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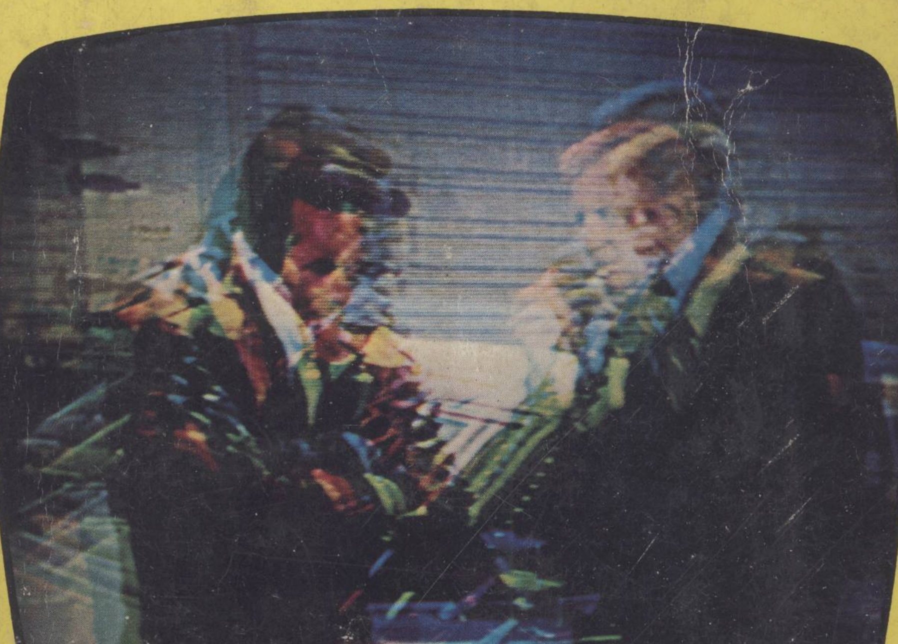
BEGINNER'S GUIDE TO TV REPAIR—2nd Edition

Step-by-step instructions show you how to find and repair almost any fault in a color or B&W TV set.



BY GEORGE ZWICK

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Preface

To serve a useful purpose a preface should be a sort of abstract or summary stating what a book is about as well as what it is not. For the sake of absolute clarity we shall first state what this book is not. First, it is not a complete course in TV repair. It will not teach you how to do jobs that can be done only by a competent, experienced TV servicer. This includes many and varied tasks, for example, the replacement of the picture tube and the subsequent adjustments—a task definitely not in the beginner category.

Second, this book will not teach or recommend any repair involving personal hazard. There are such repairs in the complex machine called a TV set, particularly a color TV set, and no man, however handy or mechanically inclined, should be foolhardy enough to attempt any of these.

Finally, this book will not suggest any repair in which there is a low probability of success. To do so would likely to more harm than good because it is liable to condition the TV owner to accept a mediocre, substandard level of performance, rationalizing that this is "the best he or she can get."

What does the book intend to accomplish? It is the purpose of this book to enable anyone interested enough to learn the basics of TV repair to keep his or her receiver performing at its best by following a safe, simple, preventive and corrective maintenance program that requires no specialized tools or equipment. This maintenance includes such things as adjustments to compensate for aging, deterioration, image distortion, etc. It also tells how to correct such defects as improper illumination (brightness/contrast), picture instability (rolling/tearing), and overloading (smearing, etc.). In addition this book includes procedures on how to remedy such catastrophic defects as loss of vertical (decrease in picture height to a thin horizontal line), loss of sound, loss of picture, loss of both sound and picture, as well as such frightening symptoms as smoke, crackling and frying sounds, etc.

In the case of color receivers the uninitiated will find that this book solves the mystery of color without creating new technical mysteries by showing that the color TV receiver is basically a black-and-white set with added capabilities.

