TELEVISION SERVICING HANDBOOK

GORDON J. KING
Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S.

TELEVISION
SERVICING HANDBOOK

2230/26

Books on Radio and Television

by Gordon J. King

F.M. RADIO SERVICING HANDBOOK

THE HI-FI AND TAPE RECORDER HANDBOOK

RADIO AND TELEVISION TEST INSTRUMENTS

RADIO AND AUDIO SERVICING HANDBOOK

THE PRACTICAL AERIAL HANDBOOK

SERVICING WITH THE OSCILLOSCOPE

RAPID SERVICING OF TRANSISTOR EQUIPMENT

BEGINNER'S GUIDE TO RADIO

BEGINNER'S GUIDE TO TELEVISION

COLOUR TELEVISION SERVICING

TELEVISION SERVICING HANDBOOK

GORDON J. KING
Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S.

LONDON
NEWNES-BUTTERWORTHS

THE BUTTERWORTH GROUP

ENGLAND	BUTTERWORTH and CO. (PUBLISHERS) LTD. LONDON: 88 Kingsway, WC2B 6AB
AUSTRALIA	BUTTERWORTH and CO. (AUSTRALIA) LTD. SYDNEY: 20 Loftus Street MELBOURNE: 473 Bourke Street BRISBANE: 240 Queen Street
CANADA	BUTTERWORTH and CO. (CANADA) LTD. TORONTO: 14 Curity Avenue, 374
NEW ZEALAND	BUTTERWORTH and CO. (NEW ZEALAND) LTD. WELLINGTON: 49/51 Ballance Street AUCKLAND: 35 High Street
SOUTH AFRICA	BUTTERWORTH and Co. (SOUTH AFRICA) (Pty.) LTD. DURBAN: 33/35 Beach Grove

First published 1958
Reprinted 1959, March 1960, July 1960
Second edition 1964
Reprinted 1965
Third edition 1970

Published in 1970 by Newnes-Butterworths,
an imprint of the Butterworth Group

ISBN 0 408 00033 3

T.365.R5.G.E.

MADE AND PRINTED IN GREAT BRITAIN BY
THE GARDEN CITY PRESS LIMITED
LETCHWORTH, HERTFORDSHIRE

Preface

In the course of a discussion about the servicing of television receivers and the instruments most often required by the service technician, those of us taking part were struck by the amount of useful information which can be obtained from a few simple tests made on a receiver with nothing more than a screwdriver, even before the connecting of instruments. Apart from performing its normal function, a screwdriver can serve as an indicator of high voltage, a producer of transient test signals, or a device for producing quick and reliable short circuits, while the handle—providing it is of the highly insulated type—will serve to produce vibrations which can be used to check suspect valves, components, soldered connexions and chassis sections. This book contains a number of references to this simple but efficient method of testing, which is practised probably by the majority of service engineers every day.

These remarks must not be taken as intended to disparage test instruments of the more conventional type. Indeed, specialized instruments are indispensable for full efficiency in the modern television service department, as will be made clear in the pages which follow.

As there always appears to be more work than time available in the service department, quick, short-cut methods for tracing faults are continually being evolved. Experience gained through regular practice in service work is, of course, the essence in this respect, the most successful technician being he who is able to locate a defective component or circuit section in the shortest time and with the minimum of effort. The actual repair operation usually entails far less time and trouble than finding the fault! Speedy fault diagnosis is also assisted by the logical association of the effects on a receiver's picture and sound as its main and pre-set controls are adjusted.

It is along these lines that this book has been written: the main emphasis is on the fault symptom. Locating the faulty part—as guided by the fault symptom—and the subsequent action to be taken follow in logical sequence. Although the correction of simple television-receiver faults is possible without a full understanding of the operation of the various circuits, the speedy correction of more complex faults—which are increasingly common in complex modern circuits—demands at least a working knowledge of each section concerned. Such information is also given in these pages.

It has been my aim throughout this book to deal with television servicing at an essentially practical level which will be appreciated most by the service engineer (particularly the radio service engineer who is just starting with television servicing), the amateur enthusiast, the apprentice and student.

