

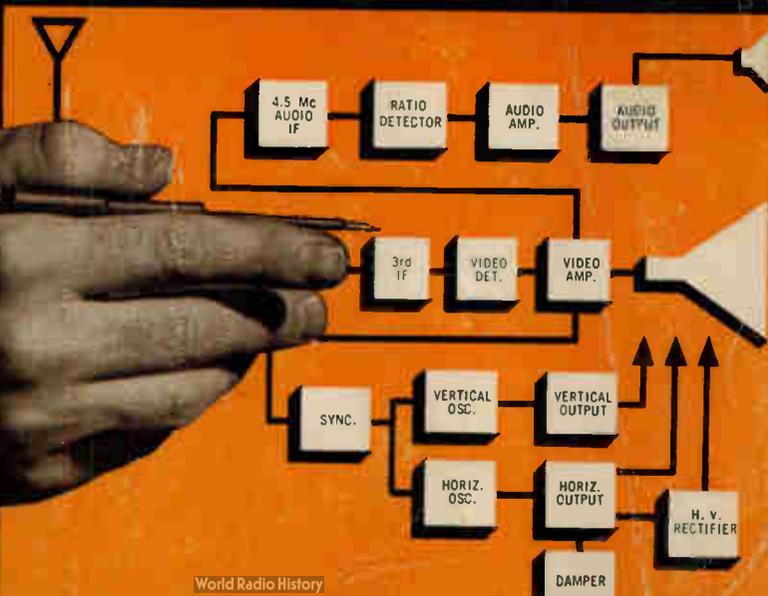
\$1.00

TELEVISION ANALYZING SIMPLIFIED

by MILTON S. KIVER

Author of "Television Simplified"
"Transistors in Radio and Television"
and many other books

Tells how new technique makes
trouble shooting fast and easy.



TELEVISION ANALYZING SIMPLIFIED

By
MILTON S. KIVER

B & K MANUFACTURING CO. CHICAGO, ILLINOIS

COPYRIGHT 1958 BY B & K MANUFACTURING CO.
CHICAGO, ILLINOIS

Time is the most precious ingredient of any service business — time to repair as many sets as possible. Every instrument that a serviceman purchases is acquired with one purpose in mind, to enable him to do his job more competently and more quickly than he could without that instrument. Once this is recognized, then the next question formulates itself very quickly; that is, "What instrument will help the serviceman track down every type of trouble in a television receiver, both black and white and color, in the shortest possible time?"

This book discusses various approaches to television servicing and introduces the new point-to-point signal-injection direct-viewing method, made possible by the development of the TELEVISION ANALYST.

The ANALYST is the most comprehensive TV service instrument that has appeared commercially to date. This device, correctly applied, enables a technician to cut his servicing time in half or more. This is substantiated by the impartial opinion of the thousands of servicemen who have used the instrument.

In this book, the reader is shown how to apply the TELEVISION ANALYST to every section of a television receiver, for fast, easy troubleshooting and pin-pointing. The direct approach made possible by this unit will prove, we trust, to be an eye opener and demonstrate the high degree of efficiency that can be achieved by the application of the proper test instrument. This is true, irrespective of the skill of the man using the ANALYST, whether he be an experienced technician or a beginner.

The author of this book, Milton S. Kiver, is widely known for such popular books as "Television Simplified," "Transistors in Radio and Television," "FM Simplified," and many others. He has also written well over a hundred articles on all aspects of electronic servicing, and is currently editor of "Electrical Design News" magazine.

TABLE OF CONTENTS

	PAGE
PREFACE.....	iii
SECTION I	
The Three Approaches to Television Servicing.....	1
SECTION II	
The Conventional Signal Tracing Method.....	11
SECTION III	
The Television Analyst.....	23
SECTION IV	
The Test Pattern.....	25
SECTION V	
Using a Test Pattern Signal for Servicing.....	35
SECTION VI	
How to Use Television Analyst for General Trouble Shooting.....	41
SECTION VII	
How to Use Television Analyst to Trouble Shoot Audio Systems.....	45
SECTION VIII	
How to Use Television Analyst to Trouble Shoot Video IF System.....	51
SECTION IX	
How to Use Television Analyst to Trouble Shoot Front End Tuner.....	61
SECTION X	
Locating AGC Defects with the Television Analyst.....	67
SECTION XI	
How to Use Television Analyst to Trouble Shoot the Sweep Systems.....	73
SECTION XII	
Using the Television Analyst for Intermittents.....	83
SECTION XIII	
How to Service Color-TV Receivers with the Television Analyst.....	89
SECTION XIV	
Other Uses for Television Analyst.....	99
SECTION XV	
Summary.....	103

SECTION I

THE THREE APPROACHES TO TELEVISION SERVICING

Thousands of articles have been written on the subject of television servicing and yet, when these have all been analyzed, they will be found to fall into one of three categories. As a matter of fact, an even more positive statement can be made.

Every trouble that afflicts a television receiver can **always** be found by the proper application of one of three servicing methods.

If a service technician is unable to locate the trouble by one or more of these methods, it is only because he is not applying them properly. It may be that he is either using the wrong approach or he does not have the proper testing tools to apply these methods as they should be.

But if he knows what he is doing **and** he has the right test tool for the job, then he **cannot** fail!

It is the purpose of this book to examine these three approaches and then to outline a method of servicing which will guide you to a defect surely and quickly 99 times out of 100. And, as you gain skill, you will make it 100 out of 100 times — consistently.

Miraculous? Not at all. Servicing of a television receiver, whether it be black-and-white or color, is based on logical, straightforward principles which every reader of this book has been exposed to at one time or another. The reason every serviceman is not a top notch craftsman stems from two major causes. (1) Either the servicing principles, logical as they are, have never been presented to him in a logical manner; or (2) the readings or other indications provided by the normal test instruments are so obscure or difficult to interpret that it is hard to arrive at a clear-cut answer.

In either case, the serviceman, who is always working against time, becomes so confused that he wanders away from the true path to the trouble and thereby loses valuable time — and money.

Remember that every serviceman is basically selling his time. In any one week, the amount of time there is to sell is limited. You must do whatever you have to do within these limits. If you do less — which means servicing fewer sets — then you will generally make less. But if you utilize this time efficiently and service a greater number of sets, then you will be in a position to make more.

It's as simple as that!

