic forces will hold the paper in place. Now examine the line structure of the picture very closely and adjust the field hold control from end to end of its hold range. Are the lines evenly spaced at all settings of the field hold, or are the lines "pairing"? Does the pairing effect change as the hold control is adjusted? Try the effect of adjusting the field amplitude control as well over a reasonable range, noting the behaviour of the line spacing.

### Summary

To sum up progress, so far you have checked the raster display for size, shape, linearity and focus; the customer controls for range and centring; the sound output for adequate volume; and the timebase synchronisation on strong signals. Next month we continue with the i.f. and video responses; signal interferences; sound quality; and fringe area performance under bad signal conditions. When we have exhausted the monochrome aspects of receiver performance we will move on to colour and take a critical look at another range of possible defects. Having compiled a fairly comprehensive check list of what to look for we shall then consider the basic causes of the various defects that occur and the approach that should be adopted in trying to cure them: but this will have to wait until a follow-up series.

**TO BE CONTINUED**

# Serviceing POWER SUPPLY CIRCUITS



## PART 1

VIVIAN CAPEL

THE power supply circuit of a television receiver or test instrument is usually regarded as being straightforward and hence deserving little attention. Faults are generally quickly located and repaired. As a result of this however there are numerous misconceptions as to the function of the various components in the circuit and this often leads to their replacement with unsuitable ones. Sometimes too symptoms are encountered which may not at first be associated with the component causing it. In this and the following article therefore we will examine the function of the various types of power supply circuit particularly with the servicing and replacement of components in mind.

### Half-wave Circuit

The most commonly used of all power circuits for television receivers is the half-wave a.c./d.c. type. Here the single rectifier is connected in series with the supply from the mains to the h.t. circuit, with the anode going to a.c. and the cathode to h.t. With this circuit, shown in Fig. 1, use is made of only the positive half cycles of the mains supply, the rectifier being non-conductive on the negative half cycles.

### Reservoir Capacitor

The output from the rectifier is shown in Fig. 2(a) and is totally unsuitable for supplying the receiver circuits, consisting as it does of a train of disconnected positive pulses. Apart from the effect of the 50Hz pulses the average voltage in the circuit would be low—something in the region of a third of the peak value—because for half the time there is no voltage at all. Hence the use of the reservoir capacitor.

This is connected directly across the output of the rectifier and is sometimes erroneously called the smoothing capacitor which it is not—that one comes later. When the first positive half cycle occurs the reservoir capacitor charges. After several cycles it is fully charged to the peak value of the applied voltage. If no load is imposed then the capacitor maintains the peak voltage from one peak to the next as seen in Fig. 2(b) and the d.c. voltage will therefore be 1.4 times the r.m.s. a.c. voltage applied to the anode of the

rectifier. Thus if a mains voltage of 240V appears at the rectifier the d.c. output off load will be something around 330V.

### Switch-on Surges

This is a point to watch where metal or silicon rectifiers—which operate instantly—are used in valve circuits since the valves take time to warm up and impose a load on the supply. Consequently under these conditions capacitors in the circuit may well be operated at above their maximum voltage rating during this warm up time. Mains dropping resistors in series with the rectifier will not reduce this voltage as there is no current to produce a voltage drop (unless they are also part of the heater chain circuit).

In a few sets the rectifier anode is tapped in: at some point in the heater dropper circuit in order to reduce the voltage during the warm up time. It is during this period that the heater current is greatest and so the voltage reduction to the rectifier will also be greatest. When the heaters have warmed up fully the heater current drops to normal and the voltage to the rectifier rises to partly compensate for the h.t. drop which occurs when the full h.t. current is being drawn. The high switch-on d.c. voltage is thus somewhat reduced without causing too large a reduction when the set is running normally. Even so it can still be high, anything from 280-300V, and capacitor ratings must be chosen accordingly.

### Dropper Resistor Precautions

When repairing or replacing mains dropping resistors never reduce any values that are common to both h.t. and heater circuits as this will reduce the h.t. line protection when switching on. Also, because of the higher current flowing through such resistors than flowing in the h.t. or heater resistors alone any variation in value will have a greater effect on the voltage. Furthermore, never be tempted for any reason to isolate a common feed so that it goes directly to the mains supply without passing through part of the heater circuit. These points of course would not be so important with valve rectifiers.

### Effect of Load

Returning now to the reservoir capacitor, when a load is imposed current is supplied by the rectifier during its periods of conduction. When the rectifier is non-conductive however the current is drawn from

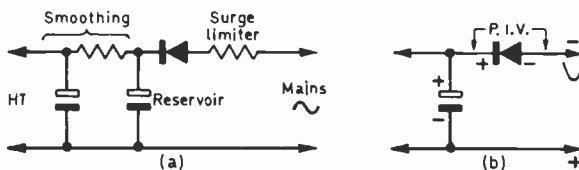


Fig. 1: (a) Basic half-wave power circuit. (b) On the negative half-cycles of the mains input the rectifier does not conduct and as the charged reservoir capacitor is effectively in series with the mains supply an inverse voltage which is the sum of the charge in the capacitor and the peak mains voltage is present across the rectifier. Hence the importance of the rectifier's peak inverse voltage rating.



the reservoir capacitor. This reduces the capacitor voltage until the next peak tops it up. Thus the waveform is as shown in Fig. 2(c) and although substantially flat has a superimposed ripple which is subsequently dealt with by the smoothing circuit.

If the value of the reservoir capacitor is too low or the load current too high then the rate of discharge from the capacitor will be higher, giving a waveform as shown in Fig. 2(d). This will produce two effects, first the average voltage will be lower thus giving a lower d.c. output voltage, and secondly the ripple will be greater.

The rectifier is usually blamed for low h.t. voltage and is of course a frequent culprit. The possibility however of a low-capacitance reservoir capacitor should not be overlooked. The increased ripple may or may not be adequately dealt with by the smoothing circuit. If it is not, a useful clue is thereby provided. Low h.t. and excessive ripple points immediately to the reservoir capacitor.

### Reservoir Capacitor Value

It should not be deduced from this that higher values of reservoir capacitor will give a higher h.t. voltage so that it is good practice to increase the value when a replacement is to be made. If the correct value has been used in the first place for the current required then as can be seen from the waveform (Fig. 2(c)) an average voltage that is usefully much higher will not be obtained. Let us however compare the waveforms in Fig. 3(a) and (b). These give a closer view of the tops of the rectified pulses for two different reservoir capacitor values. At (a) we have the lower value and it can be seen that the capacitor is recharged by the next peak during the period marked  $T$ . Comparing this with (b) we see that the capacitor voltage has not dropped so much although the same amount of current has of course been drawn from it. Hence that current must now be replaced during the time marked  $t$ , and it is clear that this period is much less than  $T$ . As a result of this the charging current must be much greater in order to replenish in the shorter time the current that has been drawn. Thus a heavy current will be taken from the rectifier and this may cause damage.

Also, on switching on the uncharged capacitor presents a low-impedance path to the rectified current, resulting in a heavy surge. This is dependent on the capacitance, so too high a value could cause a current to flow of a magnitude that would destroy the rectifier.

It can be seen then that for each rectifier there is a maximum value of reservoir capacitance. This value is often specified in manufacturer's data and can only be exceeded if a higher value surge limiting resistor is included. A number of maximum capacitor values along with minimum surge limiter values are sometimes given in rectifier data. Usual capacitance values for half-wave television receiver power circuits are 60-100 $\mu$ F. When making replacements therefore do not reduce or increase the original value (though some increase is permissible if the surge limiter value is also increased).

### Ripple Current Rating

From what we have discussed so far it will be obvious that a continual current is flowing in and out of the reservoir capacitor. This "ripple current" has

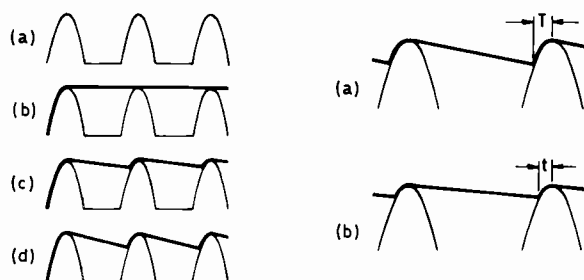


Fig. 2 (left): (a) If the mains input is applied to the anode of the rectifier—as in Fig. 1—it will conduct during the positive half-cycles of the mains input to provide an output consisting of a series of positive-going pulses as shown here (if the rectifier is connected the other way round the result will be a series of negative-going pulses). (b) The effect of adding a reservoir capacitor is to maintain a steady off-load voltage between the peaks of the input waveform. (c) On load the voltage drops between peaks as current is supplied by the reservoir capacitor to the receiver circuits. The capacitor is recharged on the next input peak. The current supplied by the rectifier to the reservoir capacitor on each peak is called the ripple current. The ripple voltage across the capacitor is filtered out by the smoothing components. (d) If the reservoir capacitor capacitance is too low or the load current too high the voltage drop across the reservoir capacitor between input peaks will increase; the result is heavier ripple as well as low d.c. output voltage.

Fig. 3 (right): (a) With the correct value of reservoir capacitor the time taken to recharge is  $T$ . (b) With too high a reservoir capacitor value the voltage drop is less so that the recharge current flows for a shorter time ( $t$ ): a higher current for a shorter time is thus taken from the rectifier and this may damage it.

an average value which is equal to the direct current drawn by the receiver. The capacitor must be designed to handle this current and maximum values are quoted by the capacitor makers.

This brings us to a common mistake made when replacing a multiple capacitor. One of the sections only is suitable as a reservoir, having a high ripple current rating. In most cases it is the outer section and the solder tag is coloured red. In cases where the capacitance values are the same, for example a 100+100 $\mu$ F unit, it is sometimes found that a replacement has been made which has been incorrectly wired. The repairer has obviously assumed that as the values are the same it doesn't matter which is connected as the reservoir. This can only lead to a premature failure, sometimes a violent one. Always make sure then that the right section is used, this being even more important than the actual value.

An effect which is not always expected arises when an excess current has been drawn from the h.t. line over a period. This could be caused by leaking coupling capacitors to an output stage, incorrect bias, leaking decoupling capacitors or any of many other possible faults. This imposes a strain not only on the rectifier but also on the reservoir capacitor as it is possible that the ripple current has been increased to beyond the maximum specified level. It is therefore

possible that this component may have suffered and be in need of replacement.

There is another effect of ripple current which can be overlooked. Surge limiters wired in the anode circuit of the rectifier or in the cathode circuit before the reservoir capacitor often show signs of overheating and frequently go open-circuit. When calculating the current through them and the resistance according to Ohm's law it appears that the wattage dissipation is well within the rating of the resistor so that one is at a loss to explain the trouble. This however ignores the fact that the ripple current taken by the reservoir capacitor also passes through the resistor so that the current should be doubled in the calculation. Let us take an example. Suppose an h.t. current of 250mA is being drawn and a surge limiter of  $50\Omega$  is fitted. Using the formula  $W=I^2R$  we have a value of 3W so that a 5W resistor would appear to be more than adequate. If however we include the ripple current and so calculate for 500mA we have a value of 12.5W. Thus a 5W resistor or even a 10W one would be grossly over-run. No less than a 15W resistor should be used in this case.

For a  $25\Omega$  resistor—as is now commonly used—the total dissipation would be 6.75W and so a 10W resistor would be suitable. This question of adequate power rating should be taken into account with all resistors appearing in the rectifier anode circuit including mains droppers and voltage adjustment ones.

### Peak Inverse Voltage

Next another rating which must be considered, the peak inverse voltage (p.i.v.) rating of the rectifier. Let us take another look at Fig. 1. On the positive half cycles the rectifier conducts and as we have seen the reservoir capacitor charges. It is the negative half cycles that now claim our attention. During the negative half cycles the anode of the rectifier is negative while the other pole of the mains which is connected to chassis is positive. This positive pole is thus connected to the negative terminal of the reservoir capacitor, which is charged, and the positive terminal of the capacitor is connected to the cathode of the rectifier. The charged reservoir capacitor is thus effectively in series with the mains on the negative half cycles and the combined voltage is applied across the rectifier. This voltage is twice the peak a.c. voltage appearing at the anode of the rectifier and if the full mains voltage of 240V r.m.s. is applied we have something in the region of 660V applied in reverse across the rectifier.

Irrespective of whether the input is directly from the mains, from a transformer winding, e.h.t. flyback system or voltage doubler stage, whenever a rectifier is followed by a reservoir capacitor this reverse voltage effect will be present. The rectifier maker's specification for p.i.v. must never be exceeded.

There may be pulses or transients in the mains supply which when added to the existing reverse peak voltage could well exceed the maximum rating of the rectifier. For this reason a small capacitor—usually about  $1\mu\text{F}$ —is generally shunted across a silicon rectifier to bypass such transients.

### Smoothing

Having obtained a more or less steady d.c. voltage with superimposed ripple the next step is to smooth

it to get rid of the ripple. The ideal way of doing this is to pass the current through a series inductance to be followed by a shunt capacitance. The inductance offers a low-impedance path to pure d.c. but offers reactance to the 50Hz ripple. The capacitance does the reverse, passing no d.c. but offering a low-impedance path to any remaining ripple. Thus the two components form an effective filter which smooths the supply to render it suitable for the various receiver circuits.

Actually the smoothing capacitor has a busy time. It not only smooths out ripple from the rectifier and reservoir capacitor but also bypasses field pulses from the field timebase, line pulses from the line timebase, sound waveforms and video and sync waveforms coming from their respective circuits. All these are dumped into the h.t. line and when the smoothing capacitor goes open-circuit they form a merry throng. It serves then as a general decoupling capacitor as well as providing conventional mains smoothing. Auxiliary decouplers are fitted to particular circuits but the bulk of the decoupling is handled by this one component because of its normally high value.

There are no particular restrictions to smoothing capacitor values as there are with the reservoir capacitor. If a higher-than-usual value is encountered however do not replace it with a lower more normal value just because such a value is used in other sets. The set manufacturers would not have used a high value if they could have got away with using a smaller one and any reduction in value will undoubtedly lead to decoupling difficulties. Some sets need a remarkable amount of capacitance to filter the h.t. line so that it is "clean" whereas other sets seem to manage well with a great deal less.

The working voltage rating of the smoothing capacitor—as with the reservoir—varies from set to set; 250, 275, 300 and 350V ratings are all in common use. The higher voltages are necessary (although not always used) with metal or silicon rectifiers where as we have seen a high voltage appears in the off-load condition when the set is first switched on. Lower voltage capacitors are usually used with valve rectifiers. It is generally easier to stick to the original working voltage because the diameter of the can increases with the voltage rating. Thus the clip and chassis-hole will be wrong if a different rating and hence diameter component is employed.

### Replacements

There is another common practice which should be avoided when replacing capacitors. If only one section of a multi-electrolytic needs replacement one often sees a single tubular wire-ended capacitor connected across the tags which are used as anchoring points. This means that the old capacitor is still in circuit and could be a source of trouble. If it needs replacement because of low capacitance it is quite probable that it is or may become defective in some other respect, such as passing a high leakage current or developing a leak to another section. The best thing is to either replace the whole unit (which will save a lot of labour cost with little increase in the cost of materials) or, if the unit is a special one with several sections only one of which is faulty, then that section should be isolated and the replacement mounted and wired separately.

—continued on page 163

# Building a COLOUR SET

## PART 2

**BARRIE P. SPINK C. Eng.**

Tests have shown that the shunt stabiliser triode (PD500) is the only valve to radiate X-rays in sufficient quantities to be dangerous. If the design built by the constructor uses one of these valves it *must* be completely screened for safety.

I used a manufacturer's surplus timebase unit. This uses valves for both the line and field sections. It also employs a 25kV winding on the line output transformer: the output must be rectified and shunt stabilised. I recommend however the use of an e.h.t. tripler arrangement if possible as this gives the following advantages: X-ray screening is unnecessary; a smaller line output transformer can be used with a smaller overwind to give 8.4kV (this is less prone to burn out or breakdown); such a circuit reduces the total number of valves by two, giving improved reliability.

### General Adjustments

In this section I intend to deal with only those adjustments that proved difficult to carry out. We will assume that the set has been built and the i.f. strip, luminance channel and colour-difference output stages bench tested. The next thing to do is to test the set with the e.h.t. switched off (remove the fuse in the h.t. lead to the timebases or fit a toggle switch) and the tube base removed. Measure the voltages on the tube base and check that the brightness control functions and that there is sufficient bias to cut the tube off. Then switch off.

Set the brightness control to minimum, fit the tube base, switch off the voltage supply to the tube first anodes and restore the supply to the timebases. The next step is to measure and set the e.h.t. voltage. To connect an e.h.t. voltmeter *first* connect the earth lead to the earth point on the tube base, making certain that the lead cannot fall off, then take the e.h.t. probe and tease it under the tube e.h.t. connection. Great care must be taken whenever this operation is carried out since the tube capacitance can retain a charge for a considerable time. Switch on and if all is well you should have a reading of e.h.t. on the meter. If the timebase employs a shunt stabiliser the designer's instructions should be followed. If it has a tripler adjust the "set e.h.t." control

for 25kV e.h.t. When this control is set the current through the line output valve should be measured to check that the valve is not being overrun.

If the voltage supply for the tube first anodes is now switched on it should be possible to obtain brightness and the three primary colours red, green and blue. Next demagnetise the tube and carry out purity adjustment by first moving the scan coils backwards and then forwards along the tube axis and secondly by rotating the purity rings. When doing this great care must be taken as the tiny plastic lugs holding the purity rings break very easily (they did actually break on my scan coils and proved to be quite a difficult job to repair).

Once brightness is present it should be a relatively easy matter to obtain a picture on the screen and to lock the timebases. While attempting to do this I discovered that I had inadvertently missed out the sync separator! This was hastily added. When a picture is obtained all the conventional black and white adjustments (shift, height, width etc.) should be made. The receiver is then ready to be converged. The aim at this stage should be to obtain a perfect black and white picture.

### Convergence

Convergence adjustment is best done using a cross-hatch generator. If you do not have one of these the answer is to use the BBC or IBA test card F. The main disadvantage is that this will restrict the time at which the adjustments can be made. Also when one is just getting on nicely a film starts! If the design of the set is such that the convergence panel can be reached from the front of the set this will help during the adjustments: if this cannot be done recourse will have to be made to either a mirror or the assistance of wife or a friend.

The main thing about convergence is to follow the designer's instructions and to repeat them several times. If you still can't get it quite right move the convergence coils around the neck of the tube slightly and try again. One other difficulty may be experienced: the design could call for the field convergence coils to be connected in parallel but when this is done the coils are connected in antiphase. If there is no effect when the potentiometers are adjusted and oscilloscope checks show that the correct waveforms are being fed in this point should be checked. On some surplus coils designed for series operation the middle winding connections are connected to a common tag as shown in Fig. 4(a) thus ensuring that a parallel connection will be out of phase. In this case the winding connections should be carefully untwisted from the tag and the coils reterminated with the tags in parallel as shown in Fig. 4(b). There is another small point: the constructor may not be certain which way to connect the coils into the circuit. If they are the wrong way round this will show up on the test card as the pictures moving away from instead of towards each other.

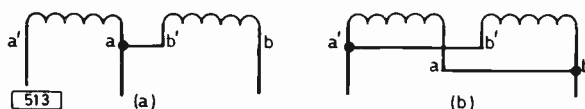


Fig. 4: Radial convergence coil connections.