I wish to record my thanks to the many manufacturers who have kindly supplied photographs and details of their equipment, and to my colleague Peter Berry, whose work in the photographic field has become well known, for his assistance in the preparation of certain photographs. In particular I must thank Mr. H. Read of Pye Ltd. and Mr. B. M. Whale of Mullard Ltd. for their much-valued information and photographs and for the use of equipment for testing, analysis and experimentation. Last, though far from least, my thanks go to my wife Barbara for her assistance in the preparation of the MS. and for her tolerance during many late hours when my attention was devoted solely to its writing.

The need for a third edition of this book has enabled me to include a large chapter on colour TV and to update some of the material in the other chapters. Aerials and feeders are omitted as they are adequately covered in *The Practical Aerial Handbook*.

Before I thoroughly examined the second edition for revision I felt that it might have been necessary to withdraw quite a lot of the earlier material, but, due to the advent of the 625-line-only set, much of the original text dealing with the 405-line standard continues to have relevance. There are significant differences between the two standards, of course, and these are highlighted in the chapters on u.h.f. bands, dual-standard and 625-line-only sets and transistor sets.

From the servicing viewpoint, however, there is not a great deal of difference between the basic principles involved. Indeed, some of the latest single-standard sets, both monochrome and colour, are found with circuits revived from the early 405-line-only days. We thus once again see sine wave line oscillators with electronic reactance control, gated vision a.g.c., d.c. restoration diodes and so forth!

Thus by leaving some of the earlier information intact, though updating and adding new information, especially on colour, this *Servicing Handbook* has assumed a new importance.

Brixham G. J. K.

Contents

CONTENTS

Introduction

THERE are four primary operations involved in the repair of a television receiver. Firstly, it is necessary conclusively to establish the fault symptom, and this is not always as easy as it may sound, particularly if the trouble is of an intermittent nature. Secondly, it is required to associate the fault symptom with a particular section of the receiver. Thirdly, the section under suspicion must be subjected to an overall test in order to prove the second requirement, and subsequently tested in more detail to bring to light the defective part or circuit section. The fourth, and usually least complex operation, is actually replacing the faulty part or making good the defective circuit.

Although it is essential to possess a fair knowledge of the operation of the various sections which go to make up a television receiver, it is far from necessary to be a mathematician or to be endowed with the gifts of a designer simply to perform a repair or maintain in service even the most complex of television equipment. The successful servicing technician has, essentially by way of practice, acquired the art of quickly associating the various fault symptoms—as seen on the screen of the picture tube, heard from the loudspeaker or observed within the receiver itself—with breakdowns or fault conditions existing in certain sections of the receiver as a whole.

There are a number of fault symptoms which are common to receivers of all makes and types, while certain symptoms are characteristic only of certain makes. The technician with plenty of experience may well look at a fault display on the tube, switch off the set and remove the back cover, replace one of the valves without hesitation, and thereby eliminate the fault within a couple of minutes.

It is not the purpose of this book primarily to discuss the principles of operation of the modern television receiver; we shall follow through the various sections only from the aspect of fault conditions. In this way we will become speedily familiar with the operation of the various sections within the limitations necessary to clear a defect—the emphasis will be on repair and not design.