Now, if you stop to analyze where the major portion of your time is lost on most servicing jobs, you will find that it occurs in the beginning. It is during this period that you are trying to decide where the trouble is and a wrong choice here can easily cause you to lose many valuable hours.

What every serviceman needs, therefore, is some way or some thing which will get him going on the right track. It is the purpose of this book to provide him with just that information.

And to present the full story, we will examine the three approaches to TV servicing mentioned above.

A word of caution before we start.

The three methods to be outlined are not unrelated to each other. At one point in your service work on a certain receiver you will use one method, at another point, a second method. Still later, the third method may be brought in. Sometimes, only one method will be needed to uncover a defect. It all depends on the job at hand. But, at no time, will more than three methods ever be required. This is the important point to keep in mind.

Method No. 1. Tube Testing. When faced with a defective receiver, many men employ this method first. Simply stated, it consists in checking tubes in a television receiver until a defective one is found. This is a good approach if you have a quick-testing tube tester such as the unit shown in Fig. 1. With this tester, you can check all the tubes in an average receiver in less than 10 minutes. It is particularly effective when

series-wired filaments are employed and none of the tubes are lit. It is similarly useful if a comparison of the sound and picture points to a certain section of the set.

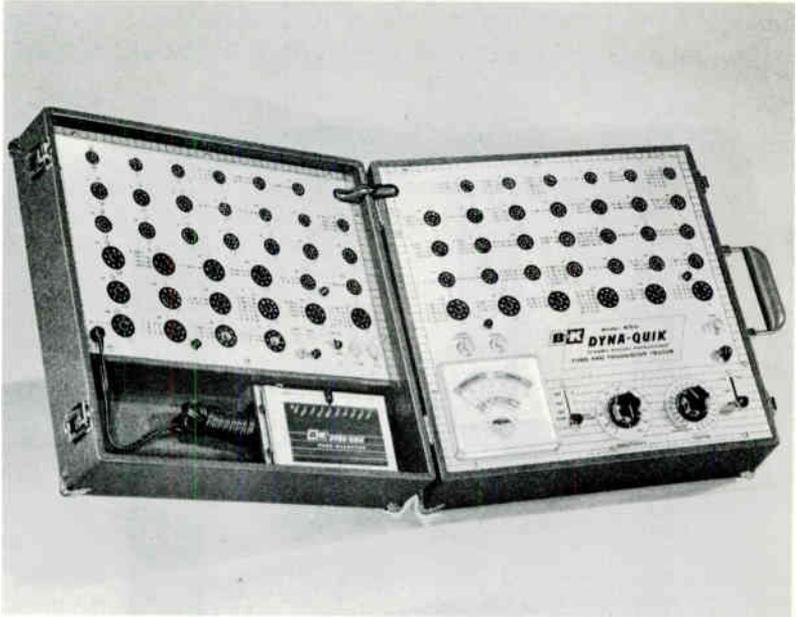


FIGURE 1

The B & K Dyna-Quick tube tester, Model 650. With this instrument, all the tubes in the average television receiver can be tested in 10 minutes.

For example, suppose you have sound and a raster, but no picture. This means that the RF tuner and the video IF system are functioning because both video and sound signals pass through these stages together. If something here were to stop the video signal, it would most likely stop the sound signal as well. The video detector could also be counted as operating normally for the same reason. Beyond the detector, the two signals separate, with the video signal continuing on to the picture tube while the sound signal travels to its system. Since the sound is heard normally, we can dismiss the entire sound system.

Thus, we are left with the video amplifier tube or tubes to check.

When the trouble is a defective tube, this method of servicing seldom takes more than twenty minutes to fix the receiver. It must be kept in

mind that the picture tube can also be the defective component and must also be tested. For example, a receiver which has poor contrast could have a weak video amplifier tube or it could also be a poor picture tube. We must therefore include in this first method the testing of the picture tube with an instrument such as the B & K Model 400 in Fig. 1A.



FIGURE 1A

The B & K Model 400 picture tube tester and rejuvenator quickly picks out defects in the picture tube.

But what if the trouble is not a bad tube? Then the method is not very useful and any serviceman relying on it alone would really find himself in trouble.

After all the tubes have been checked and found to be good, what do you do next?

To summarize, tube testing is an excellent first step to practically all television receiver servicing jobs. But if the trouble is not a tube, then the method has very limited usefulness.

Method No. 2. Voltage and Resistance Measurements. Here is the second approach to television receiver servicing. It should be preceded by Method No. 1 and is invoked after it has been determined that no tube is defective. Then the serviceman removes the chassis from the cabinet and measures a number of d-c voltages throughout the receiver. In order to do this effectively, a full schematic diagram of the circuit is definitely required. With the diagram spread out before you, a good place to start is with the d-c voltage output of the power supply. As a first step, the power supply section must be located. Next, the terminal where the output voltage first appears must be found. Then the voltage here is measured.

At this point, a major problem arises.

What is the normal value of the d-c output voltage of the supply? If this value is not stated on the diagram, then you must rely on your own judgment based on past experience. Even this may be of little help since different production runs of the very same model may have considerably different voltages.

Consider the ideal situation where the desired voltage values are indicated on your circuit diagram. Suppose you measure the d-c voltage of the supply and find it low by 10 per cent. Does this indicate that something is wrong or can it be considered as normal? Even a factory serviceman who is intimately familiar with this model would be hard put to provide a firm answer. This is because normal changes in tubes and other components (or even a variation in power line voltage) could readily alter the d-c voltage by 10 per cent and still permit the set to function normally.

The foregoing is not meant to prove that a voltage and resistance check of a television receiver will never help you locate a defect. Voltage analysis can prove extremely helpful **if** there has been a considerable drop in value and you know what the correct value should be. The method, however, is not a fast one and will frequently entail a considerable amount of checking before the point where the defect exists is uncovered.

There is still another serious limitation to this method.

Many circuits, such as the video detector, FM detector, horizontal

phase discriminator and others have practically no d-c voltage in them. These cannot be analyzed with a voltmeter.

Or, suppose several turns of a coil in one of the tuning circuits are shorted together. There is no practical way to uncover this either by a resistance or a voltage check. The change in resistance within the coil or in voltage drop across the coil (if the current passes through it) is too minute to detect with any but highly expensive instruments.