With the advent of solid-state technology in TV receivers, whether hybrid (part tube, part transistor) or all solid-state type, the do-it-yourself TV owner must of necessity acquire a modicum of familiarity with the infrastructure of this type of equipment. This involves not only the gradual disappearance of vacuum tubes and their replacement by semiconductors—transistors, diodes, varactors, etc.—but also the almost-revolutionary change in construction through miniaturization. Bulky discrete parts with their point-to-point wiring have been almost totally replaced by miniaturized subassemblies, printed-circuit wiring and integrated circuits (ICs). As a logical consequence the handling of such components has also undergone a radical change. The old familiar screwdriver, soldering iron and long-nose pliers have been superseded by semiminiature, almost jeweler-type tools. Their manipulation requires new techniques and considerable circumspection. This does not mean the end of do-it-yourself. In fact, in many instances it has actually become easier. Yet there still are areas best left to the professional repairman, and I identify those in the book. But I also guide the would-be home do-it-yourselfer through the new required procedures in handling transistors, ICs and printed-circuit (PC) boards. A new chapter, *Solid State and How to Treat It*, is a sort of "minimal adequate" course in the new techniques for the do-it-yourself TV owner.

To establish correlation between functional circuits and physical components—a vital step in identifying actual TV parts and subassemblies by the TV owner—I have shown parts of actual set schematics of modern receivers, sectionalized on the diagram in correspondence with physical circuit boards. This follows the very common practice of TV manufacturers in their service manuals and data; thus, when you look at such a partial diagram, you also see the physical PC board or subassembly of that diagram. Following the same logic I have also shown some actual sample procedures for removal of circuit boards from a complete TV set.

As to the *don'ts* for the TV owner I identify those tasks which for reasons of safety—as in case of picture tube replacement—or of technical complexity—this includes such functions as IF and tuner alignment, rarely needed, but extremely complicated—so that you will not go out on a limb so to speak. While the more courageous TV owner might attempt, following manufacturers' instructions and admonitions, to replace the picture tube, he or she would still risk the predicament of a possible "stuck"tube which refuses to slide out of the yoke assembly. In case of tuner or IF adjustments, although not involving the danger of an implosion as in case of the picture tube, I caution the do-it-yourselfer against almost 100% certain failure, unless you sport an elaborate and expensive array of sophisticated test equipment. In such cases, and wherever feasible, I direct the TV owner to an alternative procedure, as in some cases of tuner replacement.

The technical level of this book is necessarily different for different users. While the more experienced reader may find some of the detailed explanations somewhat naive, these same explanations may be nothing short of astounding revelations to the uninitiated; however, the overall level of the subject matter is such that the average reader will be able to progress from page to page without difficulty, so that what may at first glance seem too technical and overwhelming will in due course become quite logical, fairly simple and relatively easy to accomplish.

Lastly, and by no means negligible, this book is intended to perform a needed service for those who do not ever wish to tinker with a TV set but who would very much like to have a general understanding of a TV receiver: how it works and why it fails, without resorting to engineering or mathematics or even technical language. For there is a great advantage to be gained from an intelligent appreciation of how any household appliance works, especially so a television receiver, even if only to be able to talk intelligently to a professional servicer, as well as listen to him or her understandingly.

George Zwick

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Chapter 1
The TV System

Before embarking on a detailed, nontechnical description of various portions of a modern TV system it is desirable to present a brief synopsis of the overall process, from end to end, in order to provide a continuity of visualization so that as you read about a particular step in the system you will have in the back of your mind, so to speak, the complete picture of the overall purpose and end result to be achieved.

BASIC SOUND & PICTURE SYSTEMS

The TV system, whether monochrome (black and white) or color, consists of two distinct transmitter-receiver systems—the sound (audio) system and the picture (video) system. The interconnections and any commonalities between the two systems is entirely incidental. In other words it is not essential that there be any common connections or functions between the two systems. It is done merely for economy and convenience. Let it be thoroughly understood that a physically separate sound system alongside a corresponding totally independent picture system would be just as feasible from a strictly technical viewpoint.