Block diagrams are always handy things, and with television such a

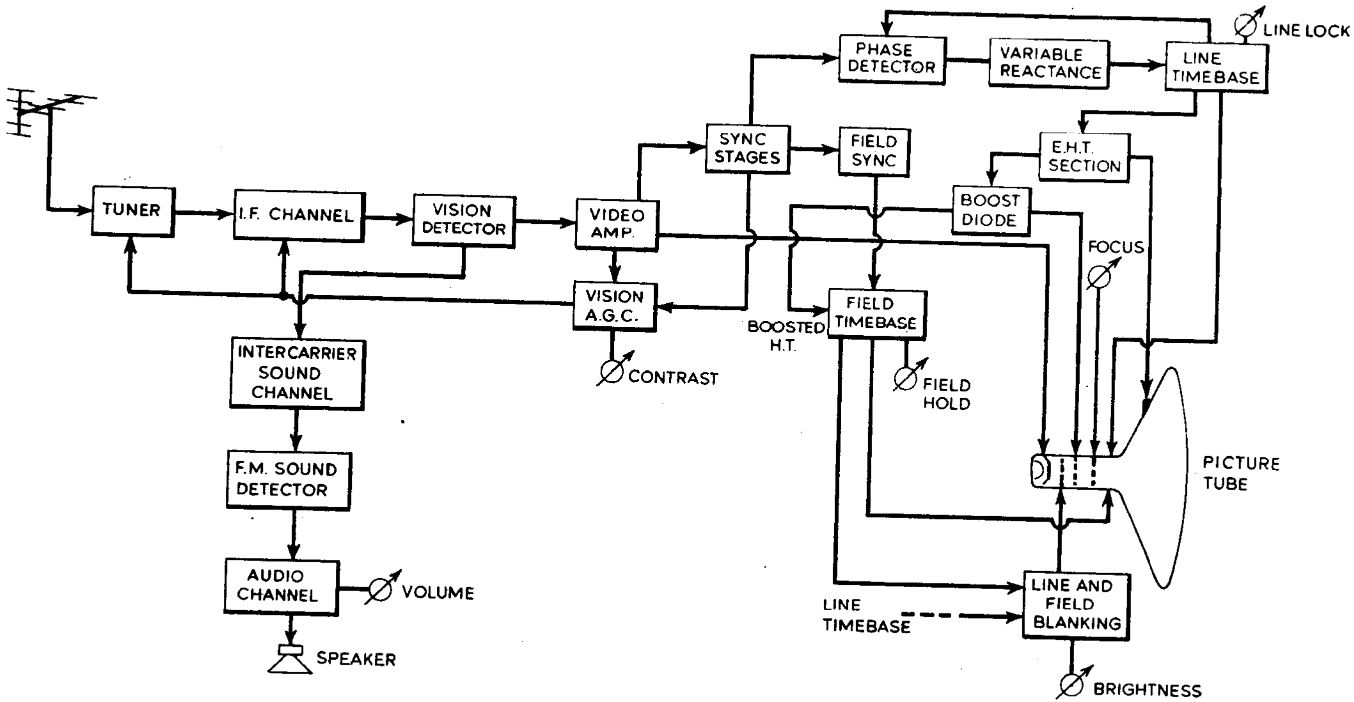


FIG. 1.1. *Block diagram of a 625-line-only set. Block diagrams of a dual-standard set and a colour set are given in Figs. 15.1 and 13.21 respectively.*

diagram reveals the overall function of a complex chain of stages at a glance. Fig. 1.1 is a block diagram of a modern 625-line single-standard set. From this we can easily see how the signals picked up by the aerial are selected by the tuner and travel through the various sections, and how certain stages are interconnected to provide such things as synchronization, frame flyback suppression, automatic gain control (a.g.c.) of the vision channel and other features demanded of present-day receivers.

PROCEDURE CHARTS

Apart from being extremely useful in car handbooks, procedure charts can be employed to considerable advantage for television servicing. Since, however, to embrace even a small proportion of all possible faults in modern equipment, a universal procedure chart would possess unwieldy dimensions, individual charts of relevant association are given at the beginning of sections dealing with fault symptoms. In this way we shall be able to cover in greater detail faults which are not always considered in a book of this nature, but which are liable to cause much trouble to the technician and experimenter.

NORMAL OPERATION

Although some fault displays are obvious, some often leave doubt as to whether the trouble is due to an actual fault condition or to limitation of receiver design. Since our job is not normally that of improving on the design of receivers, we must have a basis on which to work. Previous experience of how the receiver of the particular series under examination performs on the appropriate Test Card is conclusive in this respect.

Difficulty is encountered when the receiver brought in for examination or repair has not previously been handled. Nevertheless, it is frequently possible to secure a general assessment of the performance of any receiver within a particular price range and age group, bearing in mind, of course, that popularly-priced receivers suffer from certain limitations that might well be revealed on the picture. Our comments must not be taken as criticism of a derogatory kind, however, since it is our object to establish the term "normal operation". Vintage receivers cannot be expected to give the high-quality reproduction possible on present-day equipment, even when properly serviced and working under ideal conditions. As with sound reproduction, improvements to vision presentation are progressively taking place, and there is a distinct difference in quality between modern sets and those of a few years back.