Voltage and resistance measurements are useful when the trouble can be narrowed down to a single stage or two. Then, by measuring the voltage at various points and, if need be, the resistances in the circuit, a defective component can be uncovered. Thus, this is seen to be a supplemental or assisting type of method where you are working in a limited section of the receiver.

If you have no prior information where the trouble is located, this method, even after all the tubes have been tested, will usually mean many tiring hours of work while every section of an 18-tube receiver is checked. And, as we noted above, there are many places where it is normal to have no d-c voltages and here the method fails entirely.

Method No. 3. Signal Tracing. We come now to the third method of television receiver servicing and this employs either external signals or certain special waveforms within the receiver itself to track down the source of the trouble. This is, by far, the most powerful method yet devised to service any electronic circuit because it checks each circuit in precisely the way that the circuit itself operates.

Thus, we examine a circuit or system under normal operating conditions. If it fails to respond normally, this fact immediately becomes obvious and we know that the general area of the trouble has been located.

Since this method is so powerful, let us spend some time examining it in some detail.

There are several different signals we can use, but one of the most common is the signal from a television broadcast station. This signal is picked up by the antenna and brought to the receiver by the transmission line. In the receiver, the signal is amplified by the RF stage, then transferred to the mixer tube where it combines with the signal from a local

oscillator to produce the IF signal. This may either be in the 20 or 40 mc range. See Fig. 2.

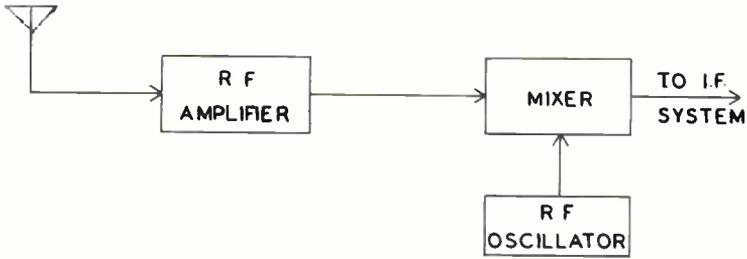


FIGURE 2
Block diagram of typical TV tuner.

The signal is now passed through the video IF system which contains anywhere from 2 to 4 stages. Each stage causes the signal to become a little bit stronger until, by the time it reaches the video detector, it has grown from several thousand microvolts to 3 to 5 volts. At the video detector, the signal is demodulated, and if it is viewed on an oscilloscope screen now, it would appear as shown in Fig. 3.

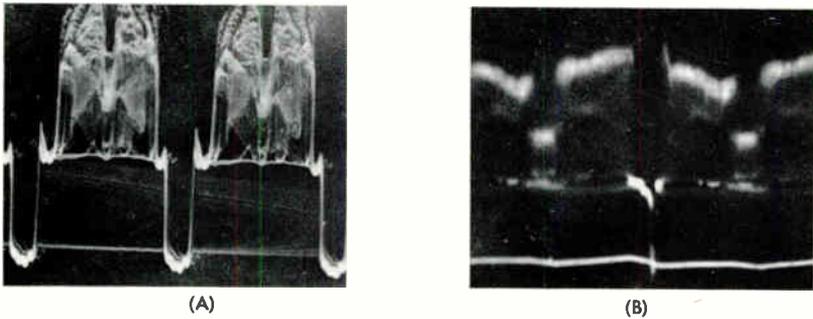


FIGURE 3

The appearance of the video signal at the output of the second detector. (A) shows the form of the signal when the scope sweep is set at 7875 cycles. (B) shows the signal when the scope sweep is set at 30 cycles.

Two views are shown, corresponding to a fast and a slow setting of the scope's sweeping rate. When the sweep rate is half the horizontal sweep frequency (or 7875 cycles), then two horizontal lines in the signal are obtained. Note how the horizontal sync pulse in Fig. 3A stands out. This is an important item to look for because the correct operation of the horizontal sweep system depends on this pulse.

The second waveform, in Fig. 3B, shows the vertical sync pulse. These, too, must appear sharp and clear, otherwise the picture will not be locked in vertically and will have a tendency to roll.

From the video detector, the signal is fed to a video amplifier where it is further strengthened; then it is applied to the control grid or cathode of the picture tube. See Fig. 4. At the same time, a portion of the signal is applied to a sync separator. Here the sync pulses, vertical and horizontal, are separated from the rest of the video signal. These pulses then divide, with the vertical pulses going to the vertical oscillator and the horizontal pulses going to the horizontal sweep system. In this way, the incoming synchronizing pulses control the frequency of the vertical and horizontal oscillators, locking in the image on the screen with the picture being sent by the broadcast station.

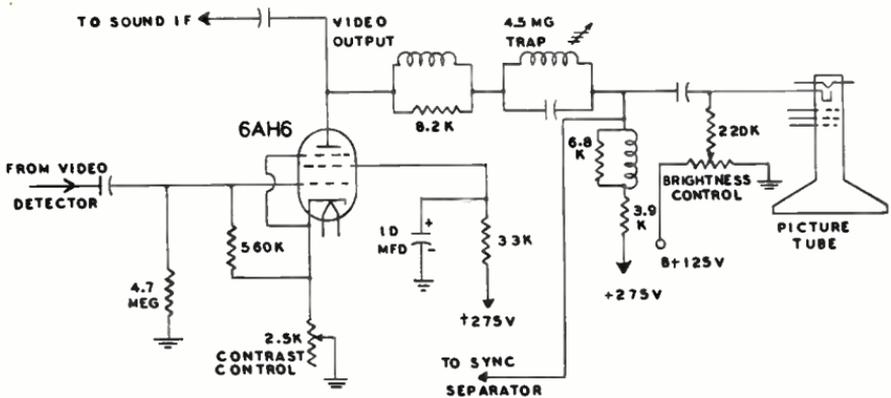


FIGURE 4
Typical video amplifier circuit.

While all this is happening to the video signal, the sound signal, at the output of the video detector, or video amplifier, is being shunted off

to its section. See Fig. 5. The sound signal, at the detector output, has a frequency of 4.5-mc. This signal is amplified by a 4.5-mc sound IF amplifier (or two,) then fed to an FM detector where it is converted back to audio signals again. After this, it is amplified by an audio voltage amplifier, a power amplifier, and then it is applied to a loudspeaker.