The sound system is essentially the same as the FM portion found in AM/FM receivers. The FM sound part of the TV signal picked up by your antenna has the same general characteristics of an FM signal—namely, high immunity to noise (static, electrical interference, etc.), relatively short-range reception capability and (po-

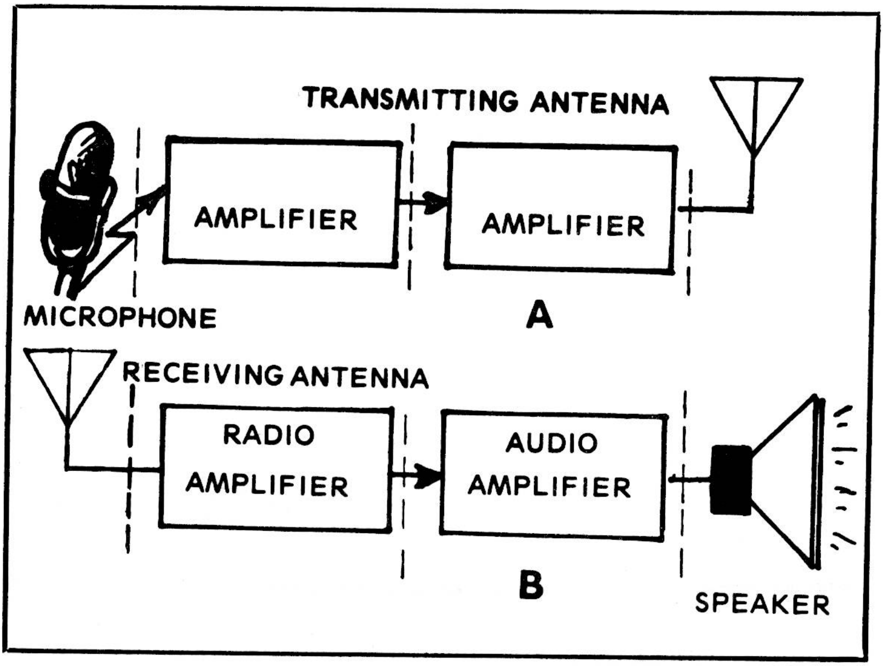

Fig. 1-1. Simplified block diagram of a sound transmitter (A) a sound receiver (B). Notice that the two systems are virtually mirror images of each other.

tentially) a higher sound quality. Figure 1-1 shows, in block diagram form, the major components of the TV sound system.

Figure 1-2 shows, in similar form, the building blocks of the video (picture) system. This is an AM signal (similar to the AM music stations) and is subject to the same general conditions accompanying AM station reception—fading, freak long-distance reception, interference (streaks, etc., across the screen) and so on.

Terminology

A few words about the terminology we just used might not be out of order here. AM stands for *amplitude modulation* and signifies a system of radio transmission and reception in which the magnitude of the signal varies directly with the loudness of the voice or music or with the brightness of the image in case of a TV picture. Since electrical noise can add to or subtract from such a signal it is only logical that such noise is reproduced by the receiver as physical noise (static, clicks, etc.) or as streaks, dashes, etc., on the TV screen. In other words AM is not immune to noise.

FM stands for *frequency modulation*. This system ignores any variations in size of the radio signal as might be caused by the addition of noise to the signal and transmits and receives sound information by means of a variation in the *spacings* (modulation) between adjacent waves. Technically, both picture and sound could be AM or FM, but there are other reasons for the present use of FM sound and AM picture.

Transmitting & Receiving Systems

In Figs. 1-1A and 1-2A the vertical dashed lines define the three distinct major functions of each transmitting system. On the extreme left of Fig. 1-1A is the microphone which changes sound waves to electric currents. In Fig. 1-2A the camera performs the corresponding function of changing light into electric energy.

The second sections of Figs. 1-1A and 1-2A serve the major functions of amplification (enlargement) of the faint signals. The third sections in both illustrations convert the amplified signals into a form suitable for transmission via the antennas. They also further amplify them before feeding them to the antennas. The right-hand sections in both illustrations actually radiate the signals into space to be received by many receiving antennas.