Most receivers are produced within component tolerances and although pre-set controls are used to aid in balancing the effect of the tolerances, slight imperfections of the test card are often present, even when all the controls are adjusted for optimum performance. It is often found, for example, that the circle can only be made truly circular by introducing a little cramping or stretching at the top, bottom or sides of the test card. Conversely, if adjustments are made for optimum linearity at the edges of the picture, it is invariably found that a slight bulge occurs on the circle.

In a number of cases such timebase limitations are perfectly normal. It is possible, of course, to achieve a hundred per cent linearity of both scans, but this may involve changing a number of components, including transformers in some cases, so that their value tolerances cancel out, instead of adding up. In this way the overall distortion can be reduced. It is rarely necessary to contemplate such alterations on new receivers as the effects are generally small and visible only on the test card. Nevertheless, it is as well to remember that distortion of this kind, even on a new set, may not indicate a fault condition, and that correction of the trouble really lies outside the service department.

Where such trouble is consistently brought to the notice of manufacturers, however, a modification chart is often published which details methods of altering the circuit (officially) to eliminate or reduce the disturbance in the most economical manner possible. It is not generally a good idea to perform unofficial modifications to new commercial receivers, for even though the desired results may be achieved, there is the possibility that other sections of the receiver will be upset.

Apart from the timebase sections, limitations of a similar nature are sometimes present in other stages, and in this respect it is hardly possible to compare the performance of individual sections of different makes of receiver. Every make of receiver and each series has certain characteristics, and there is really no such thing as a "typical" receiver. One set may be endowed with excellent linearity and slightly impaired synchronizing, while another set of different series or make may have excellent synchronizing and not so good linearity.

TEST CARDS

Test Cards are exacting test patterns screened out of programme hours. They represent a "standard" by which all receivers may be judged. Any small departure from the original presentation might well be caused by design limitations of the receiver itself, as already mentioned. Equally, however, distortion of the reproduction may be caused by maladjustment of the receiver's pre-set controls or by a fault in its circuits. There are three main Test Cards in use: Test Card C for B.B.C. 2 625-line transmissions, Test Card D for B.B.C. 1 and I.T.A. 405-line transmissions, and Test Card E for B.B.C. 1 625-line transmissions. Test Card C is reproduced in Fig. 1.2 and Test Card D in Fig 1.3. Test Card E is the same as Test Card D except for the frequency of its definition gratings.

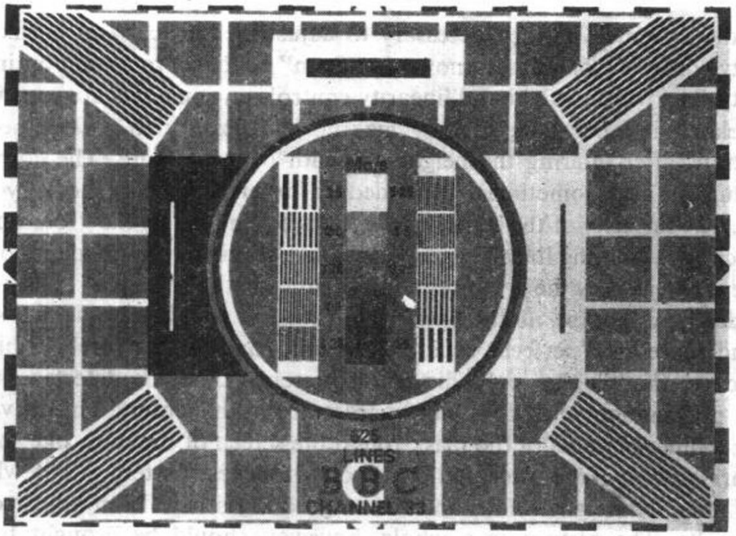
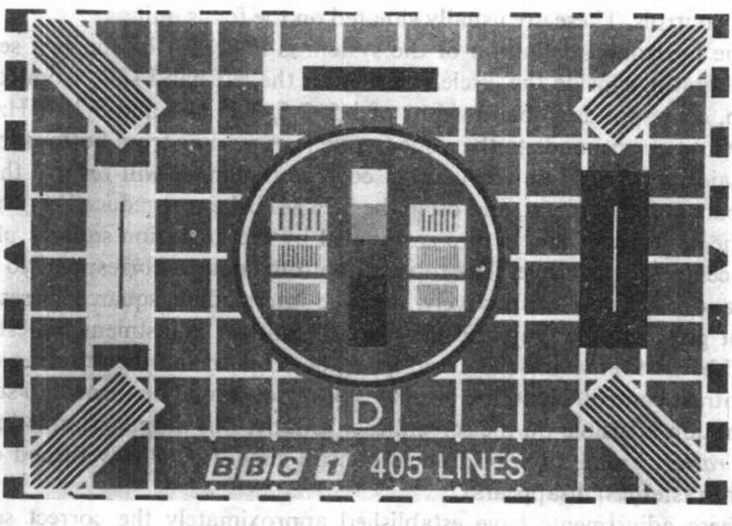