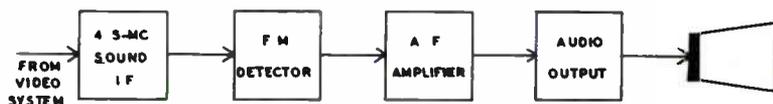


FIGURE 5
The sound system of a TV receiver.

The foregoing indicates the manner in which incoming signals travel through a television receiver. There may be variations of this, but if so, they are slight. In the signal tracing approach to television servicing, we will use the foregoing behavior to help us track down any defects that may arise. Just how this is done is the subject of the next section.

SECTION II

THE CONVENTIONAL SIGNAL TRACING METHOD

The best way to summarize the signal tracing method is to state that in this method you look for the place where the signal is not treated as it should be. Either the signal becomes distorted at this point or it is lost completely.

A typical case history will show how the method is used. Let us assume that a receiver is producing normal sound, but no picture. However, there is a raster on the face of the picture tube. See Fig. 6.

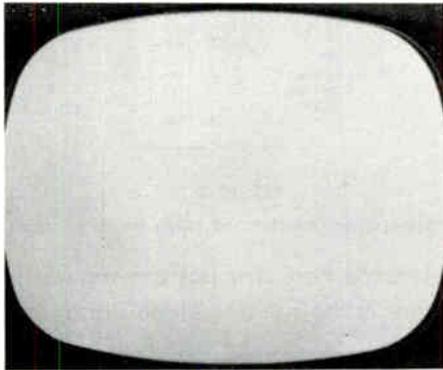


FIGURE 6

Good raster, but no video or picture.

The object is to find where the video signal is lost. For this purpose, we will need an oscilloscope. The instrument is set up so that its beam is sweeping across the screen at a rate of about 7875 cycles per second. This is half of the horizontal sweep frequency and is a good value to choose because it enables you to develop two complete horizontal video

lines on the scope screen, as in Fig. 3. The first step is to check the signal where it enters the picture tube. This is either at the control grid or the cathode. See Fig. 7. The ground terminal of the oscilloscope connects to the receiver chassis and the vertical input lead of the scope connects to the control grid or cathode of the picture tube.

In the present case, no pattern appeared on the scope screen. This tells us that there is no video signal at this point in the receiver.

The next step is to check the video signal at the control grid of the video amplifier. This is point X in Fig. 7. Consequently, the vertical input lead of the scope is connected to point X. When this is done, nothing appears on the scope screen. Still no video signal. Hence, we would move closer to the front of the receiver. A good place to check is at the video detector, point Y in Fig. 7. When we place the vertical in-

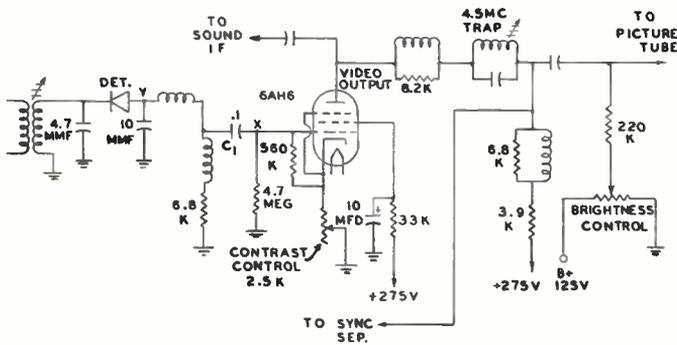
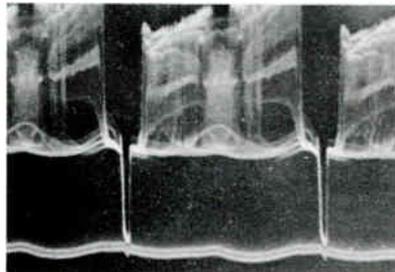


FIGURE 7

Complete video detector and video amplifier circuit.

put lead of the oscilloscope here, the pattern shown in Fig. 8 appears on the scope screen. Here is the missing video signal. Since it is obviously

FIGURE 8
Video signal on scope.



present at point Y but not at point X, then something must happen to the signal somewhere between these two points. From the schematic diagram, Fig. 7, we see that capacitor C1 is a likely prospect because the video signal must pass through it to reach the control grid of the video amplifier. When C1 is checked, it is found to be open.

Second Case History. The preceding illustration revealed how the signal tracing method uncovered a defective capacitor between the video detector and the video amplifier. The same approach is equally effective elsewhere in the receiver.

For example, suppose that a television receiver exhibits good sound, but the picture refuses to lock-in horizontally, as shown in Fig. 9. No matter how the horizontal hold control is turned, the picture does not lock-in.

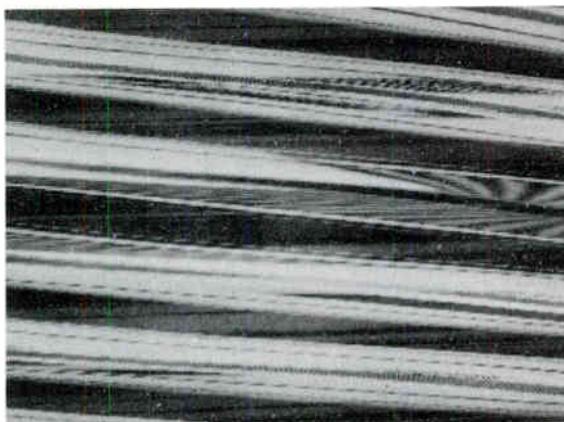


FIGURE 9
Loss of Horizontal Sync.

To track down the trouble, the television set is turned on and a station tuned in. With an oscilloscope, the video signal is checked at the picture tube and found to be normal. Then, the vertical input lead of the oscilloscope is shifted to point X in Fig. 10 because the video signal is tapped off here for the sync separator. The signal, at this point, also appears normal.