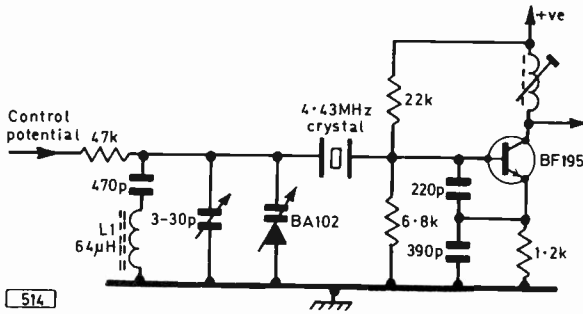


Fig. 5: Crystal oscillator circuit.

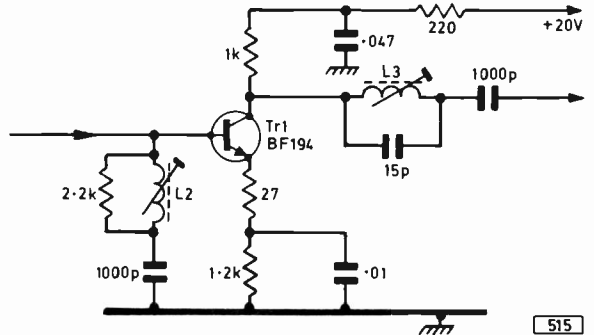


Fig. 6: Chrominance amplifier circuit.

Finally remember that adjustment of convergence is more of an art than a science and that with ordinary circuits it is only possible to get about 90 to 95% correct convergence.

**The Decoder**

The decoder is the least understood and most complicated part of a colour TV set. A good oscilloscope with a response from d.c. to about 7MHz is an absolute must and a signal source that gives about 1V and covers from 1-6MHz is a great help. When using the oscilloscope a 10:1 probe should be used to reduce the loading effect of the oscilloscope input capacitance on the external circuits. In general oscilloscopes have an input impedance of 1MΩ in parallel with 30pF. A probe changes this to 10MΩ in parallel with 3pF. We don't get this for nothing of course: the Y amplifier gain has to be increased by a factor of 10 to compensate for the probe. Some oscilloscopes have a × 10 button for this purpose.

The reference signals for the synchronous demodulators will require to be set so that they have a phase difference of 90°. With a single-beam oscilloscope this can be done by triggering the oscilloscope from the reference signals fed into the external

trigger socket. If each signal is then fed into the Y amplifier and the position marked on the graticule the phase displacement will be easily seen. If the oscilloscope has a beam switch this operation can be done instantaneously with both waveforms displayed together. With a double-beam oscilloscope both waveforms can also be displayed simultaneously but before doing the test the constructor should check that the phase shift through each amplifier is the same. This can be done by feeding the same waveform into each Y amplifier and checking that the outputs displayed can be superimposed where the waves cross the zero line. This should be repeated if the Y amplifier gain is changed.

In most colour decoders the burst and the colour information are separated early in the circuit and then processed separately. The burst amplifier generally consists of a two-stage high-gain gated amplifier circuit. During testing I had difficulty keeping this stage stable. The remedy is to keep the input leads short and ensure that the decoupling on the supply side is adequate. In extreme cases it may be necessary to make a copper screen to go round the stage. The coils in this part of the circuit should be peaked by feeding in a source of 4.43MHz and

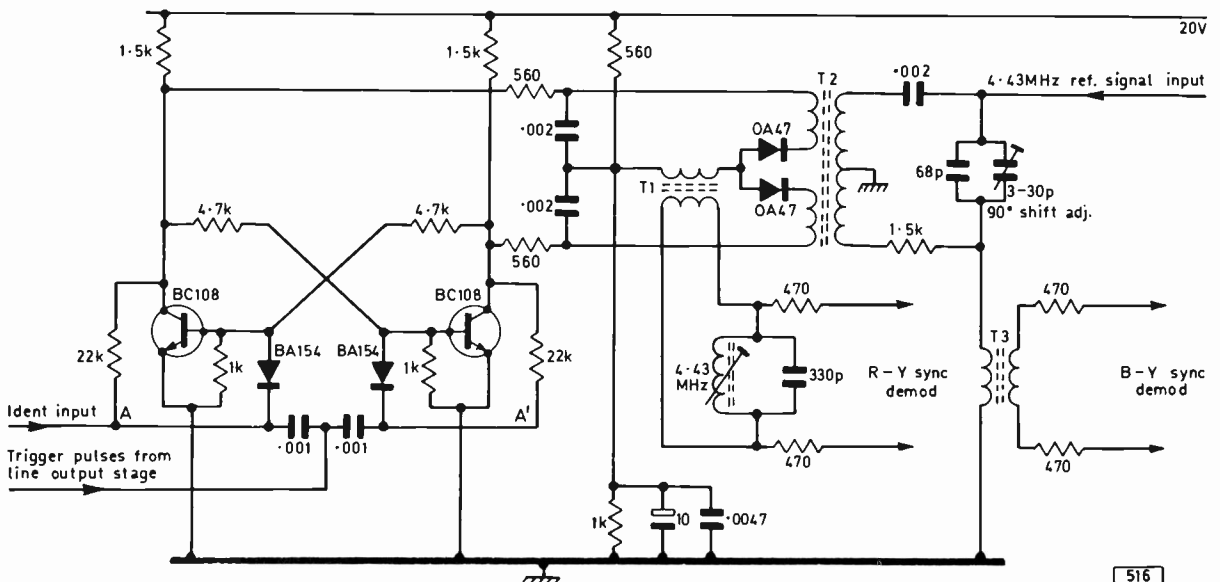


Fig. 7: PAL switch circuit and reference signal feeds to the chrominance signal synchronous demodulators.

opening the gate by connecting it to a decoupled source of 2V.

The 4.43MHz crystal oscillator should present little difficulty: it either works or it doesn't. Persuading it to lock in is a different matter. It is extremely difficult to examine this on an oscilloscope but the effect will be seen as a rainbow pattern on the screen. Coil L1 (Fig. 5) in the design I followed puts positive reactance into the circuit. If due to BA102 diode spreads and stray capacitance there is too much capacitance in the circuit and the frequency of oscillation is below 4.43MHz L1 has the effect of reducing the effective capacitance and thus increasing the frequency of oscillation. The nominal value for L1 is  $64\mu\text{H}$  and together with a 3-30pF variable capacitor it should be possible to tune most crystals to 4.43MHz.

In the chrominance amplifier circuit coil L2 (Fig. 6) is tuned to 4.43MHz. I found that adjustment of this coil had virtually no effect. In fact it is designed to cancel out the input capacitance of Tr1. L3 is tuned to 6MHz to reject any sound signals that may get through.

There is one other thing that caused me considerable concern. This was the transformer connections to T1 and T3 (see Fig. 7). Even if it is stated in the design which connection is a start and which a finish it is very easy to make a mistake when connecting in the transformer. Using wire with a different colour enamel for each winding simplifies things but the average constructor will find it a problem to get the right gauge of wire without trying to get different colours as well. The easiest way out of the problem is to make the connections on T1 and T3 easily reversible. In the case of T1 reversing the connections has exactly the same effect as changing the ident input from A to A': it is essential that the phases of T2 are correct but this can be easily checked with an oscilloscope. If a colour-bar generator is available T1 and T3 can also be easily checked on an oscilloscope. Not many constructors will have access to one of these instruments however. It is rather difficult to do it on the test card unless one can synchronise the oscilloscope from the field timebase and strobe out one of the lines con-

taining the colour bars at the top of the picture. Fortunately the effects can be observed on the picture. If T1 connections are reversed the red parts of picture will be green and vice versa. If T3 connections are reversed the blue parts of the picture will be yellow and vice versa.

Although there are a lot of other things that can be wrong with a decoder I have space only to deal with those problems that caused most trouble. To be honest I expected more problems than actually did occur!

### Power Supplies

For the low-voltage (+20V) supply to the transistorised parts of the circuit a stabilised supply although not essential is to be recommended. This gives the following advantages for little extra cost: ease of setting up irrespective of load; good regulation; very low ripple content. It also removes a further unknown factor when looking for faults.

It is possible to derive all the low-voltage supplies from windings on the line output transformer. From a constructor's point of view however it is desirable to be able to run things without the line output stage being operative. Thus although more expensive it is probably better to derive these supplies from the 50Hz mains through a transformer.

### Conclusion

To conclude with, brief details of the rest of the set as built. The convergence panel was made from a piece of plain synthetic resin bonded paper (S.R.B.P.) board mounted at the top of the set. The colour decoder was built on a section of 0.1 matrix Veroboard. It was extremely difficult to get a standard mains transformer with all the low-voltage windings on it so two transformers had to be used in the power supply.

It is my ambition to have the set all solid-state and I am at present working on a solid-state timebase and an integrated colour decoder. I would finally like to thank Jennifer S. Spink for all the trouble taken reading and typing this article. ■

## SERVICING POWER CIRCUITS

—continued from page 160

As may be expected it did not take the set manufacturers long to find out that the series inductance—a fairly costly component—could be replaced with little loss of effectiveness by a resistor. This is not frequency selective so it resists both d.c. and a.c. ripple. However it forms with the capacitor a potential divider to the ripple, the bottom part (the capacitor) being of much lower impedance than the top part (the resistor). For this purpose a higher value capacitor is needed than would be required with inductive smoothing, but this is still much cheaper than using a choke. There is no ripple current passing through the smoothing resistor so any replacement needed can be of wattage calculated on the basis of its resistance and the total h.t. current.

One further fault that can be baffling is lack of smoothing and decoupling although test capacitors bridged across the smoother seem to make little

difference. Assuming that the fault is actually in the h.t. circuits and not due to valve heater-cathode leaks the next step is to measure the value of the smoothing resistor whilst it is in circuit. The reading may be found to be much lower than it should be and the trouble is due to a leak between the reservoir and smoothing sections of the multiple capacitor, the leak effectively shunting the resistor. If the reading is not appreciably lower a leak could still occur when the h.t. voltage is applied. This can be checked by removing the lead to the reservoir section and connecting a replacement to the lead so that it is now isolated from the smoothing capacitor. It is usually easier to do this than to substitute the smoother as there are only one or two leads going to the reservoir whereas there can be a large number involved with the smoother.

It can be seen then that there is more involved in the deceptively simple power circuit than at first meets the eye. Next month we will examine some further types of power circuits.

**TO BE CONTINUED**

# COLOUR RECEIVER CIRCUITS

## EHT SYSTEMS

GORDON J. KING

SOME of the more substantially built early monochrome receivers employed a voltage-dependent resistor (Metrosil) as a bleeder across the e.h.t. supply to keep the load substantially constant with changes in beam current, thus keeping the e.h.t. voltage constant. A voltage-dependent resistor differs from an ordinary resistor (which of course faithfully follows Ohm's Law) in having a non-linear volt-ampere characteristic: the current in a typical Metrosil would rise by about twenty times when the voltage across it was doubled.

In more recent times it has become the general practice to use a voltage-dependent resistor to generate a bias potential for the line output valve governed by the e.h.t. loading. This it does by line flyback pulse rectification. The non-linearity of the v.d.r. produces a d.c. bias from the line frequency pulses fed to it and this is applied in series with a small standing bias to the line output valve. The effect is that if the e.h.t. loading increases then the pulse amplitude and hence the bias fall, the line output valve being turned on harder to supply the extra load current. This scheme is used in receivers with valve line output stages and was illustrated in our instalment in the December issue.

E.H.T. stabilisation is desirable in a monochrome set to prevent defocusing on peak white picture content. It is even more necessary in a colour receiver as the three rasters (and pictures) are superimposed upon each other to secure the colour display.

Early colour receivers used a substantial overwinding on the line output transformer and an e.h.t. rectifier valve to obtain the required potential for the final anode of the picture tube. Later, multiplier rectifier circuits came into general use in colour receivers: these produce the required 25kV e.h.t. from a relatively lower amplitude line pulse, considerably relieving line output transformer insulation problems.

Some receivers have employed a separate e.h.t. generator driven from the line timebase to produce the pulses for the e.h.t. rectifier. This makes it less complicated to design into the e.h.t. generation system some form of voltage control.

Let us start at the beginning however, with the type of e.h.t. generation and stabilisation employed by receivers at the commencement of the colour era.

### Stabiliser Valve System

In Fig. 1 the e.h.t. overwinding on the line output transformer feeds the anode of a GY501 e.h.t. rectifier valve in the usual manner. The valve's heater is energised by pulse current from a heater winding

on the transformer and the overwind ratio is such that 25kV is available at the GY501's cathode, the reservoir capacitance being provided by the tube in the conventional way.

In shunt with the e.h.t. supply is a PD500 stabiliser valve whose anode is connected to the e.h.t. supply while its cathode is connected to the h.t. line via the 1kΩ resistor shown. The stabiliser valve provides a path for the e.h.t. current in addition to that provided by the picture tube and the plan is to get the PD500 current to increase as the picture tube current decreases and vice versa, in this way obtaining a constant e.h.t. voltage.

The current passed by the PD500 is of course controlled by the voltage at its grid (the more negative the grid the less current passed by the valve). Thus it only remains to sample the effective e.h.t. current in a manner so as to produce a negative voltage of value geared to the e.h.t. current for the grid of the PD500. In the circuit the "cold" side of the e.h.t. overwinding is returned to the boost h.t. rail via R1 which forms the top arm of a divider with R2 which is returned to the h.t. line. E.H.T. current thus flows through R1, and since this comes from the "cold" side of the overwinding the voltage across R1 and hence at R1/R2 junction is negative with respect to the h.t. line—the positive boost h.t. voltage is outweighed by the negative voltage. With this kind of circuit the line output stage is stabilised by the v.d.r. feedback loop previously mentioned, so the boost voltage will remain reasonably constant under varying load conditions and will not affect the e.h.t. control.

An increase in beam current results in an increase in the negative voltage at the PD500's grid. This reduces the bypass current through the valve so that more current is available to meet the increased demand of the picture tube. In other words this arrangement results in the loading of the e.h.t. supply

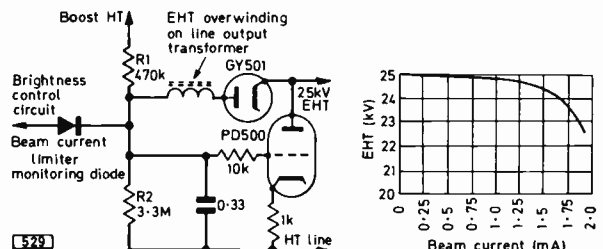


Fig. 1 (left): E.H.T. supply circuit with PD500 shunt stabiliser triode.

Fig. 2 (right): Range of control provided by the circuit shown in Fig. 1.

being made essentially constant over the dynamic beam current requirements of the picture tube.

There are other ways of obtaining similar control with a PD500 stabiliser. Some differ only in detail, others—used mostly in early American receivers—monitor the voltage rather than the current of the e.h.t. supply. If a v.d.r. stabilising loop is not used in the line output stage the change in boost h.t. voltage resulting from a change in e.h.t. loading can be used as the basis of the bias for the PD500. Circuits have also been used in which the bias stabilising the line output valve is employed as the control for the PD500.

Many chassis which use the type of circuit shown in Fig. 1 incorporate the beam current limiter in the stabilising circuit. A separate diode can be used to monitor the negative potential at R1/R2 junction. The diode cathode is connected to this point and the diode is biased to cut-off under normal values of beam current. Should the beam current tend to rise above the preset maximum however the diode will conduct as its cathode is then more negative than the normal biasing. This action reflects a “turn-down” bias in the brightness control circuit.

Beam current limiting is necessary in addition to e.h.t. stabilisation because the PD500 can do nothing to control a fault condition that could result in excessive beam current. The control range of the PD500 is such that it passes maximum current when the beam current is zero and zero current when the beam current is at the normal maximum. Thus the valve is not conducting if the beam current should rise above the normal maximum value. The stabiliser current is generally set to 1.2mA with zero beam current and it is normal for the valve anode to glow red hot under these conditions. The curve shown in Fig. 2 indicates the control range.

### Bang & Olufsen E.H.T. Circuit

A rather more elaborate approach to generating a stable e.h.t. supply, using a separate e.h.t. generator circuit driven by pulses from the line timebase, is used in B and O colour chassis. The circuit is shown in simplified form in Fig. 3. The PL509 is the e.h.t. generator output valve (it is not part of the line output stage) and the first half of the PCC85 is a driver. Pulses from the line output transformer are coupled to the grid of this triode via C1. The triode shapes the pulses and delivers them to the PL509 grid via C2. Transformer T1 loads the anode of the PL509 and the large-amplitude “flyback” pulses produced are applied to the anode of the e.h.t. rectifier valve GY501 in a similar manner to the e.h.t. producing arrangement in an ordinary line output stage. The h.t. for the anode of the PL509 is applied via the PY500 which operates similarly to the boost diode in a conventional line output stage, C6 acting as the boost reservoir capacitor.

The e.h.t. voltage produced by the circuit is controlled by the other half of the PCC85 (right-hand side of the circuit). Pulses are applied to its anode from a winding on T1 and as a result of its rectifying action C3 charges negatively. The potential developed across this capacitor appears via R1 as grid bias for the PL509. The extent to which C3 charges and hence PL509 grid bias depends on the grid voltage of the PCC85 control triode—because the conductivity of this valve is governed by its

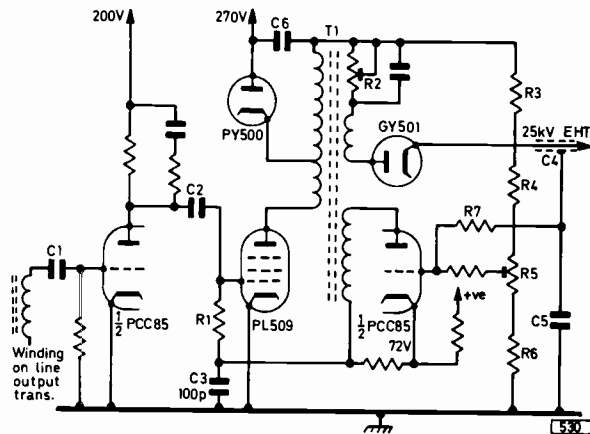


Fig. 3: Simplified circuit of the e.h.t. generator used in Bang and Olufsen colour receivers.

grid bias. The e.h.t. current flows through R2/3/4/5/6: thus if the e.h.t. current increases, due to a rise in beam current, the voltage across R2 also increases. The “boost” h.t.—developed by C6—is applied to the junction R2/R3. Thus the result of an increase in e.h.t. current is that the potential at the top of the resistive divider will decrease: this happens because the rise in voltage across R2 due to the rise in beam current subtracts from the “boost” h.t. voltage. The positive voltage at the grid of the PCC85 then falls, and the triode conduction decreases with a corresponding fall in the rectified voltage across C3 and hence in the PL509’s grid bias. The PL509 is thus turned on harder to cater for the extra beam current demanded by the picture tube.

The range of regulation provided in this way is adjusted by R2 so that 25kV is present at maximum brightness and by R5 so that 25kV is also present at minimum brightness.

The circuit as so far described caters for slow variations in beam current—up to about 80Hz. Control of rapid fluctuations is provided by the capacitor divider C4/C5. C4 consists of the capacitance between the inner conductor and the screen of the e.h.t. cable and works out at about 270pF. The junction of the divider is connected to the grid of the PCC85 via R7 and the mechanics of operation are the same as previously described.

### BRC 2000 E.H.T. Control

The use of a compensating shunt load regulator is difficult with solid-state receivers. To overcome this problem BRC developed for their all-transistor 2000 series dual-standard chassis a remarkably efficient series supply regulator for e.h.t. control. The basic circuit is shown in Fig. 4.

The e.h.t. generator is Tr1 which is driven by a squarewave from the line timebase. The “flyback” pulses which occur at Tr1 collector when it is cut off by the squarewave drive are stepped up to around 8.3kV by the overwinding on T1 and are then applied to the e.h.t. tripler which produces the required 24kV e.h.t.