FIG. 1.2. *Test Card "C".* (*Below*) FIG. 1.3. *Test Card "D".*



The edge of Test Card C is surrounded by alternate black and white oblongs, which provide a guide when adjusting for the correct width and height—the width to height ratio is generally known as the *aspect ratio*. In the present system the height of the picture is arranged to be three-quarters of its width. Thus, on a 12 in. screen we are able to secure a picture about 10 in. wide and 7½ in. high; this corresponds to an aspect ratio of 4 to 3.

When the width and height of the picture have been adjusted completely to fill the screen, it may be necessary to adjust the vertical and horizontal linearity controls (sometimes known as "form" controls) to obtain optimum linearity. The width, height and linearity controls on some sets are somewhat inter-related in operation, thereby making it necessary to make linearity corrections after altering the height or width of the picture. The converse procedure is also sometimes demanded in order to obtain the very best results. The linearity of the centre of the picture is judged by the "roundness" of the circle, while the linearity generally and particularly at the edges of the picture is revealed by the background of squares on the pattern.

Ideally, of course, all the background squares should resolve the same size and represent "perfect" squares, but this condition is rarely achieved in practice, though the slight distortion present cannot be detected on an actual programme and does not detract from the entertainment value. Owing to uneven edges of the mask round the screen of the tube, one should not worry unduly if the black and white edge of the test pattern is not wholly visible after the height, width and linearity controls have been adjusted for best results. The picture as a whole, however, should be brought to the centre of the screen by making appropriate adjustments to the picture "shift" controls. These are usually situated on the focus unit.

The horizontal definition of the system is indicated by the two sets of vertical gratings inside the circle. The set on the left-hand side, from top to bottom, corresponds to bandwidths of 1·5, 2·5, 3·75, 4·5 and 5·25 MHz; the opposite set corresponds to the same frequencies reading from bottom to top. The majority of 625-line receivers in correct alignment will resolve the 4·5 MHz bars at full contrast, and often the 5·25 MHz bars at reduced contrast.

The contrast of the picture is revealed by the gradation squares placed in the centre of the circle. The top and bottom squares correspond to peak white and black level respectively, and the intermediate squares correspond to light grey, middle grey and dark grey. Contrast adjustment is best performed by first removing the aerial from the receiver and then turning down the contrast control. Next, the brightness control should be turned up so that illumination is visible on the screen. Incidentally, this illumination is known as the *raster*. Finally, the brightness control should be slowly turned down until the raster *just* disappears.

These adjustments have established approximately the correct setting for the brightness control. After reconnecting the aerial, the contrast control is used to obtain a picture of desirable contrast ratio as revealed by the test card gradation squares. If there is a tendency for defocusing to occur on the peak white square, the effect can generally be eliminated, without upsetting the overall contrast to any large degree, by slightly retarding the brightness control.

Although electrostatically focused picture tubes give an even focus over the entire picture area, magnetically focused tubes, many of which are still likely to be encountered, tend to suffer from slightly impaired focus towards the edges of the picture. For this reason, therefore, it is best to aim for a compromise focus adjustment. The focus in the centre of the picture can be judged by the vertical definition gratings, while the sharpness of the four diagonal corner patterns indicates the focus performance at the edges.