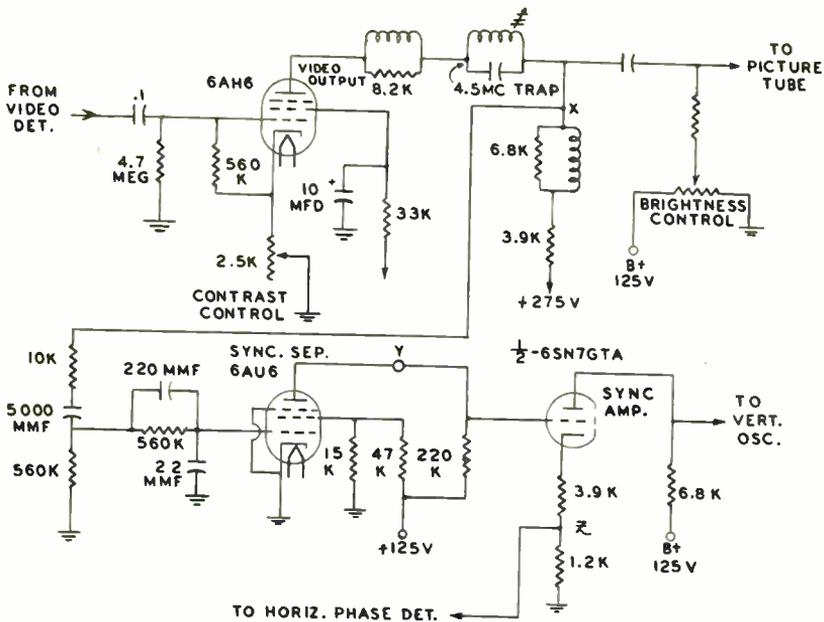


FIGURE 10
Typical sync circuits.

The next step is to check the signal at the output of the sync separator stage. The pattern that appears on the scope screen when the vertical input lead is connected to point Y is shown in Fig. 11. Note that the horizontal sync pulses are clearly visible, while much of the video signal has been removed. This is the proper function of the sync separator and we conclude it is operating normally.

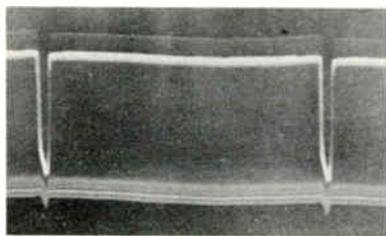


FIGURE 11
The form of the signal at point (Y) figure 10.

The scope is then shifted to point Z. This is the place where the horizontal pulses are obtained for the horizontal sweep system. No pulses are present at this point. Since the signal was present at point Y the trouble has been isolated to the Sync Amplifier tube. Resistance and voltage checks will show that the 1-2K cathode resistor is open.

Note, again, how we traced the video signal through the system until we found where it either became distorted or it disappeared entirely. At that point we checked the various components until the defective one came to light.

The same conventional signal tracing method can also be used elsewhere in a television receiver, although sometimes it has to be modified somewhat or additional test equipment must be employed. (We use the word conventional to describe this signal tracing method because there has recently become available a modified signal tracing system which not only cuts down the amount of servicing time required, but it also drastically reduces the need for any additional test equipment. We will describe this new, revolutionary approach shortly.)

For example, suppose you see the pattern on the screen shown in Fig. 12.

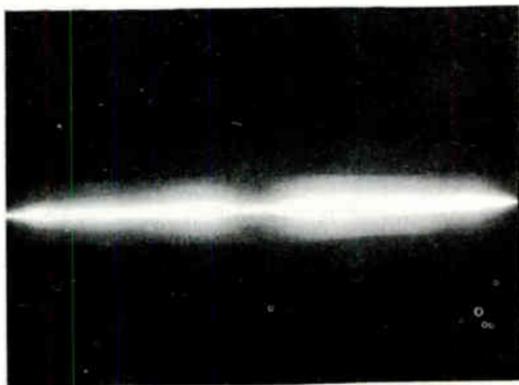


FIGURE 12
Loss of vertical sweep.

The appearance of a single horizontal line, with the rest of the screen completely dark, indicates that the picture tube is not receiving any ver-

tical deflection voltage. The circuit to check, then, would appear to be the vertical deflection oscillator and output tube. The oscillator in this receiver is a blocking oscillator utilizing one half of a 6AW8 tube. The output stage uses a beam-power 12W6GT. See Fig. 13.

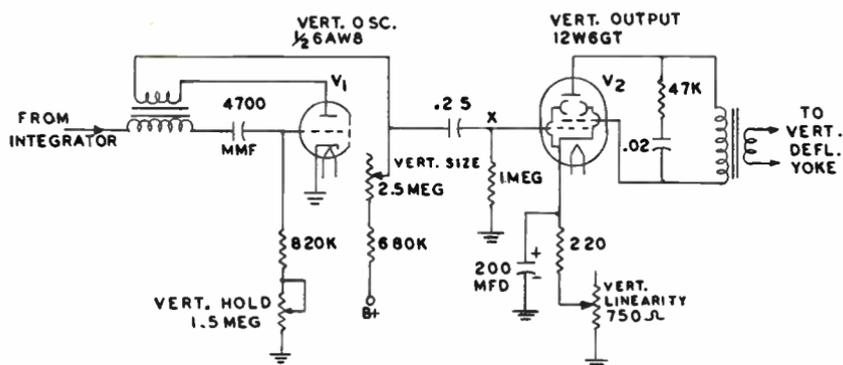


FIGURE 13
A vertical sweep system.

Now, when these two stages are functioning properly, the waveform shown in Fig. 14 is generated by the blocking oscillator and fed to the control grid of the 12W6GT. The latter tube amplifies this signal and transfers it to the vertical windings of the deflection yoke via the output transformer, T1.

Note that this action takes place whether an R.F. signal is received or not.

When a television signal is present, its sync pulses lock the vertical oscillator in, so that the vertical sweep frequency is kept in step with the vertical sync pulses of the arriving signal.

Since a signal is not required to keep V1 and V2 functioning, all we need to check this circuit is an oscilloscope. With this scope, we would first check the waveform at the control grid of V2. If the circuit is normal here, the waveform will possess the shape shown in Fig. 14. In the present instance, this was not true. The waveform was distorted. This indicated that something was defective in the circuit. The tube, V2, was pulled out and tested, but it checked okay. However, with the

tube out of the circuit, the waveform at point X returned to normal. Apparently whatever was causing the trouble was doing it through the tube.

The manufacturer, in his schematic diagram of the receiver, indicated that the cathode voltage was on the order of 15 volts. With the 12W6GT tube back in place, the voltage, as measured here with a VTVM, was found to be zero. This seemed to point definitely to the cathode circuit as the cause of the trouble. With the set power turned off, each of the components present here were checked and the cathode filter capacitor was found to possess an internal short circuit.