Receiving systems (Figs. 1-1B and 1-2B) are virtually the mirror opposite of the transmitting systems just described. On the extreme left are the receiving antennas, located so as to "get in the

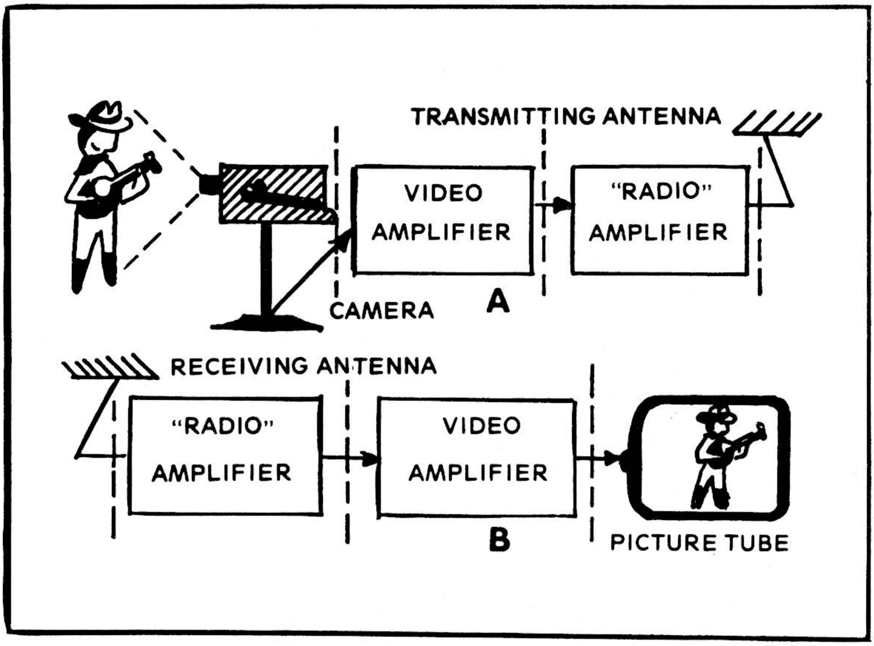

Fig. 1-2. Simplified block diagram of a picture transmitter (A) and a picture receiver (B).

way" of the radiated energy from the transmitters. (That is why receiving antenna location is so important.) The second section of each receiver amplifies or builds up the minute signals to the levels necessary for further processing. The third section in each illustration converts the signals back to a form suitable for display as picture or sound, as well as amplifying them. The right-hand sections reproduce sound waves from the electrical energy in the sound signal and form pictures from the electrical energy carried in the picture (video) signal.

ORIGINAL SOUND TO REPRODUCED SOUND

All sound (voice, music or noise) is produced by a physical force which sets the air into vibration. The amount of force applied to the air determines the loudness of the sound, while the different pitch (from bass to a whistle) results from the rate (speed) of vibration of the air.

Microphone

The microphone is a device which converts mechanical energy (air pressure or vibration) into electrical energy. The amount of the electrical energy produced depends on the physical force applied (sound loudness). The pitch of the original sound determines the frequency (numerical rate of vibration) of the electrical energy produced. For sound the frequency may be as low as 20 vibrations per second (a deep, organ note) and as high as 20,000 vibrations a second (a very high-pitched whistle). Incidentally, ordinary household AC has a *frequency* of 60 vibrations (cycles or hertz) per second.

Amplifier

These electrical devices, using either tubes or transistors, have but one function—to faithfully enlarge the feeble electrical currents emanating from the microphone. No one tube or transistor can provide all the amplification that is required; so there usually are a number of amplifiers, following each other, each amplifying the output of the preceding amplifier or stage until the required maximum is obtained.