The collector supply for Tr1 is obtained from the 60V line via the series regulator transistor Tr2, the

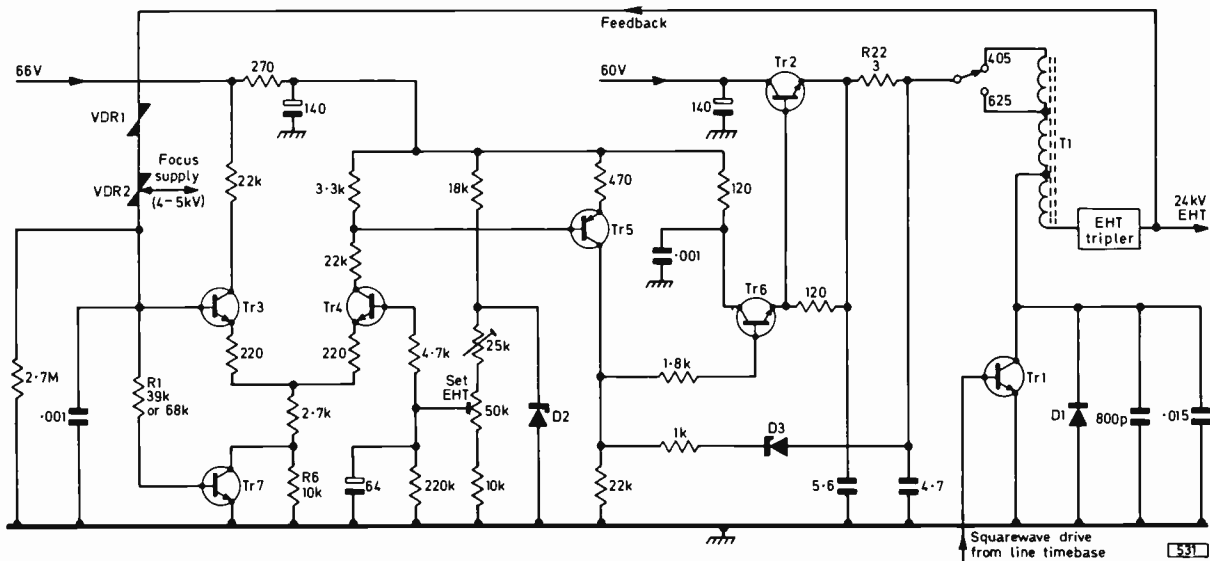


Fig. 4: The BRC 2000 chassis used a separate e.h.t. generator stage: a series regulator transistor (Tr2) controlled the supply to this stage and was in turn controlled by the feedback amplifier Tr3-Tr6.

conduction of this transistor determining the power of the supply to Tr1. The idea is that when the beam current demand rises Tr2 turns on more power for Tr1 to cater for the extra demand and vice versa. The conduction of Tr2 must be geared to the beam current variations therefore.

This is achieved by the controlling amplifier circuit Tr3-Tr6. Tr3 and Tr4 comprise a differential amplifier circuit. Tr3 base is fed with a sample voltage derived from the e.h.t. line via the voltage divider VDR1/VDR2/R1, the output from this stage to drive Tr5 being taken from Tr4 collector. A differential amplifier circuit is used to give a suitable input impedance: it communicates information on the instantaneous level of the e.h.t. voltage to Tr5 which gives the phase inversion necessary to operate Tr6 and hence Tr2 in the correct sense.

Thus should the beam current fall the e.h.t. load will also fall and the e.h.t. voltage will rise. This changes the biasing of Tr3 and hence that of the subsequent transistors so that Tr2 is turned down reducing the power fed to Tr1. The e.h.t. voltage decreases in consequence. Conversely if the beam current rises the resulting fall in e.h.t. voltage changes the sense of the biasing so that Tr2 supplies increasing power to Tr1 and the fall in e.h.t. voltage is compensated.

The circuit is able to handle slow and fast variations in e.h.t. voltage since its response is flat from d.c. to 1kHz. The net result is that the effective source resistance is decreased from the uncompensated values of about 6M $\Omega$  on the 625-line standard and 10M $\Omega$  on the 405-line standard to a common value of round 1M $\Omega$ . The regulation characteristics are switched at T1 to suit the line standard. The working level of the amplifier is adjusted by the 50k $\Omega$  preset which sets the e.h.t. voltage. D1 is a damping diode and D2 a zener which stabilises Tr4 base voltage.

The zener diode D3 provides current overload protection by sampling the voltage between Tr5 collector and R22. It is normally non-conducting but

if the current drawn is excessive the voltage across D3 approaches its zener voltage: it then conducts, clamping Tr6 base and in consequence limiting the output current.

If the feedback to Tr3 base is open-circuit the control amplifier will assume that the e.h.t. is low and thus turn on increased power to Tr1—with possible damage. Tr7 is incorporated to overcome this problem. If the feedback is open-circuit Tr7 receives no base bias and in consequence R6 increases the bias on Tr3 and Tr4. When the feedback is present Tr7 switches on, short-circuiting R6 and reducing the bias on Tr3/Tr4 so that the control amplifier operates normally.

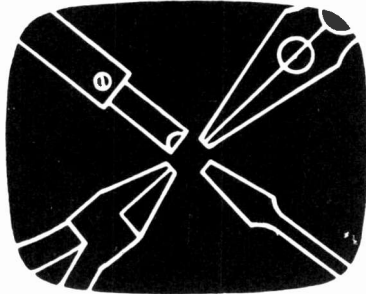
### Multipliers; Focus Supply

The action of e.h.t. multiplier arrangements was described in detail recently by C. R. Boggis—see *E.H.T. Systems for TV Sets*, December 1972. As that article pointed out most current colour chassis use a multiplier for the e.h.t. supply. One advantage is that the insulation difficulties in the line output or e.h.t. transformer are reduced due to the decreased pulse voltage step-up required when a multiplier is used. Having said that however it is noteworthy that some of the most recent models are reverting to simple rectifier e.h.t. supply arrangements, with the line output transformer supplying the high-voltage pulses as in the earlier days! The BRC 8000 chassis is one example. The recent Pye 18in. 713 solid-state chassis on the other hand employs a doubler circuit.

Some early receivers employed a separate e.h.t.-type rectifier valve energised by line flyback pulses to obtain the picture tube focus potential. Nowadays however the practice is to obtain this from a potential-divider connected to the e.h.t. supply. With a tripler the focus potential can be obtained from the first stage. In Fig. 4 it is tapped from VDR2 which forms part of a potential-divider across the e.h.t. supply.

**TO BE CONTINUED**





# SERVICING television receivers

L. LAWRY-JOHN

PHILIPS T-VETTE/STELLA COMPANION

THE Philips T-Vette (Model 11TG190AT) and Stella Companion (Model ST1100) are dual-standard mains-battery portable receivers. Models suffixed /95 are not fitted with a u.h.f. tuner.

It is with some trepidation that we have made these sets the subject of an article in this series: we fully expect a deluge of letters asking why we didn't mention this or that fault or why we didn't fully explain this or that feature. The answer is that although the writer has serviced a goodly number of these sets they do not seem to follow a pattern of common faults to the extent that most chassis do. As a matter of fact before we start to service one of these sets we always look first to the heavens for comfort and reassurance that this one will not be as difficult as the last. It is with the same attitude that we commence this article. We seem to remember this feeling when we tackled the early Philips projection sets some time in the summer of 1955: as it happened that wasn't a bad article all things considered!

Since these sets are designed to operate from either a 240V mains supply or from a 12V battery it is as well to deal with the power supplies first. There are two supply plugs at the rear left side, one for battery—suitably marked with polarity—and the other for mains. Fuse FS1701 is in the mains supply and is rated at only 250mA. Fuse FS1702, rated at 2A, is in the chassis return and is common to both battery and mains operation. It is important not to exceed these fuse ratings, especially the 2A one, as serious damage can occur if a short-circuit causes a heavy current to flow and this is not checked by fuse failure. We have seen some of the results of this where the print on the panels has been burnt away making a tidy servicing job even more tedious.

As with all transistorised sets it is essential to keep the supply line constant under varying load conditions. The job of regulation is undertaken by the circuit consisting of T4012, T4014 and T1513. We will have more to say about this later. The mains supply is transformed down by L1618/L1619 and rectified by the two bridge rectifiers MR1605 and MR1622. The voltages shown on the circuit diagram are with a smoothed, regulated supply at HT1 of 11V.

## Fault Condition: Low Voltage

It is a natural instinct in most of us to suspect a short or partial short when we find the supply line much below what it should be although the supply

is correct (i.e. from a 12V battery or the output of the rectifiers in this case). This may well be so but it often isn't and a few minutes checking the regulator circuit may save a lot of time spent chasing suspected line output transistors etc.

The first action should be to take out the 2A fuse and measure the current. A reading of about 1.5A is correct. If the current is low it is reasonable to assume (taking the low supply voltage into consideration) that the regulator circuit is in need of attention. A resistance check on all three transistors (T4014 T4012 and T1513) can save a lot of time and can be done without disconnection. With the meter switched to the lowest resistance range apply the probes as follows. T4014 is an AC127 which is an npn type: when the negative probe is applied to the base a reading of some  $10\Omega$  should be obtained when the positive probe is applied to either the emitter or collector; when the leads are reversed the reading should be much higher—depending on the circuitry (say over  $200\Omega$ ). There should be no reading except that of the external circuitry between collector and emitter. T4012 is an AC128 which is a pnp device as also is the power regulator T1513 (type AD149). The same test can be applied but this time the positive probe is applied to the base with the negative probe to the collector or emitter for the low reading.

Of the three transistors it is the AC128 which is most likely to be found at fault although it must be said that the last spot of trouble we had with this power circuit was traced to the AD149 which had a collector-to-emitter short.

Low voltage is normally caused by an open-circuit transistor or a shorted one depending upon the circuit position. The makers suggestions which follow are worthy of note.

If the supply line is high on mains and adjusting R4035 has no effect check T1513 and T4014 (both could be defective).

If the supply line is low on battery but correct on mains R4040 could be open-circuit.

If the line is low on mains but correct on battery R4038 could be open-circuit.

If the line is low on both battery and mains the zener diode X4006 could be shorted.

If there is no supply check R4039 (could be open-circuit).

If the supply line is low and there is excess current flowing switch to 405 and listen for the line whistle. Also note the presence or absence of some sort of noise from the loudspeaker.

The two main causes of excess current and over-

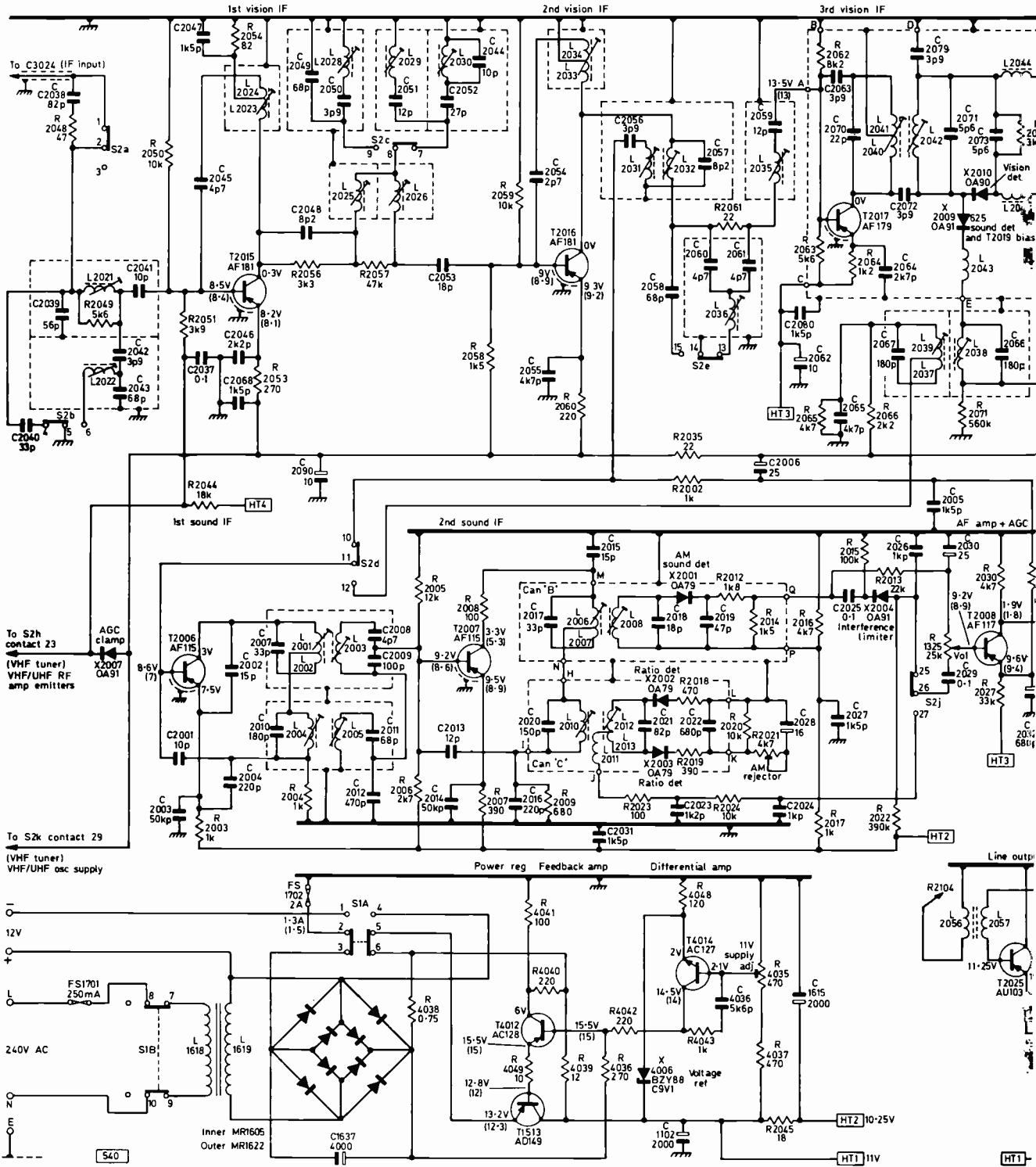
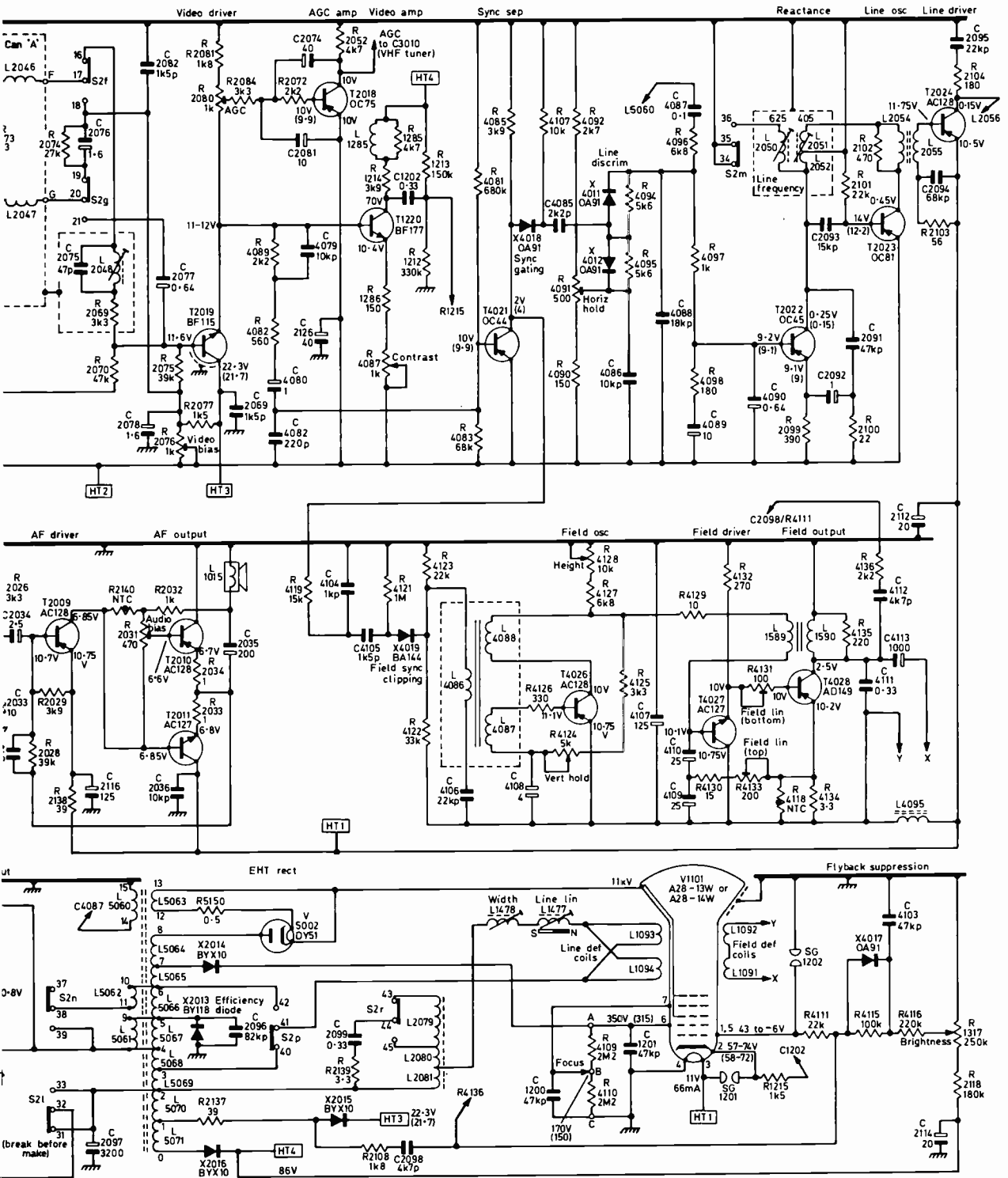


Fig. 1: Circuit diagram, Philips T-Vette (Model 11TG190AT) and Stella Companion (Model ST1100). Volt

heating are a faulty transistor in the line output stage (AU103) and thermal runaway in the sound output stage where the AC128 is usually the culprit, burning out its emitter resistor on the way to final ruin. So when the line whistle is present a hand run under

the front centre of the panel may find overheating if the sound output stage is in distress. The repair usually consists of fitting a new AC128 and a new 1Ω resistor (R2034). The AC128 referred to is T2010 not T2009 which with the AC127 (T2011) usually



Pages shown measured with a 100kΩ/V meter and no signal input: readings in brackets apply to u.h.f.

escapes and lives to fight another day. It is as well however to check all three transistors along the lines already described for the power regulator circuit transistors.

If there is no line whistle on 405 it is reasonable

to concentrate on the line timebase with particular reference to the AU103 output transistor as this is easily damaged by arcing in the output stage (check the wiring to the DY51 and the possibility of arcing

—continued on page 183

# LONG-DISTANCE TELEVISION

## ROGER BUNNEY

NOVEMBER has been a rather uninspiring month. Little of note was received apart from the usual Meteor Shower/Scatter type signals. No Sporadic E propagation made itself known—at least neither during the periods when I was active nor from correspondents' letters. The tropospherics gave a lift at the beginning of the month however—particularly November 3rd—with reception into the UK from various Band III and u.h.f. transmitters in W. Germany, Belgium, Holland and Denmark. My own log for the period—relating to Band I activity—shows the rather quiet state. In all cases reception was via MS except for BRT (Belgium) which was via tropospherics.