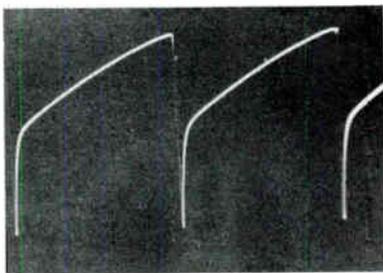


FIGURE 14

The waveform that would normally be present at the control grid of V_2 , Fig. 13, when the circuit is functioning properly.

Note that in the foregoing case history, the signal tracing method was altered somewhat. In the vertical system a signal; i.e., the deflection waveform generated by the vertical oscillator, was already present. Hence, there was no need to inject a signal. All we had to do was to use an oscilloscope to view the signal in the circuit. If it was distorted, then the point of trouble was indicated and all that remained to do was to locate the individual item that was responsible for the distortion. In the present case, this turned out to be a capacitor in the cathode circuit of the vertical output tube.

If the oscillator had been prevented from working, no waveforms at all would have been present, either in the oscillator or the output circuits.

How would we have located the trouble now?

The oscilloscope would have indicated initially the absence of any waveforms. Thereafter, a voltage and resistance check would have been necessary to locate the reason for this inaction.

Is there a faster way of individually checking out these circuits under these conditions? The answer is YES, but a special instrument is needed for the job. Just what this instrument is will be discussed presently.

Third Case History. Another case history involving signal tracing that would be instructive to study concerns a receiver in which there was neither sound nor picture. There was, however, a raster on the face of the picture tube.

A good starting point, when both picture and sound are absent, is at the video detector. See Fig. 15. This point is selected because the sound and video signals separate at this stage, with sound signal going to the sound IF system and the video signal continuing on through the video amplifier. With a local station tuned in, the waveform at point P in Fig. 15 was checked with an oscilloscope. Nothing was found here, indicating that the incoming signal was not reaching the video detector.

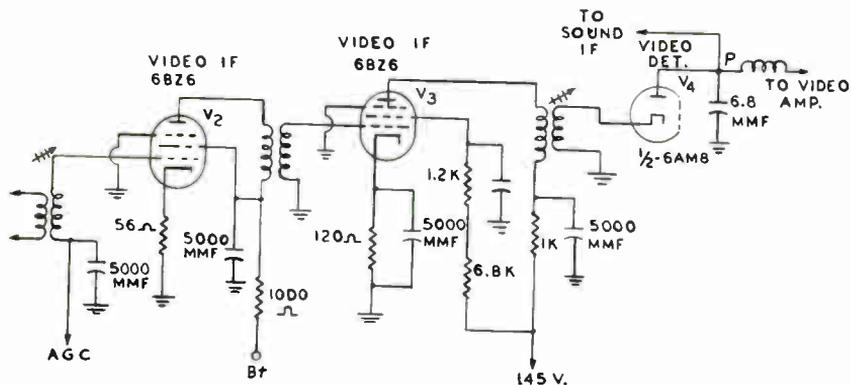


FIGURE 15
Typical IF amplifier system.

The next logical step would be to move forward to the control grid of the last video IF amplifier to see if the signal is present here. However, now, a problem is encountered. The signal at the grid of V3 is at the IF frequency, in the neighborhood of 45 mc. This signal cannot be applied directly to the vertical input terminal of the oscilloscope because its frequency is too high. It is necessary first to demodulate the signal and for this job a special demodulator probe is required.

The signal output of the probe connects to the vertical input terminal of the oscilloscope. The probe output also has a ground lead and this attaches to the ground terminal on the oscilloscope. At the probe itself, there is a short ground lead and this connects to the receiver chassis at a point near the place where the probe needle is to be touched.

With the equipment in operation, the tip of the demodulator probe is touched to the control grid of V3. If the video signal is present at this point, the signal pattern shown in Fig. 16 will appear on the scope screen. In the present instance, nothing was obtained; this meant that no signal was present here.

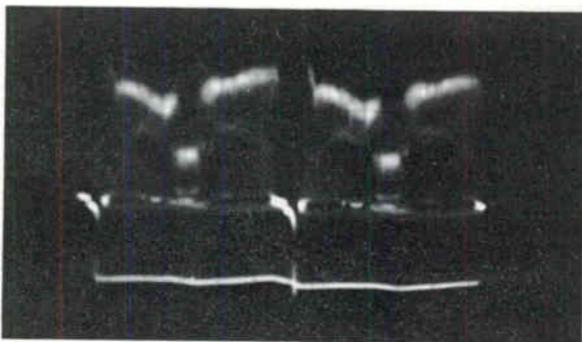


FIGURE 16
Demodulated video signal.

As a next step, the probe (and its ground lead) was moved to the control grid of the second video IF stage. (Note that we are moving toward the antenna input terminals in an effort to locate the signal.) This time, the pattern shown in Fig. 16 was seen on the scope screen, indicating that a signal was able to reach this point in the circuit. Something was apparently preventing this signal from passing through V2. The job was now to find what the trouble was.

As a first step, the probe was touched to the plate of V2. No signal was found here. This meant that the signal was definitely not getting through the tube. The tube itself, however, checked out good on a tube tester. At this point, voltage and resistance measurements of this circuit had to be resorted to and when this was done, it was found that the 1,000-ohm plate resistor had opened up, preventing any B + voltage from reaching the plate.

In the foregoing application of the signal tracing method, we needed an oscilloscope and a demodulator probe. This not only places an additional burden on the serviceman, the burden of properly setting up the equipment, but it also slows him down. This is unfortunate, because time is money and the more time spent on a job, the less there is available for another job. Thus, the number of different sets a technician can work on per day is reduced.

If the trouble had occurred in the tuner, the probing work, as outlined above, would have continued forward through the video IF stages until the tuner was reached. Then, the serviceman would have gone into the tuner, stage-by-stage.

However, in the tuner the signal level is very low, on the order of microvolts and it would not be possible to pick up a signal, even if present, and have it develop a usable pattern on the screen. Hence, still another piece of equipment would be needed. This is a preamplifier between the probe and the scope. Many service shops do not even own such a unit and for them, signal tracing **in this way** could not be carried out. They would have to rely solely on voltage and resistance measurements, and this procedure could take quite a while.