Audio & Radio Frequencies

To attain a useful understanding of TV transmission and reception it is essential to have a clear concept of frequency. As was mentioned earlier electrical energy exists as a wave-like phenomenon, just as sound energy consists of air waves, and not unlike the waves or ripples caused by a disturbance in water. The term frequency is used to denote the number of times a wave recurs in a certain period of time, usually 1 second; thus, in all future reference to frequency in this book the meaning will be the same: the number of waves per second, or, preferably, cycles per second. As stated before, audio frequencies (AF, sound frequencies audible to the ear) are assumed to extend from about 20 cycles per second (deep organ note) to about 20,000 cycles per second for a very shrill whistle. Above 20,000 or 30,000 cycles, they are called radio frequencies (RF for short), extending through AM and FM radio, TV and radar transmitting and receiving frequencies to the near-optical (light) portion of the spectrum. Here we find first infrared (invisible heat waves), followed by the visible light spectrum (red through violet), the ultraviolet (again invisible) and on to X-rays, etc. Video (picture) frequencies are related to television. They stand for those frequencies which carry picture information and extend from about 20 cycles per second to about 4,000,000 cycles per second.

Until several years ago frequencies in the entire spectrum from audio through invisible light we referred to as cycles per second, thousands of cycles per second (kilocycle), millions of cycles per second (megacycle), etc. Now by international standards the term hertz, abbreviated Hz, is used instead of cycles per second. Heirich Hertz, a German physicist, was the first to demonstrate the production and reception of electromagnetic or radio waves. Thousands of cycles is referred to as kilohertz (kHz), etc.

A final note on waves and frequencies. The higher the frequencies, the shorter the length of the wave. For example, the sound wave of a telephone bell (with a frequency of, say, 1000 hertz) is approximately 186 miles long. By contrast the radio wave transmitted by a UHF television station is little more than 1 foot long. This explains why the elements or metal rods of a UHF TV antenna are so much shorter than the corresponding VHF types. While any frequency can be transmitted from place to place over wires, only those classed as radio frequencies (RF) can be sent through space (wireless transmission).

RF & AF Amplifiers

The middle sections of our simple diagrams in Figs. 1-1 and 1-2 consist mainly of amplifiers, accessory devices and controls. Those immediately following the microphone are audio amplifiers, as stated previously; however, in order to transmit this audio economically and efficiently over great distances a temporary change is made. The audio wave is superimposed (that is, it modulates) on a radio wave piggyback style. This combined RF+AF energy is further amplified and finally applied to the antenna.

Antennas

A transmitting antenna has but one function: to radiate the energy applied to it, in the desired direction (or in all directions), in the most efficient manner possible. While the obvious purposes of the receiving and transmitting antennas seem to be quite different from each other they actually behave very much alike. Incidentally, despite many claims to the contrary, there is no substitute or shortcut worthy of its name for a high-grade, elaborate antenna, whether for transmitting or receiving.

At the receiving end the antenna does not radiate energy—it collects. Located in the path of the radiated energy the receiving antenna collects or acquires a very small sampling of the original energy or signal as radio waves cross it. By means of a transmission line (sometimes called lead-in) the intercepted signal is carried to the input of the receiver.

It is unfortunate but true that while a properly designed receiving antenna will favor the stations (frequencies) for which it was designed and discriminate against others, it is fairly helpless in rejecting undesirable electrical energy, such as noise, static, etc. The transmission line, or lead-in, is equally susceptible to noise or static pickup, although something can be done here. Shielding, or protecting the lead-in from surrounding electrical noise, is feasible. The antenna itself cannot be shielded (or it won't receive any signals); the only recourse lies in the selection of a suitable location where noise is at a minimum.

Receiver

The amplifier sequence in the receiver is virtually a mirror reflection of that in the transmitter. Amplifiers immediately following the antenna amplify the combined (RF+AF or modulated RF) signal to the required level. Next, and in the same general portion of the receiver, a reversal of the modulation process takes place by a device called a demodulator or detector. This reversal consists of stripping the RF, which has served its purpose, from the signal, leaving only the audio-frequency signal. Further amplification now