- 1/11/72 NRK (Norway) E2.
- 2/11/72 BRT E2.
- 3/11/72 SR (Sweden) E2.
- 4/11/72 DFF (East Germany) E4; RAI (Italy) ch.IB.
- 5/11/72 WG (West Germany) E2; BRT E2.
- 7/11/72 WG E2.
- 8/11/72 BRT E2.
- 9/11/72 DFF E4.
- 10/11/72 DFF E4; SR E2.
- 12/11/72 BRT E2.
- 13/11/72 DFF E4; BRT E2.
- 14/11/72 NRK E4.
- 16/11/72 NRK E3, E4; SR E2. Considerable short duration MS was noted this day (Leonids meteor shower).
- 17/11/72 DFF E4; BRT E2.
- 18/11/72 RAI IB; BRT E2.
- 19/11/72 BRT E2.
- 21/11/72 SR E2; TVP (Poland) R1.
- 24/11/72 DFF E4; NRK E2, 3.
- 26/11/72 SR E2.
- 27/11/72 NRK E3; BRT E2.
- 28/11/72 SR E2.
- 29/11/72 WG E2.

The home front has been in something of a turmoil this month due to a move to the new property, though things are now returning to a more normal state. For the time being I am operating with an omnidirectional

array (see *Practical Television* July 1969) pending the erection of a substantial lattice structure. The omnidirectional array will remain however for use as a search aerial during Sporadic E openings.

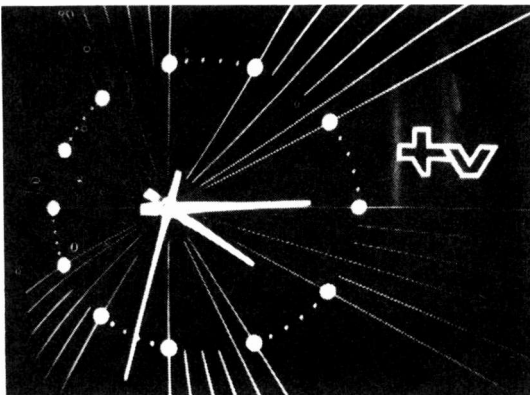
### East Germany

It is with great interest that we received from the EBU an up-dated list of East German transmitters. Since some of the revelations are of great importance we quote extensively from this list:

|                     |       |        |            |                               |
|---------------------|-------|--------|------------|-------------------------------|
| Helptenberg         | DFF 1 | ch.E3  | up to 30kW | vertical.                     |
| Rabenau             |       | ch.E3  |            | vertical (first time listed). |
| Cottbus             | DFF 1 | ch.E4  | up to 70kW | horizontal.                   |
| Dippoldiswalde      |       | ch.E4  |            | vertical.                     |
| Leipzig             | DFF 2 | ch.24  | 500kW      | vertical.                     |
| Grossheringen       |       | ch.24  |            | horizontal.                   |
| Nassau              |       | ch.24  |            | horizontal.                   |
| Gera                |       | ch.25  |            | horizontal.                   |
| Berlin-Ost          | DFF 2 | ch.27  | 500kW      | horizontal.                   |
| Loebeau             | DFF 1 | ch.27  | 500kW      | horizontal.                   |
| Dresden             | DFF 2 | ch.29  | 1000kW     | horizontal.                   |
| Scherwin            | DFF 2 | ch.29  | 1000kW     | horizontal.                   |
| Beuditz             |       | ch.29. |            |                               |
| Windischenbernsdorf |       | ch.30  |            | horizontal.                   |
| Dequede             | DFF 2 | ch.31  | 500kW      | horizontal.                   |
| Inselsberg          | DFF 2 | ch.31  | 500kW      | horizontal.                   |
| Sonneberg           |       | ch.33  | 500kW      | horizontal.                   |
| Brocken             | DFF 2 | ch.34  | 1000kW     | horizontal.                   |
| Toeppehn            |       | ch.34  |            | horizontal.                   |
| Triptis             |       | ch.34  |            | horizontal.                   |
| Muenchenbernsdorf   |       | ch.37  |            | horizontal.                   |

### News Items

*South Africa:* We understand that the first TV transmitters will be arriving in South Africa during the first half of 1973. The first u.h.f. transmitters will be installed at Middleburg, Haartbeestefontein and Davel (all in the Transvaal) and at Kroonstad in the Orange Free State. Test transmissions are not however expected to start until 1974, for commencement of the service in 1976.



Clock used by the Swiss Television Service—  
Courtesy K. Hamer.

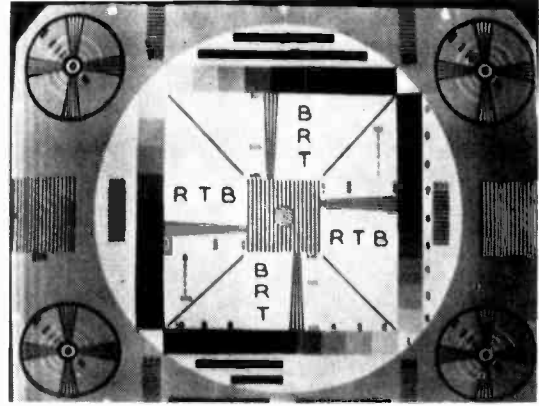
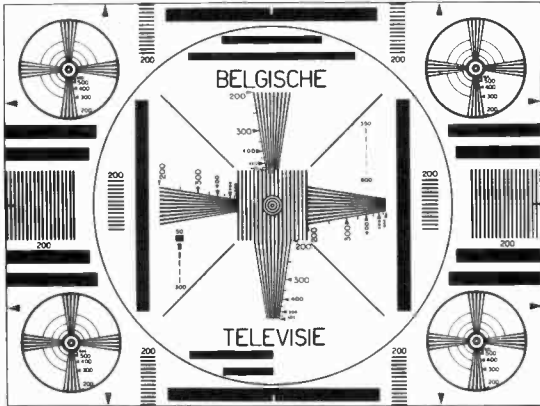


Test card used by ABV-TV ch.2 Melbourne  
Australia—Courtesy Michael Dolci.

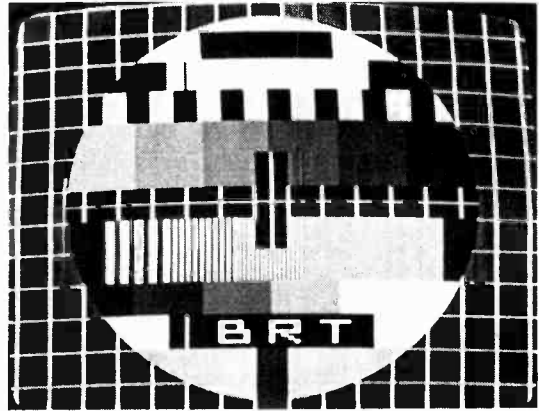
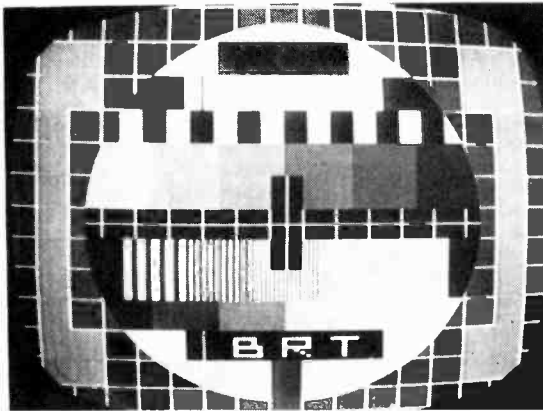
## DATA PANEL 19—2nd series

## BELGIUM

Both Dutch and French language programmes are transmitted by the television service: Belgische Radio en Television (BRT) Dutch; Radiodiffusion-Télévision Belge (RTB) French.



The test card on the left may be inscribed as shown or with "Télévision Belge"; the one on the right is often to be seen with colour bars superimposed across the lower section.



The PM5544 card (left) may be inscribed as shown or "RTB". The variation on the PM5544 shown on the right—with the side panels omitted—is also used. At times the transmitting site may be shown within the lower black rectangle.

Photographs courtesy Garry Smith, Dieter Scheiba and the Europese Testbeeldjagers.

**Rumania:** Some information is at last coming in about the TVR-2 network. The second service operates on Tuesdays, Thursdays and Sundays between 2000-2300. The test card is the same as that used for the first network and no colour is at present transmitted on TVR-2. More information is anxiously awaited!

**France:** At the time of writing a number of the ORTF-3 transmitters are testing on Tuesdays and Thursdays between 1000-1300 using normal ORTF-2 test cards. We hope by the time this column reaches the bookstalls to have some reports of actual reception of the regular service. Comparative observations between Lille ch.21 ORTF-2 and Lille ch.24 are also requested.

### New EBU Listings

**Cyprus:** Platres CBC-1 ch.E35 50W horizontal; Tsada CBC-1 ch.E38 1kW horizontal. These are the first u.h.f. transmitters to operate in Cyprus.

**Denmark:** Copenhagen ch.E4 up to 50kW e.r.p. from 10kW horizontal; Aarhus ch.E8 up to 60kW e.r.p. from 10kW horizontal.

**Hungary:** Budapest-2 ch.R24 4kW horizontal.

**Holland:** Smilde ch.E6 up to 50kW from 40kW horizontal.

**Poland:** New stations: Krakow TVP-2 ch.R2 1kW vertical; Wroclaw 2 TVP-2 ch.R2 1kW horizontal; Kielce ch.R3 100kW horizontal; Gdansk ch.R3 5kW horizontal; Poznan ch.R9 150/100kW horizontal (bidirectional); Olsztyn ch.R9 100/30kW vertical (bidirectional); Katowice ch.R21 500kW horizontal (the first TVP u.h.f. transmitter listed!)

**Rumania:** New stations: Brasov ch.R3 horizontal; Resista ch.R4 horizontal; Rimnicu Vilcea ch.R4 horizontal; Tirgu Mures ch.R5 15kW horizontal; Birlad ch.R5 5kW horizontal; Harghita ch.R5 5kW horizontal; Dragasani ch.R5 horizontal; and a station now out of use Bacau ch.R1 3kW horizontal.

*Sweden:* Vislanda ch.E5 up to 10kW from 5kW vertical; Hoerby ch.E43 up to 1000/800kW from 500kW horizontal.

*Czechoslovakia:* New stations: Praha ch.R1 150kW horizontal; Ostrava ch.R1 100kW horizontal; Bratislava ch.R2 150/10kW horizontal; Poprad ch.R5 150kW vertical; Kosice ch.R6 100kW vertical; Praha Mesto ch.R24 100kW horizontal; Bratislava ch.R27 20kW horizontal; Ostrava ch.R31 20kW horizontal; Brno Mesto ch.R35 20kW horizontal; and *out of use* Stredni/Cechy Praha ch.R1 30kW horizontal.

*USSR:* Krasnodar ch.R1 50kW horizontal; Krasnodar ch.R5 up to 150kW horizontal.

Quite an exciting list of new stations from the EBU this time: of particular note are the u.h.f. stations operating in Poland and Czechoslovakia.

### Points from the Post

Austin Uden tells us that a Russian TV channel sound frequency has been noted at 87.75MHz (thus the Vision frequency is 81.25MHz) lying *between* channels R3 and R4. The language contains Moldavian and the signal peaks NE/N.

The Europese Testbeeldjagers reports that a new type of pattern is in use by NDR (West Germany): it consists basically of the familiar colour bars but with the EBU test bar superimposed. They also advise that NRK is preparing a new card to replace test card F.

Liege in Belgium is now in service on ch.E42 with 1000kW; SECAM colour tests are being carried over the higher powered Band III transmitters in East Germany; information has also been passed to us that CLT (Luxembourg) will use the SWF/YLE card inscribed "RTL"—we have noted more recently from a photograph of the ch.E7 transmission that this card is in use less white circle and inscribed "CLT".

Two letters have arrived from South Africa (Pietersburg and Edenvale in the Transvaal) telling us that F2/TE conditions improved during October giving reception of TVE (Spain) Madrid ch.E2 and RAI (Italy) ch.IA with at times good strength signals.

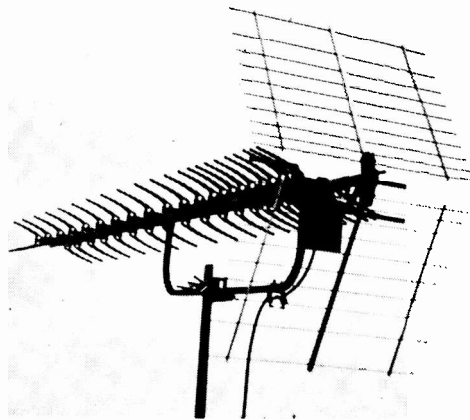
Following recent comments on the use at u.h.f. of the Fuba XC391 array W. Dryburgh of Tadcaster, Yorkshire has sent us a photograph which shows in detail the reflector, dipole (with integral amplifier) and director chain. Bill Dryburgh makes extensive use of Fuba u.h.f. arrays for his DXing activities, with somewhat startling results!

### A Correction

An error crept into the December column: reference Turkey the Istanbul University ch.E4 transmitter is now operating with 500W *not* 500kW—sorry about that!

### A Beginner's Guide—2

Last month we saw how the weather affected the troposphere, producing enhanced signal propagation. This month we turn our attention to a region somewhat higher. As we all know, short-wave communication depends upon reflective layers above the Earth: these return the signals to Earth over extreme distances. One of these layers—the E Layer—can at times affect television signals, similarly returning them to Earth many miles from the transmitter. At certain times small areas or patches of intense ionisation form in the E Layer—at a height of about 75 miles. It is these patches that are capable of reflecting v.h.f. (and consequently television) signals—during normal conditions the E Layer is not able to reflect such high-frequency information. The causes of this ionisation are not known and it is consequently rather difficult to predict exactly when such patches will appear. Indeed such a condition can occur at anytime during the year. Over the years however



*Fuba XC391 u.h.f. array—courtesy W. Dryburgh.*

certain patterns have been noticed and these enable us to say with reasonable certainty that most v.h.f. reception via this mode occurs between May and September. This period has come to be known therefore as the Season, and since this ionospheric phenomenon is known as Sporadic E the period May-September is known to long-distance enthusiasts as the Sporadic E season. Sporadic E is usually abbreviated SpE.

The patches or clouds of ionisation can move within the E Layer at speeds of 250 m.p.h. This results in a changing reception pattern and as the cloud moves so the stations received change, the "skip distance" either lengthening or becoming shorter. At times the cloud is stable, producing relatively strong signals from one area. Signal strengths themselves vary from weak to very strong, the stronger signals displaying multiple-path propagation effects (ghosting). Distant signals (i.e. over 1,500 miles) tend to resemble tropospheric signals—slow fading etc. It is unusual to experience skip distances of less than 500 miles.

The frequencies affected cover Band I through to Band II (TV) and, very rarely, reach up to Band III. Because of the high signal strengths quite simple arrays can be used and the beginner is advised to gain his first DX TV experience via this mode.

Another mode of propagation which results from conditions in the E Layer is Meteor Shower/Scatter (MS) propagation. As the name suggests meteors are responsible for the phenomenon. Throughout the 24 hours of the day the Earth is bombarded by small particles from space. These particles enter the Earth's atmosphere and burn up at E Layer height, producing localised ionisation in the form of a trail. A fast moving meteor burns up higher of course because of the greater friction, slow moving particles burning up much lower. The ionised trail produced is capable of reflecting v.h.f. signals, though for only short periods ranging from a second upwards. At times of the year there are periods of predictable meteor showers which can give sustained signals for up to 30 seconds.

The frequencies normally affected are those in Bands I and II with at times Band III, though Band III reflections can result from really intense trails. It goes without saying that the equipment used for such reception should be of high gain, stable and able to lock immediately to such weak signal flashes. It is possible to receive daily reception by this mode of propagation although of only short duration. The best times for random meteor shower reception are up to about 1100. Times of regular meteor showers can be found in the astronomical journals.

To complete our short coverage of the main propagation modes we look again to the skies—to the F2 Layer some 200 miles high (Winter daytime). Every 11 years the Sun has a peak of sunspot activity and this increases

the m.u.f. (Maximum Usable Frequency) of the F2 Layer. If the sunspot activity is very high the m.u.f. can reach into the lower v.h.f. spectrum (as indeed it did in the 1957-9 period). When the m.u.f. does rise so high television signals at these frequencies are propagated in a similar manner to short-wave signals. Thus really long distances are possible and, in the cycle mentioned above (1957-59), BBC-1 ch.B1 was received in Australia and the USA many times. More recently we have seen various African stations received in Southern Europe. The m.u.f. is always highest during the Winter and at Noon along the transmission path. A peak m.u.f. of almost 60MHz was reached during the 1957-9 period.

As night falls following a day with an extremely high m.u.f. the F Layers (there are in fact two daytime layers, F1 and F2) break up to form a single layer. When this happens over the Equator small clouds form, reflecting signals at frequencies in excess of those reached during the daytime. Such reception is usually limited to an area 40° North-South of the Equator and continues after darkness. This is known as Trans-Equatorial Skip.

Both these propagation modes produce multiple-path reception effects and severe distortion of the received signal.

### Auroras

During periods of high Sunspot activity there is always the possibility of a Solar storm—caused by a flare on the Sun's surface. When a flare occurs particles are emitted and spiral towards the Earth, taking some 24 hours for the journey. Upon arrival the various radiation belts that surround the Earth become affected and the concentration of activity at the Earth's Poles produces an Aurora. This results in a display of light towards the North Pole (or South Pole) and the formation of a vertical reflecting sheet which is capable of reflecting v.h.f. signals up to Band III—with a characteristic rumble/hum effect. For signals reflected from the North aerials should of course be similarly orientated.

### SHORT BACK-FIRE AERIAL

—continued from page 152

before have been when using super arrays like a 19 over 19 slot-fed or a Golden Gain Supreme. Using the five-element back-fire (three basic elements plus two directors) I was able to receive watchable pictures from Redruth on channels 41 and 44, with no booster amplifiers and using an old Bush Model TV115 fitted with a transistor u.h.f. tuner.

The original design specified that if the array is mounted on a mast there should be at least 8in. between the mast and the back of the rear reflector. My version however uses a light wooden frame for the rear reflector with a large broomhandle across the centre back of the rear reflector to act as strengthening for the aerial and as a 4ft. mast to fix to the normal main mast.

### Conclusion

The effectiveness of the short back-fire aerial lies in the terrific build up of energy bouncing between the two reflectors, with the dipole sitting nicely in the centre of this energy build up.

Finally some basic data. The rear reflector should have a diameter of  $2\lambda$  with the edge about  $0.2\lambda$  deep. The overall length of the basic three-element version is  $0.5\lambda$ . The diameter of the front disc reflector should be  $0.4\lambda$ .

**NEXT MONTH IN**

# TELEVISION

## RENOVATING THE 2000 CHASSIS

Next month we return to Caleb Bradley's popular colour set renovations—with the famed BRC 2000 chassis, which was the world's first all-transistor colour chassis.

## UP-DATING THE 625-LINE RECEIVER

Some more modifications from Keith Cummins to improve the performance of the Constructor's 625-line receiver. These comprise a transistorised smoothing circuit for the h.t. supply, a modified brilliance control arrangement which discharges the c.r.t.'s e.h.t. supply when switching off to prevent switch-off spots, and a 6MHz dot-pattern trap for the video amplifier.

## FAULT-FINDING GUIDE—1

In this new series we shall be taking specific sections of TV circuitry, describing the circuit action and listing fault conditions and their causes. We start with the field timebase circuit used in the BRC 900/950 chassis.

## CONVERGENCE

Gordon J. King rounds off his *Colour Receiver Circuits* series by taking a look at the convergence department—dealing with the need for convergence and the types of circuit used in practice.