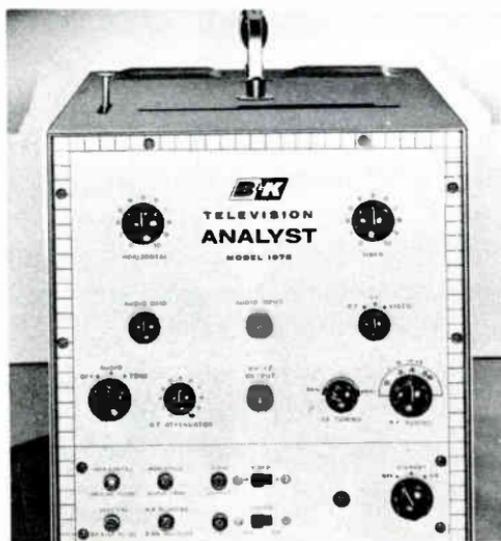


FIGURE 17

The B & K Television Analyst

Thus, while signal tracing is a very powerful method of tracking down troubles in a television receiver, it does have definite limitations **as it is ordinarily employed**.

But there is a way of using signal tracing¹ so that very little auxiliary equipment is required. In this method, complete picture signals are injected into the receiver using the special signal generator shown in Fig. 17. This is the B & K TELEVISION ANALYST, but before we show how it can cut servicing time, at least in half over conventional methods, let us take a closer look at the instrument to see what signals it can generate.

¹ When a signal from a broadcast station is received and its presence at various points in the receiver is checked by the procedure outlined above, then the process is called signal tracing. However, if a signal from a small generator is injected into the set, then the process is commonly referred to as signal substitution.

SECTION III

THE TELEVISION ANALYST

Probably the most important single feature of the B & K Television Analyst is the signal it develops. This signal is formed from a positive transparency which is slipped into the cabinet through an opening at the top. This transparency is scanned by the scanning beam in a small, 5-inch cathode-ray tube and the resulting light variations are converted to video.

Thus, the Television Analyst gives you a signal which, when it is passed through a television receiver, will develop an identical picture on its screen.

In short, the Television Analyst is a miniature television broadcast station.

Furthermore, it will produce this television signal at the normal RF frequencies (channels 2-6), at video IF frequencies (25-45 mc), and at video frequencies (0-4 mc). This enables the signal to be injected at any point along the signal path of the receiver, from the antenna to the picture tube. As we shall see presently, this is a major reason why the Television Analyst is so effective in reducing servicing time.

The video amplifiers beyond the second detector pose a special problem of signal polarity. For example, if the cathode-ray tube receives the video signal at its cathode, then a signal is required in which the sync pulses extend in the positive direction. On the other hand, if the video signal is applied at the control grid, then the opposite phase is required. The Television Analyst takes care of both situations by providing video signals of positive and negative polarity.

To form a complete television signal, sound is required and this, too, is available from the instrument. The sound, which is a 400-cycle note,

produces an FM sound carrier which is separated from the video RF carrier by 4.5 mc, just as it is in commercial broadcasting. Thus, both the video and the sound systems can be checked simultaneously.

The 400-cycle audio note is also available separately, for checking the audio amplifiers. Furthermore, if any other audio signal is desired, provision exists for inserting it in the television signal in place of the 400-cycle tone.

When trouble is encountered in the horizontal or vertical sweep systems, it is convenient to have horizontal or vertical driving pulses available by themselves. For example, suppose the screen of a defective receiver is totally black, indicating the absence of any high voltage. Wouldn't it be convenient to be able to inject horizontal driving pulses at the grid of the horizontal output tube and see whether high voltage is produced?

With conventional signal sources this is not possible. But with a Television Analyst it is.

There is one additional facility of the Television Analyst that must not be overlooked. This is its ability to develop test signals for a color television receiver. If you will look along the bottom row of pin jacks, you will find one labeled 3.58-mc color. This signal enables servicemen to check the chroma circuits of a color television receiver. Furthermore, with the color slide switch in the "ON" position, the same 3.58-mc signal will combine with the video signal and produce a color rainbow spectrum ranging from reddish-orange at one side of the screen to green at the other side. In between, the color will change gradually through red, blue, and cyan.

Finally, for the very important function of checking the convergence of a color tube, a positive transparency is made available containing a series of white dots. This will enable you to completely check static convergence. For dynamic convergence, a white-line slide is provided.

The above discussion has covered only the bare outlines of the Television Analyst. To appreciate how this instrument can speed up the servicing of a television receiver by a factor of 2 or 3 to 1, we will have to examine how it would be applied to specific sections of a receiver. However, before we actually do this, let us first examine one of the most useful servicing images yet devised — The Television test pattern.

SECTION IV

THE TEST PATTERN

The principal purpose of a test pattern is to reveal to a serviceman just how well a television receiver is functioning. It does this by means of a series of lines, generally formed into wedges, by circles, and by other appropriately chosen shaded areas. Each of these markings possesses a very definite meaning and by knowing this information, the serviceman is able to analyze, with a high degree of accuracy, the condition of any television receiver through which this test pattern has been sent.

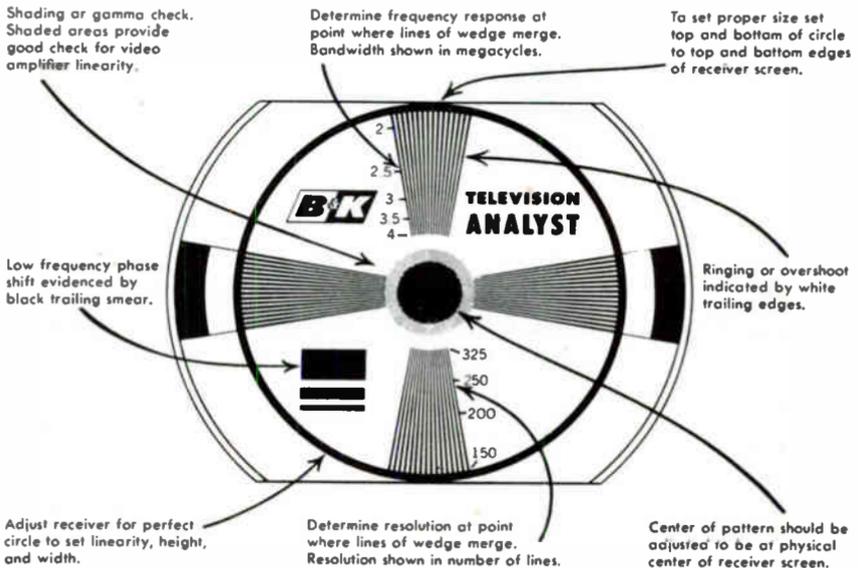


FIGURE 18
The test pattern used in the Television Analyst.