Should it be discovered that the horizontal definition deteriorates (as shown by the vertical gradings) when the picture is focused on the *horizontal* scanning lines, or, conversely, that some defocusing of the scanning lines occurs when the best definition is obtained, the trouble is almost certainly caused by uneven focusing of the scanning spot whose purpose is to trace the picture on the screen. The effect is known as *astigmatism*, and can nearly always be cured by adjusting the focus unit so that it is concentric with the neck of the tube. If the trouble cannot be cured by this method, however, either the tube or the focus magnet is at fault and, in such cases, if a replacement part is not warranted a compromise focus setting should be adopted.

The horizontal black bar on the white background immediately above the circle provides a check for amplitude and phase distortion in the vision channel at the lower video frequencies. A black smear to the right of the bar shows that distortion of this nature is present. It is as well to bear in mind, however, that a small amount of such distortion is sometimes introduced at the transmitter.

The single vertical bar on contrasting background at each side of the circle provides a test for "overshoot" and ghost images. The troubles are clearly displayed as a secondary image to the right of the corresponding bar.

The black and white rectangles bordering the test card primarily provide a test for separation of the synchronizing signals from the picture content, and video bandwidth. Displacement of the vertical content of the picture to the left at levels corresponding to the white rectangles (giving the circle a "cog-wheel" effect) is a good indication that the synchronizing (sync) separator is permitting the passage of picture signals to the line oscillator. If the displacement is to the right, however, then poor high-frequency response of the circuits immediately preceding the sync separator stage should be suspected.

Test Cards D and E allow for similar tests and adjustments. Reading the definition gratings from left to right across the card and from top to bottom, the frequencies on Test Card D are 1·0, 1·5, 2·0, 2·5, 2·75 and 3·0 MHz, while on Test Card E they are 1·5, 2·5, 3·5, 4·0, 4·5 and 5·25 MHz. The higher frequency gratings on Test Card E are necessary to check the inherently higher definition of the 625-line system, of course.

Test Card F for colour television is illustrated and described in Chapter 13, page 268.

CHAPTER 2

No Sound, Vision or Raster

WHEN a television receiver fails completely on both services, a considerable amount of information can be gleaned simply by observing the valve heaters. If they are not alight and the valves are cold, there is a strong possibility that the fault does not lie in the receiver at all. A possible cause of the trouble, as indicated on Procedure Chart 1, is a faulty mains supply. This can easily be checked at the mains socket either by connecting a household lamp across the power source (it is a good idea to make up a test-lamp set for such purposes) or by means of an a.c. voltmeter (a d.c. one for d.c. supplies, of course). If the set features a detachable mains lead this also should be given due attention, since the connexions at the floating socket often become loose or break away if the set is moved about a lot.

When it has been conclusively established that mains current is getting into the set, the set fuses should be checked for continuity—a visual examination of the wire in a glass cartridge fuse should not always be relied on. If it is found that the fuse is open-circuit, it is desirable to check the h.t. line for a short-circuit before making a replacement. A multi-range meter set on the 10,000 ohms range and connected between receiver chassis and the cathode of the h.t. rectifier valve, or the h.t. positive terminal in the case of a metal rectifier, will give a measure of the insulation of the h.t. line with respect to chassis. Do not expect to get an infinite reading, as the circuits comprise various potentiometers and potential dividers across the h.t. system and, in any case, the electrolytic capacitors have a certain insulation resistance; nevertheless, a reading of below 5,000 ohms should be treated with suspicion.

If a low resistance reading is obtained, then it is necessary to perform various resistance tests throughout the circuit as a way of establishing the component which is responsible for the trouble. From the d.c. side of the rectifier—probably after the smoothing choke, resistor or focus coil—quite a number of connexions are made to the h.t. circuits of the various stages. As the short-circuit may lie in any one of these, each h.t. feed should be individually disconnected from the main h.t. line and tested for resistance under isolated conditions. The feeds which possess sufficient insulation should