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# THE 'TELEVISION' COLOUR RECEIVER

## PART 11

# AUTOMATIC DEGAUSSING

THE shadowmask c.r.t. contains an area of steel—the shadowmask—which is quite large. Ignoring the holes in the mask the total area in for example a 22in. tube is about 1,500 sq. cm. Like all ferromagnetic materials the mask can be magnetised. Unfortunately the convergence and colour purity of a colour tube depend on the accuracy—and constancy—with which the three beams from the c.r.t. guns pass through the mask: even small effects on these beams will cause noticeable misregistration and loss of colour purity. The P-band (Rimguard) of a shadowmask tube is also ferromagnetic and in the same way this, if magnetised, can cause beam mislocation problems.

The shadowmask tube is thus extremely sensitive to external magnetic fields. A number of fields may be present in any domestic situation. Surprisingly one of these is the earth's own magnetic field. Other common objects such as metal-framed chairs, radiators, electric fires and so on are often slightly magnetised. The effect of these magnetic fields on a colour receiver picture would be to gradually pull the receiver out of convergence after installation; any further magnetic field created domestically—e.g. a vacuum cleaner operating close by—will worsen the situation. Additionally of course any movement of the receiver in the earth's magnetic field will cause changes.

It is necessary therefore to demagnetise (degauss) a colour receiver regularly. This can be done manually using an external degaussing coil—such as the service technician will have; alternatively it can be done automatically. If degaussing is to be automatic and on a regular basis it should be done at receiver switch-on or switch-off—the logical condition is at switch-on so that the receiver performance is correct while it is actually working!

Automatic degaussing is done by a pair of coils which are inserted under the magnetic picture tube shield. The coils are in series aiding connection and a control circuit governs the current flowing through them from the instant of switch-on.

To demagnetise a metal completely the field created in the material must initially be enough to saturate it: the magnetic field must then be reduced to zero, increased negatively, reduced to zero, increased positively etc. with each swing being progressively smaller. The B-H loops created in this way will be such that when the field finally reaches zero the remanent magnetism will also be zero. The positive and negative field variations are provided by using a.c. as the energising current: the amplitude reduction must be provided by the control circuit.

To saturate the shadowmask, the P-band and the magnetic shield itself about 500AT (Ampere-turns) are required: this must not be exceeded by any proportion otherwise damage can result to the shadowmask through the magnetic force on it.

With the type of control circuit used in practice it is impossible to have at the end of degaussing a resultant zero flux. The flux must be reduced below 5AT to complete degaussing but it is known that a flux of less than 0.3AT is needed for minimal effect on registration. The difference between full current and minimum current for a given set of coils is therefore in the ratio 500:0.3, i.e. 1667:1, the ratio to be provided by the control circuit.

### Circuit Operation

The heart of present degaussing circuits is the Mullard VA8650 (or equivalent) thermistor. This has a positive temperature coefficient, with a cold resistance of  $80\Omega \pm 20\%$ . As the thermistor heats up the resistance rises very considerably above this of course. When operated across a 240V mains supply the lower limit value ( $80 - 20\% = 64\Omega$ ) necessitates a series resistance of  $80\Omega$  to limit the maximum peak current to 2.6A.

The network below R605 in the circuit (see Fig. 1) must therefore appear as  $80\Omega$  at switch-on. Thus with the shunt  $680\Omega$  (R606) in position the resistance of the v.d.r. (VDR601) plus the coil pairs must appear as about  $90\Omega$ . The actual coil current flowing will then be about 2.3A. The 33V/100mA v.d.r. (VDR601) with this current passing through it will have a resistance of about  $43\Omega$  so the coil resistance (total) must be about  $50\Omega$ .

At switch-on the thermistor is cold and the voltage across the network of the v.d.r., coils and R606 will be high (an r.m.s. voltage of about  $240 \div 2 = 120V$ ). The current through the v.d.r. and the coils is high (2.3A) therefore and the magnetic flux produced is sufficient to saturate the area to be degaussed.

The current flowing heats R605. As a result its resistance increases and the voltage across the lower network decreases. As the voltage decreases the current falls and the resistance of VDR601 increases to reduce still further the current through the coils. A permanent small current flows through the  $680\Omega$  resistor (R606) but a switch-on/stable current ratio through the coils of about 2,000:1 is obtained. The exact ratio depends on the ambient temperature conditions around the degaussing components.

The coils must have a resistance of about  $25\Omega$



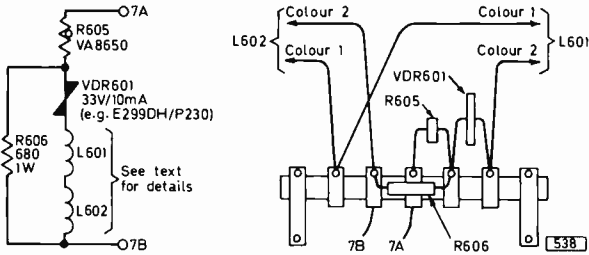


Fig. 1 (left): Automatic degaussing circuit. 7A and 7B connect to the a.c. mains on the power supply board—contacts 6F and 6B or 6D. Points 7A and 7B must not be earthed therefore.

Fig. 2 (right): Component layout on the tag strip, which should be mounted on the magnetic shield. Tag strips supplied in the component pack will be cut from standard RS 28-tagged strip.

each to meet the above total resistance requirement of  $50\Omega$  and they must have sufficient number of turns to give correct operation under the worst current conditions (which occur with the minimum possible mains voltage). When the current through the coils is 1.3A 385 turns (total) are required to give 500AT. As the diameter of the coils must be about 38cm. for 25 or 26in. tubes and about 29cm. for 19-22in. tubes it can be shown that each coil should consist of about 200 turns of 26 s.w.g. for the larger tubes and about 200 turns of 30 s.w.g. for the smaller sizes.

## Construction

The three degaussing components can be mounted on a tag strip centrally located on the bottom, back of the magnetic shield. Five insulated points are required so with the two mounting points a seven-way strip is required. This can be cut from a larger strip such as the 28-way standard strip marketed by RS Components.

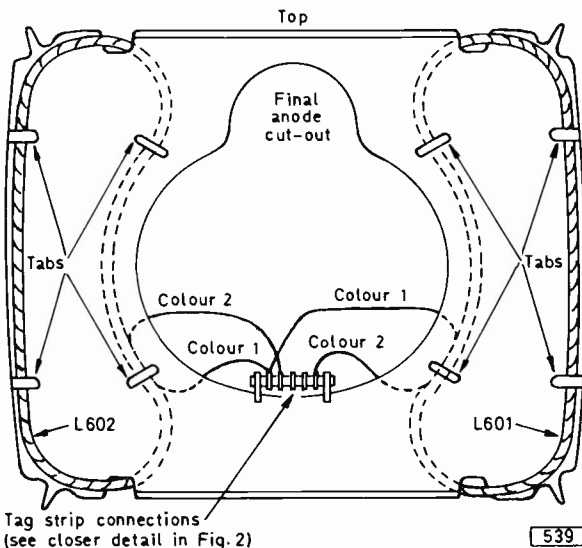


Fig. 3: Rear view showing the degaussing coils mounted on the c.r.t. magnetic shield.

Although the coils can be home-wound it is a fatiguing task and a mandrel of the right diameter for winding them has to be constructed. The wound sections then have to be wrapped in insulation and the end wires colour coded and sleeved.

The supplier listed can supply the coils, v.d.r., thermistor, resistor and tagstrip at reasonable cost. The colour coding used may differ with coils from different sources but one of the colours always indicates the start of the winding and the other the finish. The connections of the colours on the tag strip should be carefully noted: it is immaterial whether colour 1 is the start or the finish of a winding.

For series aiding coils the start (say colour 2) of the winding of L601 must finish as colour 1 and go straight to the finish of the winding of L602 (colour 1 again): the start of L602 is then the other terminal point. It might be thought that for series aiding coils the finish of one coil should connect to the start of the next. This however would only be so if both coils were on the same side of the tube: in our arrangement the coils are on opposite sides of the tube and the coils themselves must be "antiphase" connected to get series aiding effects.

In most colour receivers the magnetic shield is chassis connected—i.e. to the neutral of the mains supply. In our receiver we have a separate mains earth connection of course and *under no circumstances* should either 7A or 7B on the tag strip be earthed.

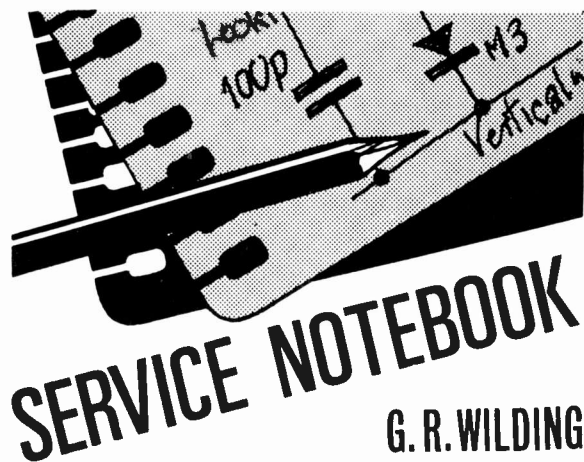
The coils are mounted partly inside and partly outside the magnetic shield: Fig. 3 shows the general arrangement quite clearly. Four metal tabs hold the coils securely in place on each side. Note that the top of the magnetic shield is where the final anode cut-out is shaped from the central hole.

The four tabs around the central aperture should be pushed through from the back using a screwdriver. The coils should then be slung over the corners of the shield so that the connecting leads fall inside near the bottom tabs. If all looks OK bend over the outer tabs to secure the vertical runs of the coils, straighten out the coils on the outer edges and then secure the inner runs behind the inner tabs. The shape of the inner sections should follow as closely as possible that shown in the diagram. The mounting is not difficult but you will probably find yourself a little ham-fisted if you have never mounted a set before. Don't press the tabs down excessively on the coils—finger pressure is quite sufficient. Be sure to mount the coils with the identification colours the right way round.

Not too much connecting lead length should be left hanging inside the magnetic shield: cut back to the coils as far as possible to make tidy connections to the tag strip. The samples of ready-wound coils that we have seen have all used self-fluxing enamel wire—this can be identified by its slightly redder colour than is normal with enamel wire. If the wire is self-fluxing it can be soldered directly to the tag strip by application of heat and solder. If the wire is normal enamel finished it must of course be cleaned off before tinning and soldering.

Finally we would like to have gone farther this month. The amount of other business to which the author has to devote time, a shortened production schedule this month because of the Christmas

—continued on page 177



### Field Faults

Field faults cause far more service calls than line timebase faults and also comprise by far the largest proportion of our servicing queries. The following run down on field timebase faults should therefore be helpful to many readers. The most common symptoms are weak hold, insufficient height—often with poor linearity—or a raster which progressively contracts at the bottom as the set warms up. In 80% of cases the cause of the trouble is simply the field timebase valve itself, generally a PCL805 in modern receivers.

Where the valve is not at fault, what then? Let us take reduced height first. If the linearity is still tolerably good the cause is almost certain to be increase in value of a limiting resistor in series with the height control (in the majority of receivers the height control is incorporated in the feed from the boost line to the triode section of the PCL805 or to one section of an ECC82 where one of these valves is used as the field generator). If the resistors in this feed turn out to be in order and even shunting them with a resistor of considerably lower value fails to restore normal height then the voltage-dependent resistor which stabilises this feed may well have developed reduced working resistance: disconnecting the v.d.r. will always increase the height considerably but if the increase is really great, to far more than the maximum needed, this component could well be defective. In many ITT/KB chassis this feed is decoupled to the h.t. line so that if the decoupling capacitor goes short-circuit the field generator is fed from the h.t. line instead of the boost line, reducing the height considerably.

Cramping at the bottom of the picture is usually caused by reduction in the capacitance of the output pentode cathode decoupling electrolytic and/or reduction in the value of the cathode bias resistor. Where these components turn out to be OK check the components in the linearity feedback loop. As always look for discoloured resistors since even slight discoloration is a sure sign of value change, and first suspect those capacitors mounted near valves and other high-temperature components since high working temperature greatly reduces the insulation resistance of a capacitor.

Weak field hold—assuming that the line sync is

normal—is commonly caused by a high-resistance sync feed (interlace) diode though poor h.t. smoothing or alteration of the voltages in the sync separator or video amplifier stages—even though not producing other coincident symptoms—can well be the cause. Shift of the locking position to one end of the hold control travel or a gradual shift of the locking position during prolonged use points to a resistor rather than a capacitor value change. Again look for discoloured resistors, suspecting first high-value current-carrying types which after years of service tend to increase in value. Time-constant capacitors (e.g. multivibrator cross-couplers) can of course be faulty, particularly those carrying high voltages: even a leak of many megohms can be disastrous.

### No Picture

THE complaint with a dual-standard RGD console model was no picture and on removing the back of the set we found that only small arcs could be drawn from the top caps of the PL36 line output valve and DY86 e.h.t. rectifier, while the PL36 anode soon began to glow faintly red. Altering the line hold control setting produced coincident sparking noises which seemed to come from the scan coils. On unplugging one of the leads to the coils the line whistle became much stronger and a very large arc could be drawn from the DY86. Replacing the lead resulted in the original very low line output, the sparking noises and the tendency for the PL36 to overheat. Removing it again restored the good e.h.t. arc.

This strengthened our suspicion that there was a short across a section of the line coils or between the line and field coils. On switching over to 625 lines however a normal e.h.t. spark could be obtained even with the scan coils connected. The fault reappeared when we switched back to 405 and was found to be still present when we switched back to 625 again. In these RGD console models the system switch is changed over by a solenoid which is actuated on operation of the v.h.f. tuner pushbuttons. On removing the chassis we found that the switch slider often rested in a midway position, sparking then occurring at the switch section feeding the line output to the scan coils via the relevant S-correction capacitor. This incorrect switch setting was found to be the result of a small nut and bolt which secures the switch slider to the solenoid core having become loose and on tightening the nut the switch slider travelled normally from one extreme to the other and no further trouble was experienced.

### Weak Colour

A PERFECT monochrome picture was displayed by a single-standard Pye colour receiver fitted with the 691 chassis but the colour was extremely weak, necessitating very accurate tuning. On the weakest local signal, BBC-1, the colour would drop out altogether. The decoder set automatic chrominance control RV9 was adjusted (see Fig. 1) but this made no improvement. Saturation control in Pye colour sets is effected by varying the forward bias applied to two diodes which are in series with the chrominance signal path (D23 and D24 in Fig. 1) so we next

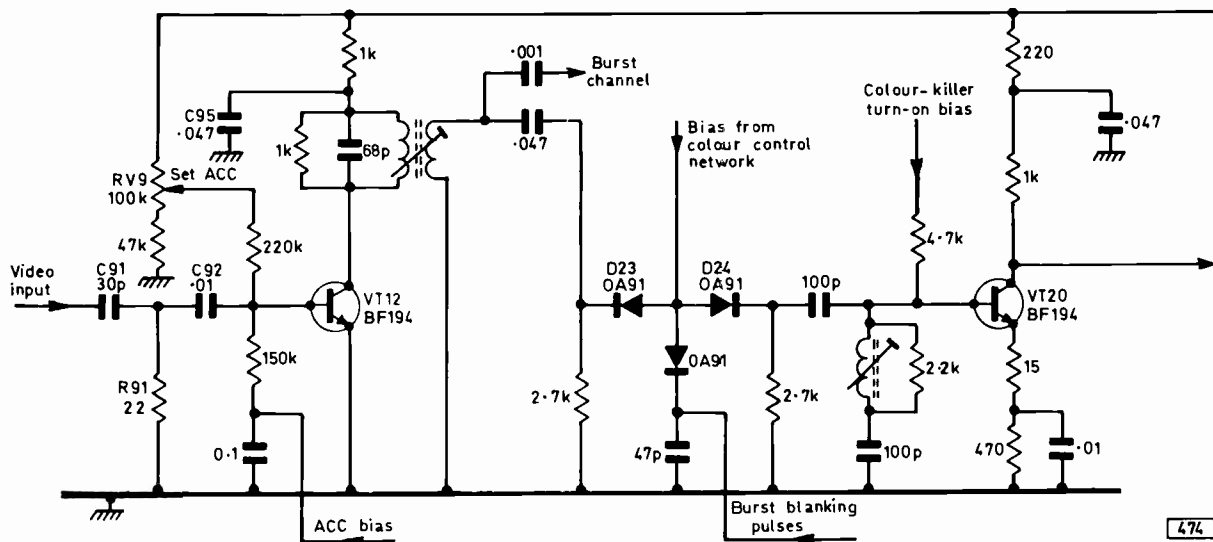


Fig. 1: First two stages in the chrominance channel, Pye group 691 chassis.

decided to check these diodes. Both proved to be OK. There are several other small diodes on the decoder panel, all concerned with providing biasing potentials or used for blanking purposes, so we decided to check them over: all had excellent forward/reverse resistance ratios.

There are three stages in the chrominance amplifier channel but in view of the occasional colour drop-out on BBC-1, likely to be due to inadequate bias on the first, gain-controlled stage (VT12), we decided to concentrate on this. The voltage readings obtained were markedly incorrect but all resistors in the stage were found to be well within tolerance. It appeared therefore that one of the capacitors must be practically open-circuit or of greatly changed value. As the emitter is connected direct to chassis our next move was to try the effect of shunting a replacement across the decoupler C95 in the collector circuit. This produced no improvement so it seemed that either C91, the 30pF high-pass (with R91) filter capacitor, or the  $0.01\mu\text{F}$  coupler C92 in the base circuit was defective. On the basis that even a small reduction in the value of C91 would have a more adverse effect than even a large reduction in the value of C92 we replaced C91 and obtained a really strong colour signal.

### Occasional Field Slip

VERY good results were obtained with an old 17in. Invicta model fitted with a new tube—there are still plenty of “seventeens” in service—but the picture occasionally dropped a frame. This we found was due to the field hold control being at one end of its travel and still not in the centre of its locking position. A new ECC82 field oscillator valve shifted the locking position well away from the end so that it was possible to make the picture roll in both directions of control rotation. A week or so later however the same fault reappeared, the hold control once more having to be set to one extreme. Obviously a component in the field generator circuit was changing value and as it can generally be

assumed that a resistor is the cause of such trouble we cleaned up all those surrounding the ECC82. We discovered that one, which proved to be the anode load resistor of one of the triodes, was very badly discoloured. It was impossible to decipher the colour coding and as we hadn't a manual for this old model we removed the resistor, placed the hold control in its centre position and tried various resistors until we obtained lock. After fitting the replacement resistor no further trouble was experienced.

## COLOUR RECEIVER PROJECT

—continued from page 175

holiday and loss of editorial time in dealing with a number of non-recurring (we hope) problems have however made this impossible.

### Component Pack 19

VA8650 thermistor, v.d.r.,  $680\Omega$  resistor, tag strip and pair of  $50\Omega$  (total) degaussing coils (state tube size).

Supplier: Manor Supplies, 172 West End Lane, London, N.W.6. Price £2.30 including post and packing. Shop price to callers is reduced appropriately. Pack also available from Forgestone Components, Ketteringham, Wymondham, Norfolk.

### Correction

Despite checking by several people the author's original convergence board drawings were incorrectly transposed on to the final drawings, one pair of mounting holes on reference line 2 being misplaced by 0.4in. Unfortunately movement of just one hole cannot be made because either 5U or 5X will be fouled. The answer is to move the hole on board 2  $\frac{7}{8}$ in. away from its longer edge and that on board 3  $1\frac{1}{4}$ in. away from its shorter edge. We do apologise for this error.

Power supply board size is  $8\frac{1}{2}$ in.  $\times$   $8\frac{3}{4}$ in.

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| CME1602 .....             | £12.00  |
| CME1702, 1703 .....       | £6.75   |
| CME1705 .....             | £7.75   |
| CME1713/A44-120 .....     | £14.50  |
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| CME1908 .....             | £7.75   |
| CME2013 .....             | £12.50  |
| CME2101, 2104 .....       | £8.25   |
| CME2301, 2302, 2303 ..... | £9.00   |
| CME2305 .....             | £14.75  |
| CME2306 .....             | £13.50* |
| CME2308 .....             | £9.95   |
| CME2413R .....            | £16.50  |
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| MW36-24, 36-44 .....      | £5.50   |
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# LETTERS

## SERVICING EXAMS

I read with some concern your editorial in the December 1972 issue, mainly because of its effect on students undergoing courses and preparing for examinations.

The punch line in the last paragraph is of course quite contrary to the actual position. Paper qualifications (I do not like the word "paper") are increasingly required and respected and I know of no distrust of the servicing examinations to which you refer. The Final Certificate in Radio and Television Servicing for example is a much sought after qualification not only by the radio and television servicing industry but the electronics industry as a whole. It is also a recognised qualification for registration as a Technician with the Engineers' Registration Board.

The main burden of your complaint was that faults used in practical tests bear no relation to the actual world of radio and television servicing. Here I must again disagree. A five-year course of study in radio and television servicing and the concluding practical test must of necessity cover more than the typical stock faults and fault-symptom relationships. It must include the whole range of possible breakdowns and their causes and the methods which one must use to detect them. In an examination based on the diagnosis of four faults one tries to include a range of difficulty and type; the most difficult fault is probably one that does not very often occur in practice but it must, in accordance with the instructions to all examiners, be capable of discovery by a logical sequence of tests. The examiners at each centre have had wide experience in the service industry and would not be party to an examination which deliberately set out to trip up candidates.

Our evidence against your scorn of paper qualifications is that the successful candidates in the Board's examinations are well equipped to tackle fault finding on any form of electronic equipment, be it domestic, professional or industrial.—A. J. Kenward, Secretary, The Radio, Television and Electronics Examination Board.

With reference to your December leader not many people like taking exams and with this in mind it is easy to knock the RTEB. One must remember (not pointed out in your editorial) that before the practical exam can be taken there are two three-hour written papers to be passed. Surely the theoretical knowledge is very important to the TV engineer. I suspect that quite a few candidates fail the written papers and thus cannot take the practical exam.

The object of any exam is to determine the candidates' knowledge and understanding of his particular subject: in the case of radio and television servicing this can hardly be assessed if only simple stock faults are used. Most stock faults can as you very well know be diagnosed and rectified by amateurs; we are talking about TV engineers not amateurs!

It is also possible to butcher a TV set with one faulty component showing one symptom: it was

when I took the exam, surely it is now. In conclusion while I think the practical exam has its faults it is not as pointless as you think.—**J. E. Foxall** (*Wolverhampton*).

We accept the points made in these letters. In a brief leader it is not always easy to bring out all the points one would like to make. We do not for one moment question the competence of those who have passed the exam. What we do have at the back of our mind is the fact that the "nose, eyes and ears" man often pounces on the cause of a fault in half the time taken by the expert diagnostician (especially if he tackles each fault from first principles). This is of course very important in a highly cost-conscious activity such as TV servicing. One wonders whether to put anyone through a five-year course is the right approach for run of the mill servicing. It has so often seemed that where we fall down in the UK is in practical training. The well-qualified engineer is essential—we need him for all those awkward faults which, with colour and increasingly sophisticated solid-state circuitry, are likely to become an increasing percentage of total faults—but if he finds himself spending his days replacing burnt out droppers and faulty electrolytics he'll soon go and get a better paid and more interesting job in industry. That doesn't help the TV service trade. We fully appreciate however that the training of the various grades of engineer is a highly complex question.—*Editor*.

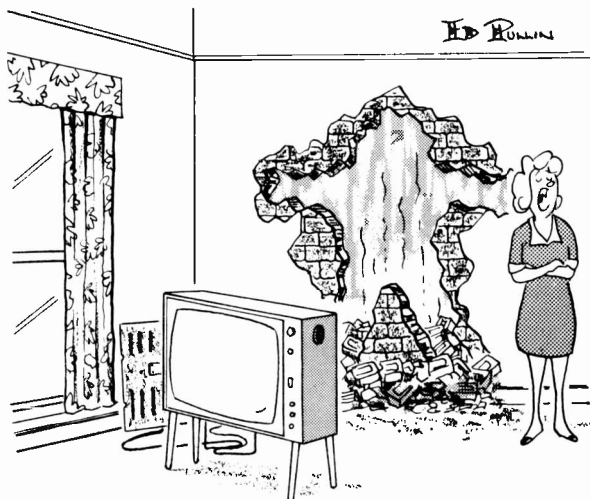
## RECEPTION IN EIRE

You may be interested to hear about the reception results that many experimenters are getting in the south of Ireland. Results can and often do vary from the ones to be expected theoretically. The aerials used are mostly the J Beam MBM46 and various German ones and aerial amplifiers are usually a must. Aerial erectors are charging around £100 for such a set-up, with a 10 or 15ft. mast at chimney level. Caradon Hill Cornwall is the most popular station in the south though Presley soon to come into operation may provide similar reception. Results depend on the weather of course because of the 150-200 miles path but are good at some times of the year. In coastal locations signals can be got for 80-90% of the time, high aerials providing improved reception of course. Redruth has been received at times but does not justify a separate aerial and amplifier (group B) to supplement those for Caradon Hill (group A).

Reception of cross-channel stations provides an alternative to Eire's single channel. Dublin area viewers are well within the reach of alternative stations and I long thought aerial installations there were huge until I saw some of the more comprehensive arrays used on the Continent. Going back to reception in the south of Ireland however I feel it would be a great help for enthusiasts to get together to pool their experiences and problems and I would very much like to hear from others in the area.—**Des Welsh**, *Ballylynch, Carrick-on-Suir, Co. Tipperary, Ireland*.

## FAULT EXPERIENCES

A recent fault I encountered illustrates how careful one has to be when dealing with a set that has had doubtful treatment in other's hands. The set in ques-



"Who took the fuse out of Daddy's mains tester?"

tion was a Baird Model 604 which had had cramping at the bottom of the raster. The owner said that the set had been converted to 625 lines, using the correct C12 kit, a fortnight previously. On examination we found the PCL85 cathode bias resistor badly overheating. The PCL85 was replaced but this made matters worse. We decided to check voltages and found both the cathode and anode voltages above normal. This surprising result was found to be due to the h.t. rail being higher than normal. At this point we noticed that all valve heaters were glowing duller than normal so we removed the heat shield of the main dropper to check the tap adjustments. Here the trouble was found: part of the conversion procedure for 625 lines is to short out the main section of the heater dropper to accommodate the extra valves on the new i.f. strip and tuner but by mistake the "engineer" had shorted out the main section of the h.t. dropper! Thus while all the valves were being severely under-run the increased h.t. was enough to maintain full scan, brightness, volume, etc., without anyone being aware that anything was amiss. On removing the short across the h.t. section of the dropper and refitting it across the correct section of the heater dropper the bottom cramping ceased and the cathode resistor stopped overheating. This fault could have gone on undetected for weeks had it not been for the excessive h.t. at the PCL85 causing its bias resistor to overheat and call attention to what was happening. I hope this experience will warn other readers.—**S. Knowles** (*London N4*).

We had a curious experience with an ageing Ferranti receiver and an equally ageing Band I/III aerial array recently. The array was clamped to a metal toilet flush pipe outside the house and every time the toilet was flushed the TV screen went completely dark for a while. There was also general aerial trouble—snow all over the screen etc. We felt there must be a short from aerial to earth, the water in the pipe completing the process. Insulation was put round the pipe anchorage therefore and the aerial overhauled. This completely cleared the problem but I feel it was one of the most amusing TV snags I've encountered.—**N. H. Hodgson** (*Hayes*).



**ASA MODELS CT5003, CT5004**

THERE is an amazing variety in the circuit techniques used in the various colour receivers on the market. This time we are taking a look at the Finnish designed and produced Asa models distributed by Maggs (Bristol) Television Ltd.

**Basic Chassis**

The basic chassis is mainly solid-state, employing only seven valves—in the timebases and sound output stage. An ELC1043 varicap tuner with push-button control is used and feeds a three-stage i.f. strip. A gated a.g.c. circuit controls the first stage in the i.f. strip and in addition applies a.g.c. via a separate amplifier to the first r.f. amplifier in the tuner. Separate detectors are used for the sound and for the luminance/chrominance signals. RGB tube drive is employed, an unusual feature here being that

the RGB outputs are used to drive the grids of the c.r.t.

**Luminance Channel**

The circuit of the five-stage luminance channel is shown in Fig. 1. The first stage T9 is an emitter-follower to which is applied the negative-going luminance/chrominance detector output. In addition to driving the second luminance stage T10 the emitter-follower also feeds the sync separator, the a.g.c. circuit and the chrominance channel. An emitter-follower is used to reduce the loading on the detector and to provide low-impedance signal sources. T10 drives the luminance delay line and the third luminance stage T11. Positive-going line flyback pulses are applied via D9 to T11 base: as this is a pnp transistor these pulses drive the transistor to cut-off, removing the sync pulses from the signal appearing at T11 collector. This is necessary because of the brightness control technique employed in the following stage.

A chrominance subcarrier rejector (C127/L50) is incorporated in the emitter lead of T11 to remove the subcarrier from the luminance channel. On monochrome the potential divider R98/R99 forward biases D10 so that the filter is short-circuited by C128, D10 and C129, full bandwidth then being maintained in the luminance channel. On colour a positive potential from the colour-killer circuit is applied to D10 cathode: the diode is thus reverse biased and the subcarrier rejector brought into operation.

**Brightness Control**

The luminance signal, now minus sync pulses and on colour the 4.43MHz subcarrier, is then fed via the contrast control and D25 to T33 base. The contrast control arrangement used gives signal level adjustment without d.c. level shift. C130 provides constant h.f. drive. We thus have at T33 base a luminance

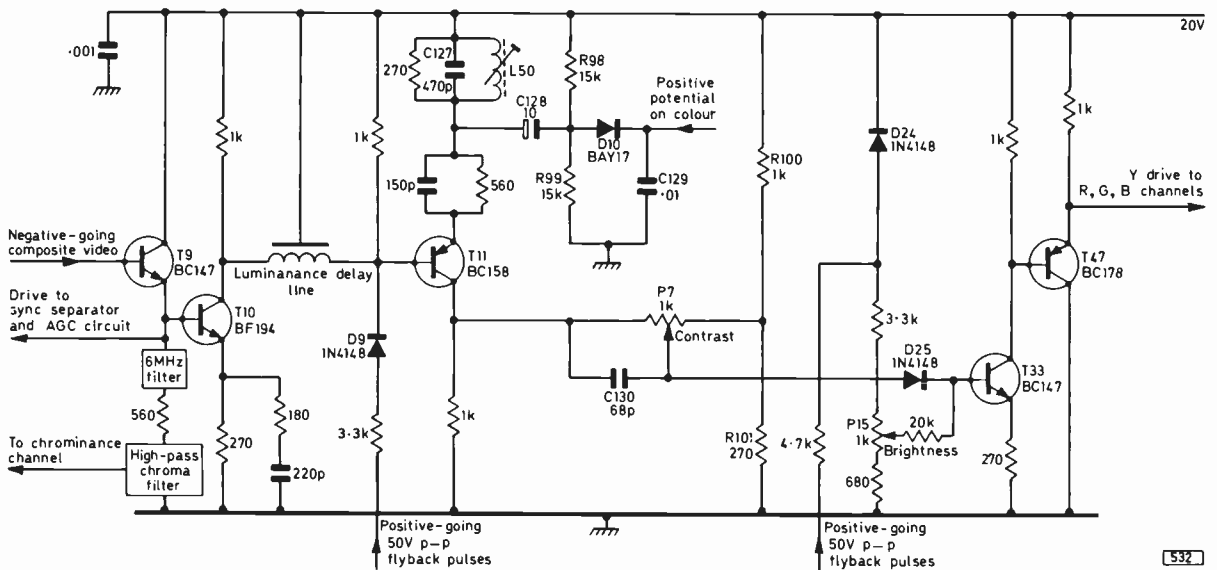


Fig. 1: Circuit of the luminance channel.

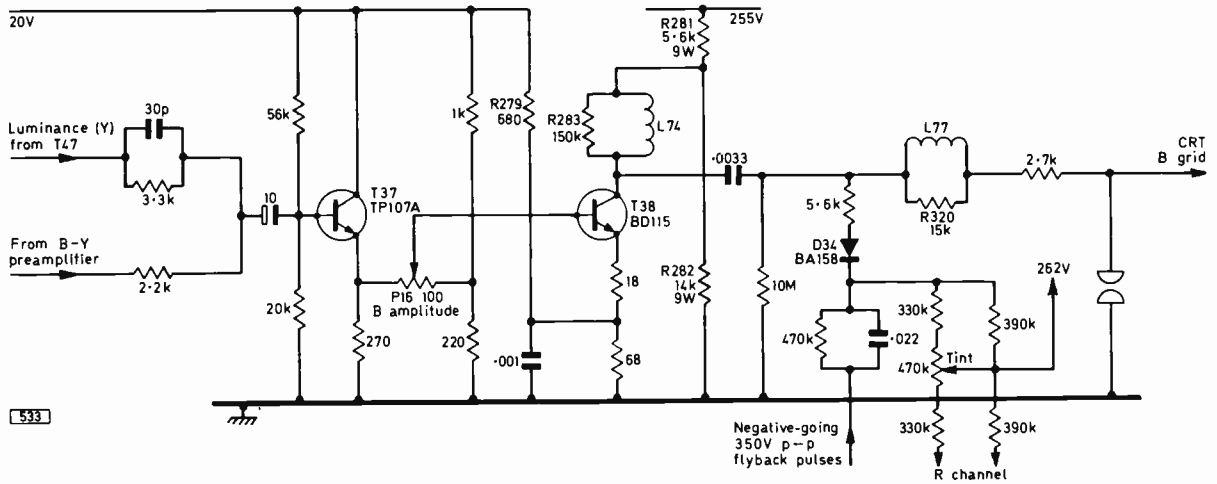


Fig. 2: Circuit of the B channel. The R, G and B output stages drive the grids of the shadowmask tube.

signal which has a fixed d.c. level. Brightness is controlled by adding flyback pulses to the signal: these are clipped by D24 so that variations in line output stage operation do not alter the brightness and adjusted in amplitude by the brightness control potentiometer P15. As a result of the action of the clamps in the RGB output stages the whole picture content shifts with variation in the level of the pulses added to the signal via the brightness control.

### B Channel

The final luminance stage is an emitter-follower T47 which drives via parallel RC combinations and a.c. coupling the first stage in each of the R, G and B channels. The circuit of the B channel is shown in Fig. 2. The first stage T37 is an emitter-follower which feeds the output transistor T38 via a drive control which again is of the type which maintains a constant d.c. level. To obtain the required high-voltage output swing T38 collector is fed from a potential divider R281/R282 connected between the 255V rail and chassis—use of a potential divider also provides protection by limiting the maximum collector voltage. The d.c. working conditions of the output transistor are stabilised by the current fed from the 20V line via R279 to the emitter circuit of the transistor. The collector load consists of the parallel combination L74/R283 in series with R281 and R282 which from the signal point of view are in parallel. The output signals are a.c. coupled to the c.r.t. grid, with L77/R320 providing h.f. boost.

### Output Clamps

As a.c. coupling is used it is necessary to clamp the signals. As, most unusually, the c.r.t. cathodes in these receivers are at virtually zero (chassis) potential the grids must be at a considerable negative voltage in order to establish the required working bias. The d.c. potential is developed by the action of the clamps—D34 in the blue channel—which are driven into conduction during the line blanking periods by  $-350\text{V}$  flyback pulses and charge the signal coupling capacitors to a potential which is

determined by the amplitude of the brightness pulses applied to T33 base.

### Beam Limiting & Spot Suppression

Having seen then how the contrast and brightness controlled RGB signals reach the c.r.t. grids let us next take a look at the simple but unique c.r.t. cathode circuit which provides beam current limiting and prevents switch-off spots. This is shown in Fig. 3. The three cathodes are connected together and returned to chassis via R330 and the beam limiter diode D37. This diode is forward biased as a result of a current drain of about 1.3mA via R331 from the  $-264\text{V}$  developed across C267 by the rectifier D38. In this way D37 is kept conductive so long as the total beam currents drawn by the tube do not exceed 1.3mA. If the beam current does rise excessively D37 is no longer forward biased and acts as a high-value resistor thus limiting the beam current.

At switch-off S1 which is ganged to the mains switch applies the  $-264\text{V}$  across C267 to the c.r.t. cathodes, causing a considerable beam current to flow and discharge the e.h.t. capacitance before the time-base scans completely collapse. This of course prevents switch-off spot formation.

### EHT Stabilisation

Thought of the e.h.t. system brings us to the unusual

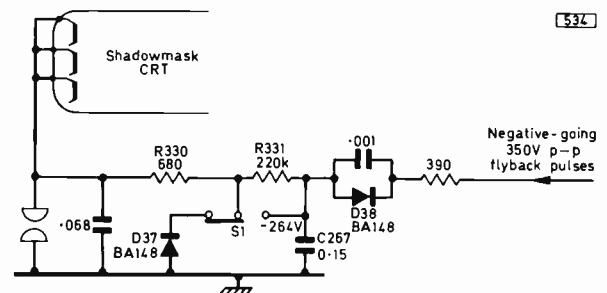


Fig. 3: Beam current limiting and switch-off spot suppression are provided in the c.r.t. cathode circuit.

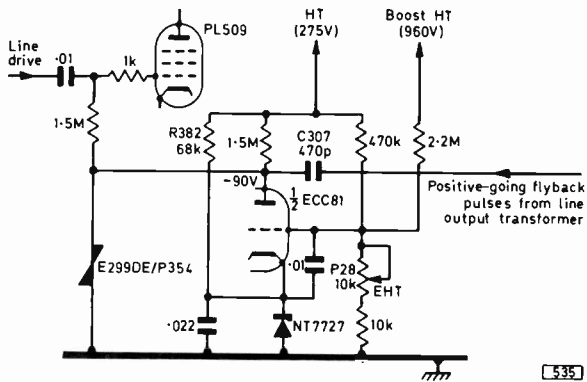


Fig. 4: The line output stage stabilisation circuit.

triode circuit which is used to stabilise the output from the PL509 line output valve. It is of course particularly important to stabilise the line timebase in a colour receiver since variation in output produces such noticeable effects on e.h.t. and convergence. The circuit is shown in Fig. 4. The triode itself is stabilised by the zener in its cathode circuit and the current applied to this via R382. The operating point of the whole arrangement is set by the e.h.t. preset P28. The triode is triggered on by the flyback pulses applied to its anode via C307 and acts as a controlled (grid circuit) rectifier, charging C307 to a negative potential which is used as the bias for the line output valve. The degree to which the triode conducts is determined of course by the amplitude of the flyback pulses applied to its anode and the boost feed at its grid: as these increase so the triode conducts more heavily producing increased negative bias to reduce the output from the PL509. If the triode fails the e.h.t. is limited to a safe level by the v.d.r. in the circuit. A tripler is used for e.h.t. rectification.

### Sync Circuit

Considerable care has been taken over the sync circuits which employ three transistors—see Fig. 5. The sync separator itself, T14, produces positive-going sync pulses across its load resistor R124: these are then fed to the pulse shaper T43. Since

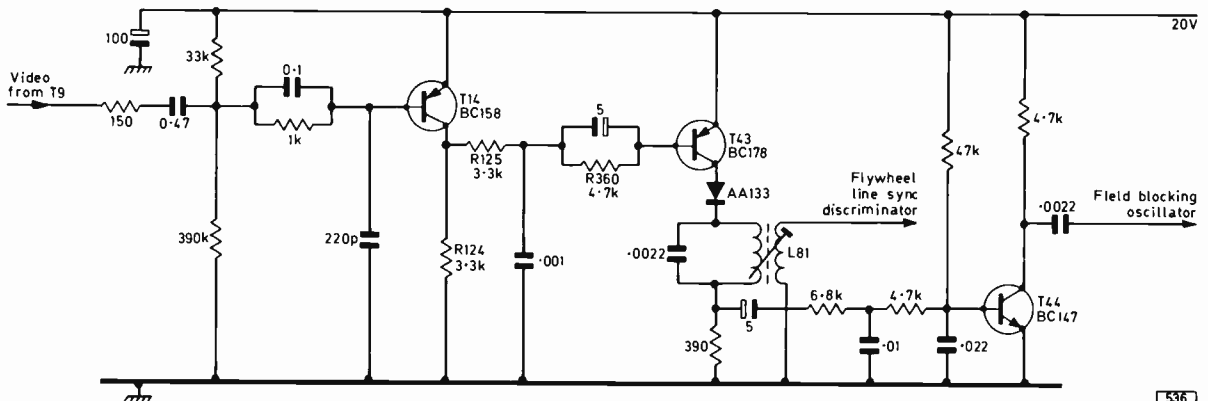


Fig. 5: The three-stage sync separator/pulse amplifier circuit. The positive-going pulses at T44 collector are applied to the grid of the field blocking oscillator: this stage drives the field output pentode via a triode amplifier/driver stage.

T43 emitter is connected to the 20V rail while its base is connected to chassis via R360/R125/R124 it is heavily conducting during picture information: the positive-going pulses from T14 switch it off however giving negative-going pulses in the collector circuit of T43. These are tapped off by L81 and fed to a conventional double-diode flywheel sync circuit which controls a sine-wave oscillator line generator stage. The field sync pulses are taken via integrating circuits to the field sync pulse amplifier stage T44. This stage is also operated in the saturated mode except when the negative-going field sync pulses arrive to switch it off and produce positive-going pulses at its collector. Though transistors take rather longer to switch off than to switch to full saturation this is of no importance in the present application.

### PAL V Switch

The subject of switching brings us to the PAL switch circuit used in this receiver—see Fig. 6. For PAL switching either the V chrominance signal or the reference signal feed to the V synchronous detector must be inverted on alternate lines. The former, less common, technique is used here. The V signal from the PAL delay line circuit is applied to a phase-splitter stage T31. Whether the output is taken from the collector or emitter of this stage to the V amplitude control P14 depends on which of the two diodes D22 or D23 is conducting. These two diodes are switched on alternately on alternate lines by the squarewave fed to them via R219/C221/R239/R240 from the bistable circuit. In this way the alternate line phase inversions of the transmitted V signal are removed—readers may recall that we found a similar arrangement in use in the ITT-KB CVC5 chassis which was the first to be covered in this series (see TELEVISION March 1972).

### Miscellaneous Features

The V amplitude control P14 operates as a potentiometer from the signal point of view, its top end being earthed by C218. As it is only 2k $\Omega$  adjusting it has very little effect on the bias applied to T32. This bias incidentally is obtained from the emitter resistor of one of the U chrominance signal amplifiers. As the



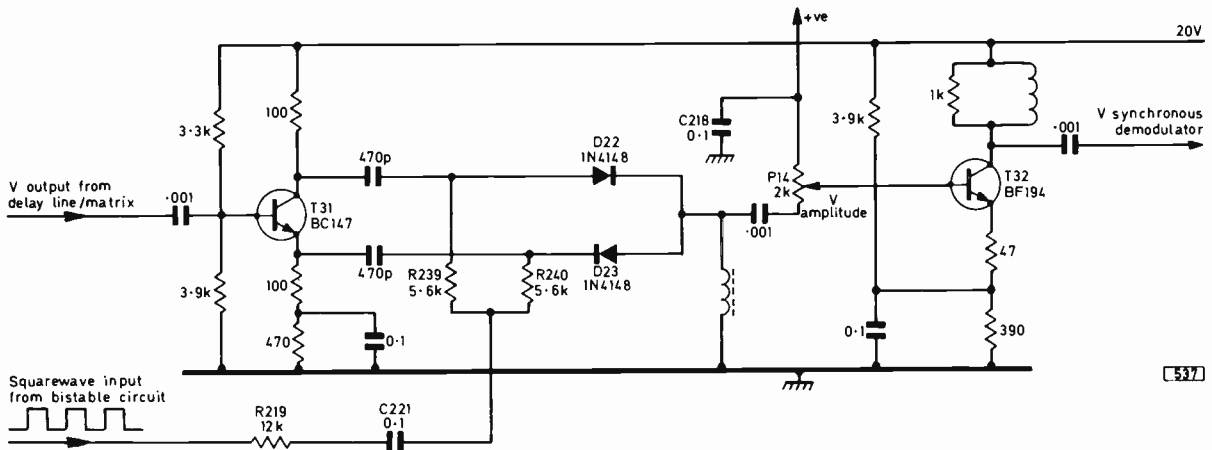


Fig. 6: The PAL V switch circuit.

colour-killer action is applied to this latter stage T32 is without bias on monochrome.

The colour-killer potential is obtained by rectifying the ident signal: the resultant voltage operates a Schmitt trigger circuit which provides the bias potentials required. One feed is taken to the R output stage, slightly tinting the overall tone towards red to improve flesh colouration.

All told this is a well made and designed chassis incorporating many novel circuit features. There is a reasonable PCL86 audio stage with a tweeter and a

tone control. To suppress noise at switch on when the receiver is operating at full gain, that is before the gated a.g.c. circuit comes into operation, the audio channel is muted until the line timebase comes into operation: the technique used is similar to that described in *Circuit Notes*, page 515, September 1972 but in this chassis a.c. from the power supply circuit is used to derive the negative muting voltage applied to the grid of the triode audio amplifier stage.

In all there are six front-mounted controls: brilliance, contrast, saturation, volume, tone and tint.

## SERVICING TV RECEIVERS

—continued from page 169

over to the screening). Unfortunately the AU103 cannot be checked in circuit as its base and emitter are coupled by L2057: it is not difficult however to cut the track to the base for test purposes and fit a wire link which will make future checks that much easier.

### Line Timebase Faults

The following are the maker's suggestions for fault tracing in the line timebase.

*Uncontrollable speed:* R4091 open-circuit.

*Uncontrollable speed with excess current being drawn:* T2022 short-circuit.

*System speeds not matched:* Adjust L2050-2.

*Raster folding over in centre after few minutes:* L2056-7 reversed on print.

*No raster and excess current:* T2025 short-circuit, usually caused by some other fault e.g. DY51 flashing over; X2013 (boost diode), X2014, X2015 or X2016 short-circuit; deflection coils faulty; line speed wrong.

*Weak line sync:* T2022 faulty; X4011 or X4012 open-circuit or high-resistance.

*Wrong line speed:* Short-circuit turns in L2050-2; T2023 faulty.

*No line scan, T2023 overheating:* Check T2022.

*No line output:* T2025 short-circuit; faulty line output transformer; T2024 faulty; L2056-7 faulty.

*Picture cramping in middle of screen:* C2099 open-circuit; matching transformer L2079-81 faulty or open-circuit.

*Low T2025 emitter voltage:* C2096 open-circuit or intermittent.

### Access

When the rear cover is removed (two screws) and the shell is lifted off it will be seen that the print side of the panels is presented. Most component replacement can be carried out by removing the appropriate panel fixing screws (one near contrast control and one each side lower down) and easing the panel out slightly. If necessary turn the receiver on its side and release the system switch screw. The tabs on the front of the i.f. panel locate into the frame. The complete front moulding is held by four screws (one is a self-tapper) and once these are removed and the speaker leads unclipped from the speaker the whole front can be taken off. There are two further screws which connect the panels together, also one which fixes the timebase panel to the frame. If the receiver is operated with the panels loose from the frame make sure that the e.h.t. rectifier cannot arc over to the frame or screening as the price for this is almost certainly a new line output transistor and this is no joke.

### Location of Components

It is sometimes difficult to locate a particular transistor or component on one of the panels, at first sight at any rate. Some time must be taken therefore to study the layout of the print, noting the base, emitter and collector contacts and the particular shape of the print at these points to confirm that the transistor or component is the correct one.

CONTINUED NEXT MONTH

# CRT

## REJUVENATOR

L.COX

The circuit of a simple, inexpensive monochrome c.r.t. rejuvenator that has been built and used successfully on numerous occasions is shown in Fig. 1: the basic idea is to connect the grid and cathode of the c.r.t. into the circuit as a diode, the flow of grid current reactivating the cathode. The device has been used on all sizes of tubes, including modern 24in. ones: there have been only two failures and these were only to be expected since one tube gave a reading of only 3V across its heater while the other had an intermittent cathode connection.

The basic procedure for using the rejuvenator is to switch the set off and remove the c.r.t. base, then fit the base from the rejuvenator to the c.r.t. and plug the rejuvenator into the mains. The 100W

bulb will light up immediately of course since it provides the heater supply: it is essential to use a 100W type and it is advisable to paint the bulb to reduce glare. The current flowing in the tube will produce various degrees of fireworks—depending on the c.r.t.'s age and condition—in the neck of the tube. The essential thing is to watch the pygmy bulb which will flash intermittently while the bombardment in the c.r.t. neck is going on: once this bulb glows brightly and continuously the c.r.t. should be fully reactivated.

If when the set is reconnected again the picture still seems silvery a second session with the rejuvenator should sort the problem out. The old tried and tested method of tapping the c.r.t. neck to remove loose particles prior to using the device is helpful with some older tubes. Obstinate cases may require two or three applications before best results are obtained.

Use of the reactivator has often resulted in tubes with hardly a glimmer of life being restored to as new. Note that due to the increased efficiency of the c.r.t. after rejuvenation a new e.h.t. rectifier (and in rare cases a line output valve) is often necessary (DY87, EY87 etc.), especially in older sets where they are running low but operate quite happily until called upon to do some real work. ■

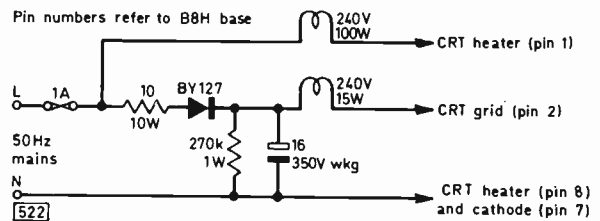


Fig. 1: Circuit of the c.r.t. rejuvenator.

## LINE OUTPUT VALVE CHECKS

by K. J. Young

THE line output valve is one of the most important parts in a television set. It is however one of the most difficult components to check in operation as the high-amplitude pulses present at the anode make it risky to use a voltmeter or oscilloscope at this point. Servicing data often shows the shape and amplitude of the waveform to expect at the grid so that the drive can be checked using an oscilloscope (the receiver under test should be fed from a double-wound isolating transformer when this is done). This is a very useful check since if it is found that the grid drive is insufficient then we know immediately that the cause of the fault must be sought earlier in the circuit: we also get a warning not to continue operating the line output valve under these conditions.

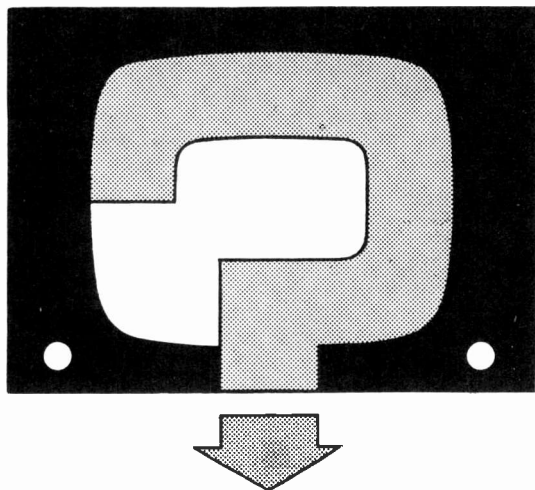
It is nevertheless feasible—provided the set is fed from a double-wound isolating transformer—to use an oscilloscope in conjunction with a resistor-capacitor potential divider to observe the anode pulse waveform. Say the grid leak resistor of the oscilloscope's Y amplifier input stage is  $1M\Omega$ : this could be shunted with a  $470pF$  earth-isolation ceramic

capacitor to form the lower arm of the potential divider, the upper arm, between the top cap of the line output valve and the scope's Y input, consisting of  $20M\Omega$  (two  $10M\Omega$  resistors in series) with a  $22pF$  disc (ionisation free) ceramic capacitor in parallel. The amplitude of the pulse will then be divided by 20.

It is better however to monitor the line output valve anode current pulse by using a small current transformer, preferably of the bar-primary toroidal type. This can be made using a ferrite ring on which about 50 turns of 26 s.w.g. enamelled wire have been wound. This forms the secondary, the ends being taken for tags for connection to the scope (do not connect the scope to the receiver chassis). A tube of tufnol or other reliable insulation, if possible of internal diameter such that the top cap and lead of the line output valve can be passed through (with the set switched off!), is then fitted inside the wound ferrite ring.

If this set-up is first calibrated using a receiver in good working order the results obtained with faulty receivers can be readily interpreted. The effect of ringing for example should show clearly.

If a shorted turn in the line output transformer is suspected it is usually best to check by substituting a known good transformer or to make a separate test with the receiver switched off. ■



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## PHILIPS 19TG155A

There is good sound on both u.h.f. and v.h.f. but no vision. The e.h.t. is not present and no line whistle is audible. The line timebase valves have been replaced but the problem persists.—B. Palmer (Chesterfield).

There are two boost capacitors C415 and C416 (both  $0.05\mu\text{F}$ ) at the bottom of the timebase panel under the PCL85. If removing the top cap of the PY800 boost diode restores some degree of line timebase working replace these capacitors or whichever is shorted—we usually fit in place of both a single  $0.1\mu\text{F}$  one rated at 1kV. If there is no difference when the PY800 top cap is removed check the line output valve screen feed resistor (R458  $2.2\text{k}\Omega$  wirewound) which is mounted above the boost capacitors. If there is some sign of overheating in the PL36 and PY800 fit another ECC82 line multivibrator valve (V404) and take voltage readings in this stage to find out where the fault lies.

## GEC 2040

Although this is a new set the sharpest picture is produced when the push-button is very loosely tuned. At this setting only the two top test card gratings are resolved. With tighter tuning the picture becomes fuzzy because of faint lines to the right of objects. With all the gratings clearly resolved there is streaking and smearing. These effects are experienced on all channels and the picture is otherwise smooth and normal. The aerial installation has been checked by connecting up another set which displayed a faultless picture.—J. Hall (Reading).

We suggest slight adjustment of the final i.f. coil which feeds the detector. This is L106 which is the top core of T103.

## FERGUSON 508T

The picture comes on normally but within a few minutes shrinks and then goes very dark. The line timebase valves have been replaced without improving matters.—R. Owen (Cirencester).

We suspect the line output valve screen feed resistor R84 ( $2.2\text{k}\Omega$ ). This is at the front right of the lower deck, near the PY81.

## PYE V220

The field hold is causing trouble. The picture can be locked when the set is first switched on if the field hold control is rotated to one extreme but after about five minutes the picture rolls rapidly and this can only be stopped by letting the set cool down. All likely valves have been replaced.—R. Charlesworth (Richmond).

The common cause of poor field sync on this chassis is loss of capacitance in C53 ( $180\text{pF}$ ) in the input circuit of the field sync pulse shaper (V13B). This allows line sync pulses into the field sync circuit.

## FERGUSON 3646

The trouble with this set is corona—arcing at the e.h.t. connection. I would welcome your advice on dealing with this.—G. Tweed (Rugby).

If the discharge is at the tube end of the e.h.t. lead you should clean around the connection, smear with silicone grease and replace. If the discharge is at the e.h.t. multiplier tray end the output lead should be straightened and the connection impregnated with rubber compound or the tray completely replaced.

## DECCA CTV25

There is a line timebase fault on this set. The castellations and half the first row of squares on the left-hand side of the test card are missing. There is however no sign of a bright line down the side of the picture or of foldover. The line linearity is also somewhat off, the picture being slightly more cramped progressively towards the left-hand side. Also during the first three minutes of use the picture expands towards the left by about  $\frac{3}{4}$  in. We have replaced the line output valve without improving matters.—R. Withey (Thirsk).

It seems that the PY500 efficiency diode V400 is losing emission. Replacement should cure the problem. Note also that the line output valve is a.c. coupled to the line output transformer, the coupling capacitor being C415 ( $2\mu\text{F}$ ): this may also be in need of replacement.

**GEC 2018**

The picture appears momentarily about 30 seconds after switching on. The screen then blacks out, the picture returning after about three minutes accompanied by spiral flashes up the centre of the screen for a few seconds. The sound is OK throughout this. Reception is very good once the picture has settled down, all controls working correctly. The line time-base valves have all been replaced without clearing the trouble.—H. Sideshaw (Eccles).

The connections to the scan coil plug should be carefully examined, also the print on the timebase panel, for an intermittent contact or dry joint.

**EKCO T418**

The trouble with this set seems to lie in the system switching. BBC-1 and ITA are normal but on changing over to u.h.f. only a narrow vertical line about  $\frac{1}{2}$ in. wide (which appears to carry the picture modulation) appears.—T. Bolton (Sudbury).

The changeover switch is likely to be the trouble and its action can be inspected by lowering the chassis and working the cam by hand. Each individual contact can be checked by shorting across it with the blade of a screwdriver: if the contacts concerned are making this action should make no difference. When replacing the chassis ensure that it does not couple to the tuner 180° out of phase.

**GEC 2028A**

The problem with this set was originally lack of width. This was cured by replacing the 5.6M $\Omega$  resistor R704 in the width circuit but now the raster is very faint and the controls have little effect. The sound is OK.—T. Railton (Cheam).

The v.d.r. in the width circuit could be faulty: as a temporary measure try substituting a 1M $\Omega$  resistor. Check that the cathode voltage of the line output valve is approximately 2.6V and that there is 2.7V at the emitter of the beam current limiter transistor Tr34.

**EKCO T521**

There is no sound or vision, uncontrollable brightness and the valve heaters are glowing too brightly—especially when the set is first switched on. The valves have been checked and there are no signs of any burnt out resistors or any other clues.—P. Ridgeway (Norwich).

It is more likely that the heater chain rectifier D11 (BY126) is short-circuit. This will remove the d.c. to the transistor stages and increase the voltage across the heater chain.

**PYE CT73**

On colour the picture is all right until an area of high saturation is present. The high saturation area is then covered with "interference fringes", i.e. a series of dark and light bands which change shape and direction continuously. If the area has a caption with sharp edges and high saturation the colour almost disappears beneath the interference, leaving the area substantially desaturated. At its most severe

the lettering and surrounding area change to a monochrome picture which tends to pull towards the right-hand side of the screen. These faults can be lessened by tuning away from the nominal position but then when lettering or any fine detail appear there is loud buzzing from the sound channel. These effects are not present on black-and-white and the saturation control has no effect on the fault. Even in the nominal tuning position most areas on the screen seem to show too much noise and cross-patterning.—P. Wilcox (Maidstone).

The symptoms outlined strongly suggest misalignment of the sound traps in the i.f. circuitry so that sound-colour beat patterns are being produced. The coils to adjust are L10 and L3b on the i.f. strip.

**SOBELL 1028A**

The fault on this 19in. colour set is field jitter on peak whites, especially on ITV advertisements. This occurs on u.h.f. only.—G. Palmer (Willesden).

We suggest you check the electrolytic C120 (160 $\mu$ F) in the a.g.c. circuit, mounted on the i.f. panel. On the timebase panel the sync separator/field sync pulse clipper valve PCF80 should be checked, also the field charging capacitor C522 (0.1 $\mu$ F).

**HMV 2618**

When the set is first switched on the field slips two or three times. The picture then settles down for twenty minutes or so after which there will be another slip, then further slips getting more frequent the longer the set is on. The field hold is otherwise good and the line hold steady.—P. Chesterton (Stockton).

If the setting of the field hold control is not critical it appears that the problem is due to an intermittent fault in the PCL805 field timebase valve which should therefore be changed.

**KB KV125**

There is a gap of about 4in. at the top and bottom of the screen. The PCL85 field timebase valve has been changed without improving matters and the h.t. voltage checked and found to be OK.—T. Wardle (Hull).

Check the boost feed to the height control: a common cause of lack of height in these KB receivers is the boost line decoupler C134 (0.1 $\mu$ F 750V). This decouples the boost rail to the h.t. line and frequently shorts so that the voltage to the height control is reduced to that of the h.t. line. Also check the output stage cathode decoupler C84 (100 $\mu$ F).

**FERGUSON 3645**

This set, fitted with the BRC 1400 chassis, exhibits an intermittent tendency to undulate, i.e. wave sideways.—E. Winder (Preston).

The most likely cause of the sideways motion is poor smoothing. To overcome this you will have to replace the main electrolytic block C120/C121 etc. On occasions however we have found the 30FL14 (PCF808) to be responsible for this trouble.

**FERRANTI T1125**

When the set is switched to u.h.f. the PL36 overheats: there is no picture, the raster balloons and goes blank. When the set is switched back to v.h.f. the PL36 cools down and the picture returns to normal but with a slight lack of contrast. The line timebase valves have all been renewed.—T. Brown (Weymouth).

It appears that the system switch contacts are faulty in the 625-line position. Alternatively the 625 line hold control could be open-circuit. The centre PCL84 video amplifier or a resistor associated with this stage is likely to be the cause of the lack of contrast.

**PYE 40F**

A picture cannot be resolved at all on 625 lines, while on Bands I and III the picture is covered with snow. I have checked the voltages in the i.f. strip and the feeds to the tuner and all seems OK here. Could the fault be in the tuner?—G. Fineson (Glasgow).

The usual cause of these symptoms is failure of the r.f. transistor (type AF186) in the integrated tuner: fit the replacement exactly as the original was positioned.

**GEC 2040**

The trouble with this 19in. colour set is that the red gun appears to switch out intermittently. When this happens green becomes predominant. This trouble is a sort of intermittent weakening of red but after a while the fault stabilises and remains.—P. Horgan (London NW10).

The symptom you describe suggests that the bistable driving the PAL switch is faulty. The circuit consists of the transistors Tr332 and Tr333, both type BC148. The voltages for each transistor should be the same, i.e. collector 7.5V, base 0.4V, emitter 0V. Since you seem to have plenty of colour the ident amplifier must be OK but the coupling between this and the bistable, i.e. C351 (0.022 $\mu$ F) and D313 (OA91), could be faulty: this is less likely than a bistable fault however.

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**TELEVISION FEBRUARY 1973****TEST CASE****122**

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.

? The field technician brought into the workshop a Murphy V2417S receiver with the complaint of intermittent line timebase operation. He observed that after twenty minutes at the customer's house examining the receiver—upon which the picture was initially fault-free—the line scan suddenly collapsed to a vertical line which then faded out leaving the screen blank. Attention was directed to the line timebase valves and finding the electrodes of the line output valve red hot he thought this valve was at fault. The valve was replaced and the receiver then operated normally for several minutes before the picture faded again, leaving the original symptom, the replacement valve exhibiting abnormal temperature.

In the workshop the receiver worked normally for several hours before the fault occurred and it was then discovered that normal working could be restored by quickly switching the receiver off and

then on again. The intermittency remained however but during the fault condition simple observation gave good clues as to the whereabouts of the fault area. What could these clues have been and why was the field technician's initial "test" inappropriate? See next month's TELEVISION for the solution and for a further item in the Test Case series.

**SOLUTION TO TEST CASE 121****Page 138 (last month)**

Vertical lines of interference synchronised to the line scan certainly signify arcing in a line timebase component during the flyback period. This classic symptom is often caused by impaired winding insulation in the line output transformer. The technician failed however to take into account the changed shape of the raster. Before replacing the line output transformer he should have checked for signs of arcing in the scan coil assembly: quite high amplitude pulses occur in some receivers across the line coils and when the field coils are at low potential a discharge can occur between the two sets of coils due to poor insulation. Such trouble would of course produce the vertical lines of interference and unlike similar trouble in the line output transformer would also account for the wedge-shaped raster.

In the case in question replacement coils cured the fault. Raster distortion of the type illustrated last month therefore is an almost conclusive indication of shorting in the scan coil assembly.

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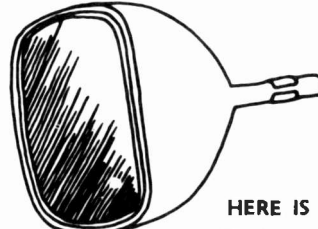
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and similar sets supplied  
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plete £4 carr. £1.50

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## ALBA

|       |         |
|-------|---------|
| T1090 | T1435   |
| T1095 | TD1420  |
| T1135 | TD1435  |
| T1195 | TD1824  |
| T1235 | TS 1320 |
| T1395 | TS 1724 |

## BAIRD

|     |     |     |     |
|-----|-----|-----|-----|
| 600 | 628 | 662 | 674 |
| 602 | 630 | 663 | 675 |
| 604 | 632 | 664 | 676 |
| 606 | 640 | 665 | 677 |
| 608 | 642 | 666 | 681 |
| 610 | 644 | 667 | 682 |
| 612 | 646 | 668 | 683 |
| 622 | 648 | 669 | 685 |
| 624 | 652 | 671 | 687 |
| 625 | 653 | 672 | 688 |
| 626 | 661 | 673 |     |

Please quote part No. normally found on tx. base plate; 4121, 4123, 4140 or 4142.

## COSSOR

|         |         |            |
|---------|---------|------------|
| CT1700a | CT1975a | CT1962-77* |
| CT1910a | CT1976a | CT1954-77* |
| CT1911u | CT2100u | CT1964-78* |
| CT1921a | CT2310a |            |
| CT1922a | CT2311a |            |
| CT1935a | CT2321a |            |
| CT1937a | CT2331a |            |
| CT1938a | CT2372a |            |
| CT1972a | CT2373a |            |
| CT1973a | CT2375a |            |
| CT1974a | CT2378a |            |

\*Two types fitted one has pitch ø/w, the other has plastic moulded overwind—please state which type required as they are not interchangeable.

## BUSH

|              |                 |
|--------------|-----------------|
| TUG versions | TV125           |
| TV75 or C    | TV125U          |
| TV76 or C    | TV128           |
| TV77         | TV134           |
| TV78         | TV135           |
| TV79         | TV135R          |
| TV83         | TV138           |
| TV84         | TV138R          |
| TV85         | TV139           |
| TV86         | TV141           |
|              | TV145           |
|              | TV148           |
|              | TV161           |
|              | TV162           |
|              | TV165           |
|              | TV166           |
|              | *TV171          |
|              | TV175           |
|              | TV176           |
|              | TV178           |
|              | 1815            |
|              | 183             |
|              | 183D            |
|              | 183C            |
|              | 1835S           |
|              | TV103 or D      |
|              | TV105 or D or R |
|              | TV106           |
|              | TV107           |
|              | TV108           |
|              | TV109           |
|              | 1865S           |
|              | TV112C          |
|              | TV113           |
|              | TV115 or C or R |
|              | 1915            |
|              | TV118           |
|              | TV123           |
|              | TV124           |

From model TV123 to TV139 there have been two types of transformer fitted. One has pitch overwind, the other has plastic moulded overwind. Please state which type required as they are not interchangeable.

## PYE

|                   |                         |
|-------------------|-------------------------|
| 1                 |                         |
| 2                 |                         |
| 3 or u            |                         |
| 11u Series        |                         |
| 11u               | State Pt. No. required— |
| 12u               | AL21003 or 772494       |
| 13u               |                         |
| 14u               |                         |
| 15u               |                         |
| 20u               |                         |
| SP17              | 62                      |
| 21f or uf         | 63                      |
| 22uf              | 64                      |
| 23uf              | 68                      |
| 24uf              | 75                      |
| 31uf              | 76                      |
| 35uf              | 77                      |
| 36                | 80                      |
| 37                | 81                      |
| 40f               | 83                      |
| 48                | 84                      |
| 49                | 85                      |
| 53                | 86                      |
| 58                | 95                      |
| 59                | 96                      |
| 61                |                         |
| PV110             | State Pt. No. required— |
| V110              | 771980 or 772013        |
| V210 or A         |                         |
| V220              |                         |
| V410 or A         | State Pt. No. required— |
| V420              | 771927 or 771920        |
| V430A             |                         |
| V510              |                         |
| V530              |                         |
| V200 or LB        |                         |
| V300s             |                         |
| V310 or s         |                         |
| V400              |                         |
| V600              |                         |
| V620              |                         |
| V630              |                         |
| V700 or A or D    | State Pt. No.           |
| V710 or A or D    | required—               |
| V830A or D or LBA | 772444 or 771935        |

## PHILLIPS

|          |          |          |
|----------|----------|----------|
| 1768u    |          | 19TG122a |
| 1792u    | Exchange | 19TG123a |
| 1796u    | Units    | 19TG124a |
| 2168u    |          | 19TG133a |
| 2192u    |          | 19TG142a |
| 2196     |          | 19TG148a |
|          |          | 19TG152a |
|          |          | 19TG153a |
|          |          | 19TG154a |
|          |          | 19TG155a |
|          |          | 19TG156a |
|          |          | 19TG158a |
|          |          | 19TG164a |
|          |          | 19TG170a |
|          |          | 19TG171a |
|          |          | 19TG172a |
|          |          | 19TG173a |
|          |          | 19TG175a |
|          |          | 19TG176a |
|          |          | 19TG177a |
|          |          |          |
|          |          |          |
| 21TG100u | G19T210  | G23T210  |
| 21TG102u | G19T211  | G23T211  |
| 21TG106u | G19T212  | G23T212  |
| 21TG109u | G19T213  | G24T230  |
| 23TG107u | G19T214  | G24T232  |
| 23TG111a | G19T215  | G24T236  |
| 23TG113a | G20T230  | G24T238  |
| 23TG121a | G20T232  | G24T300  |
| 23TG122a | G20T236  | G24T301  |
| 23TG131a | G20T238  | G24T302  |
| 23TG142a | G20T300  | G24T306  |
| 23TG152a | G20T301  | G24T307  |
| 23TG153a | G20T302  | G24T308  |
| 23TG156a | G20T306  |          |
| 23TG164a | G20T307  |          |
| 23TG170a | G20T308  |          |
| 23TG171a |          |          |
| 23TG173a |          |          |
| 23TG175a |          |          |
| 23TG176a |          |          |
| 23FG632  |          |          |

## ALL MAKES OF COLOUR TRANSFORMERS IN STOCK

|    |       |       |       |       |       |      |      |      |      |      |
|----|-------|-------|-------|-------|-------|------|------|------|------|------|
| GE | BT302 | BT314 | BT321 | BT336 | BT449 | 2000 | 2015 | 2022 | 2043 | 2064 |
| GE | BT303 | BT315 | BT322 | BT337 | BT450 | 2001 | 2017 | 2023 | 2044 | 2065 |
| GE | BT304 | BT316 | BT324 | BT342 | BT451 | 2010 | 2018 | 2032 | 2047 | 2066 |
| GE | BT305 | BT318 | BT326 | BT346 | BT452 | 2012 | 2019 | 2033 | 2048 | 2082 |
| GE | BT308 | BT319 | BT328 | BT347 | BT455 | 2013 | 2020 | 2038 | 2063 | 2083 |
| GE | BT312 | BT320 | BT329 | BT448 | BT456 | 2014 | 2021 | 2039 |      |      |

|       |      |       |       |           |
|-------|------|-------|-------|-----------|
| DECCA | DR20 | DR34  | DR71  | DR505     |
| DECCA | DR21 | DM35  | DR95  | DR606     |
| DECCA | DR24 | DM36  | DR100 | 666TV-SRG |
| DECCA | DR29 | DM39C | DR101 | 777TV-SRG |
| DECCA | DR30 | DR41  | DR121 |           |
| DECCA | DR30 | DM45  | DR122 | MS1700    |
| DECCA | DM30 | DR49C | DR123 | MS2000    |
| DECCA | DR31 | DM55  | DR202 | MS2001    |
| DECCA | DR32 | DM56  | DR303 | MS2400    |
| DECCA | DR33 | DR61  | DR404 | MS2401    |

|        |             |             |         |      |
|--------|-------------|-------------|---------|------|
| SOBELL | T24         | ST284 or ds | 1010dst | 1033 |
| SOBELL | SC24        | ST285 or ds | 1012    | 1038 |
| SOBELL | TPS173      | ST286 or ds | 1013    | 1039 |
| SOBELL | TPS180      | ST287 or ds | 1014    | 1047 |
| SOBELL | ST195 or ds | ST288ds     | 1018    | 1048 |
| SOBELL | ST196 or ds | ST290ds     | 1019    | 1057 |
| SOBELL | ST197ds     | ST291ds     | 1020    | 1059 |
| SOBELL | SC270       | ST297ds     | 1021    | 1063 |
| SOBELL | T278        | 1000ds      | 1022    | 1064 |
| SOBELL | ST282       | 1002ds      | 1023    | 1065 |
| SOBELL | ST283       | 1005ds      | 1022    | 1066 |

|      |       |       |      |      |
|------|-------|-------|------|------|
| EKCO | TC403 | TC437 | TS13 | 531  |
| EKCO | 404   | T442  | 514  | T532 |
| EKCO | 406   | T500  | 515  | 533  |
| EKCO | T418  | TC501 | 520  | 535  |
| EKCO | TC419 | T502  | 521  | 536  |
| EKCO | T420  | 503   | 524  | 540  |
| EKCO | TC421 | 504   | 525  | 541  |
| EKCO | T422  | 505   | 526  |      |
| EKCO | 433   | 506   | 527  |      |
| EKCO | 434   | 510   | 528  |      |
| EKCO | TC435 | 511   | 529  |      |
| EKCO | T436  | 512   | 530  |      |

|          |      |        |        |        |       |
|----------|------|--------|--------|--------|-------|
| FERRANTI | 1075 | TC1122 | 1163   | 1155   | 1175  |
| FERRANTI | 1080 | 1123   | 1164   | TC1157 | 1176  |
| FERRANTI | 1081 | 1124   | 1165   | 1158   | T1181 |
| FERRANTI | 1082 | 1125   | T1174  | 1159   | T1182 |
| FERRANTI | 1083 | TC1126 | T1175  | TC1160 | T1185 |
| FERRANTI | 1093 | 1137   | TC1135 | 1162   | T1186 |
| FERRANTI | 1094 | T1154  | 1136   | 1163   |       |
| FERRANTI | 1095 | T1155  | 1137   | T1164  |       |
| FERRANTI | 1096 | 1157   | 1138   | T1165  |       |
| FERRANTI | 1097 | 1159   | 1140   | 1174   |       |
| FERRANTI | 1121 | 1160   | T1154  | 1174   |       |

|    |        |               |                 |       |       |       |
|----|--------|---------------|-----------------|-------|-------|-------|
| KB | PVP20  | QV30 (90°)    | WV90            | SV20  | KV055 | KV136 |
| KB | WV05   | QV30FM (110°) | MV100/I         | SV30  | 056   | 138   |
| KB | KV001  | QV30-I        | OF100           | SV042 | 065   | 155   |
| KB | KV002  | 30            | PV100           | SV048 | 066   | 156   |
| KB | KV005  | NV40          | KV101           | SV054 | 113   | 165   |
| KB | KV006  | NF60          | KV105           | SV142 | 114   | 166   |
| KB | RV10   | RV60          | KV107           | SV143 | 124   |       |
| KB | O15    | WV60          | 115             | SV148 | 125   |       |
| KB | TV15   | XV60          | 117             | MV818 | 126   |       |
| KB | O17    | NF70 or FM    | 119             | MV819 | 127   |       |
| KB | QV20   | PV70          | KT400A          | MV903 | 134   |       |
| KB | WV20-I | QV70          | } VCI or VC2    |       |       |       |
| KB | RV20   | RV70          | KT405A          | }     |       |       |
| KB | TV20   | VV70          | by chassis No.— |       |       |       |
| KB | WV20   | WV70          | VCI             | VCA   | VC52  | VC200 |
| KB | QVP20  | WV75          | VC2             | VC5   | VC53  |       |
| KB | OVB30  | QF80          | VC3             | VC51  | VC100 |       |

|        |            |       |             |        |         |         |
|--------|------------|-------|-------------|--------|---------|---------|
| MURPHY | V430       | V520  | V879 or C*  | V789   | V20155S |         |
| MURPHY | V310       | V430C | V923*       | V153   | V20165S |         |
| MURPHY | V310AD     | V430D | V530C       | V159   | V20175S |         |
| MURPHY | V310AL     | V430K | V530D       | V973C* | V173    | V2310   |
| MURPHY | V310CA     | V440  | V539        | V979*  | V179    | V2311C  |
| MURPHY | V320       | V440D | V540        | V653X  | V1910   | V2414D  |
| MURPHY | V330 or D  | V440K | V540D       | V659   | V1913   | V2415D  |
| MURPHY | V330F or L | V470  | V649D       | V683   | V1914   | V2415S  |
| MURPHY | V410       | V480  | TH2 Chassis | V739   | V2014   | V24155S |
| MURPHY | V410K      | V490  | V843*       | V753   | V2014S  | V2416D  |
| MURPHY | V420       | V510  | V849*       | V783   | V2015D  | V2416S  |
| MURPHY | V420K      | V519  | V873*       | V787   | V20155  | V24175  |

\*Two types fitted. One has pitch overwind, the other has plastic moulded overwind. Please state which type required as they are not interchangeable.

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| 900  | 981                              | 982        | 5 stick £3.70 each |
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| £3.00 each   | £3.70 each                       | £3.00 each |                    |
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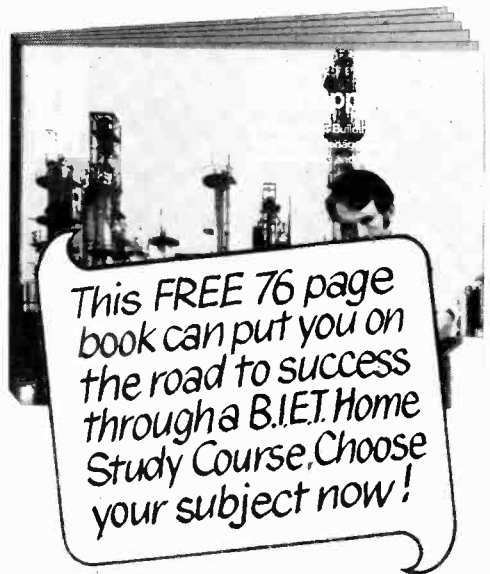
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