In the discussion to follow, we will explain the various markings on the test pattern which is provided with the Television Analyst. See Fig. 18. Since many of its markings are similar to those used in other test patterns, what we learn about this pattern will apply to the others as well.

1. Aspect Ratio and Linearity. When the test pattern is produced on the screen of a television receiver, it should completely fill the screen. In our present television system, the width is $1\frac{1}{3}$ times greater than the image height. This relationship, commonly referred to as the aspect ratio, is stated as a ratio of 4 to 3. That is, if the width is 4 units (inches or feet), the height is 3 units.



FIGURE 19A

(A) The appearance of vertical non-linearity in the test pattern.

In the test pattern of Fig. 18, the large, dark circle has a diameter which represents the three in the aspect ratio; this makes it $\frac{3}{4}$ of the image width. The picture appearing on the television receiver screen should be adjusted until the upper and lower portions of the circle are touching the top and bottom edges, respectively, of the screen mask. The width of the image is then increased until the left and right-hand edges of the image reach the corresponding edges of the screen mask.

After the foregoing has been done, look closely at the large, dark circle. Is it still round, as in Fig. 18, or has it now become egg-shaped, as in Fig. 19A and Fig. 19B.

If its roundness has been retained, then we know that the vertical and horizontal linearity of the scanning beam is good. But if the circle is distorted vertically, (as in Fig. 19A), or horizontally (as in Fig. 19B), then we know that receiver linearity is off.

As a matter of general interest, vertical non-linearity is indicated by the circle being "egg-shaped" in the vertical direction. By the same reasoning, horizontal non-linearity is indicated by having the circle "egg-shaped" in the horizontal direction. In either event, the linearity control or controls are adjusted until the circle is perfectly round.



FIGURE 19B
(B) Horizontal non-linearity.

2. Shading Check. Every television image must be capable of displaying a series of shades ranging from white to black. To check the overall shading of the test pattern, adjust the set contrast control until the concentric circles at the center of the pattern reveal their different shadings. When the shading circles are not distinguishable, it indicates amplitude distortion within the receiver. Usually this is caused by an improperly biased tube in the video system or a gassy tube.

3. Frequency Response. The frequency response of a television receiver is one of its most important features and determines how well an image will be resolved. Of particular importance is the extent of the low and high ends of this response characteristic and a test pattern is designed to bring out this information quickly and easily.

A. High-Frequency Response. The extent of the high-frequency response of a television receiver is brought out by the two vertical wedges. If you will look along the left-hand edge of the upper wedge, you will see the figures: — 2, 2.5, 3, 3.5 and 4. This represents frequency in megacycles. Thus, the 2 means 2mc, the 2.5 is 2.5 mc, etc. The frequency at which the response cuts off is revealed by the point where the lines in the wedge blend together and are no longer individually distinguishable. Thus, if the lines can be seen separately only above 2.5mc, but not below, then the band pass of the video system is 2.5 mc.

The same information concerning frequency response, but indicated somewhat differently, is given in the lower vertical wedge. Here, in place of frequency values, the resolution is shown in number of lines. The correspondence between these two methods of indicating the frequency response or resolution of a video system can be seen from the following discussion.

The use of alternate black and white lines to indicate frequency response is based upon the fact that alternate black and white dots can be considered as representing a square wave. The black dot would then represent the negative half cycle and the following white dot the positive half cycle. Both dots together constitute one complete cycle. See Fig. 20.

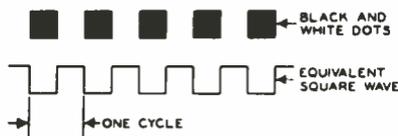


FIGURE 20

Alternate black and white dots represent a square wave.

By closely placing the black dots one above the other, we obtain a black line, and similarly, for the white dots, we obtain a white line. Actually, white lines are represented by the spaces between the black lines. It is these alternate black and white lines that form the wedges observed on the test pattern.

At the far end of each wedge, the black and white lines are fairly wide, indicating that the frequency of the square wave forming these bars is

low. As we move in toward the center of the screen, the lines become narrower and more closely spaced, indicating that the frequency of the square wave is rising. See Fig. 21.

Now, in order for all the lines in a wedge to be distinguishable from each other, the various square waves must be able to pass through the video system. If, for example, only part of the square waves can pass through the video system undistorted, then only part of the wedge will show each of the lines distinctly. The remainder of the wedge, produced by higher frequency square waves which are unable to pass through the video system without distortion, will show the lines blended together. See Fig. 21A.

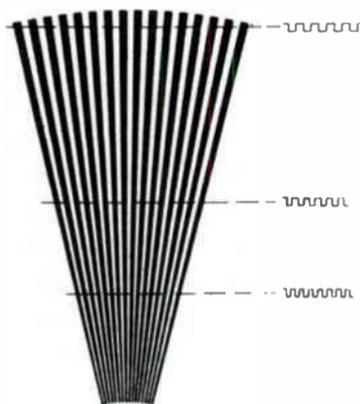


FIGURE 21

The frequencies represented by the various sections of the wedge increase as the distance from the center of the screen decreases.



FIGURE 21A

The point where the lines begin to blend together indicates the upper frequency at which the receiver response starts decreasing.

The point along the wedge where the lines start blending represents the high-frequency end of the frequency response of the system. It is this information that the serviceman is vitally interested in.

In all test patterns, there is one set of vertical wedges and one set of horizontal wedges. This enables us to check both the horizontal and vertical resolutions of the system. The horizontal wedges are used to determine vertical resolution and vertical wedges are used to determine horizontal resolution. That this should be evident from the following reasoning. Vertical resolution, for example, is dependent upon the closeness

with which lines can be placed above each other. In the horizontal wedges, the lines are placed one above the other, with the spacing between them varying at various points along the horizontal wedges. When the lines are no longer distinguishable from each other, we have reached the limit of the vertical resolution.

By the same reasoning, the vertical wedges indicate how closely lines or details can be placed next to each other horizontally. When the system is no longer able to resolve these pinpoint white and black lines, they become indistinguishable and the limiting resolution has been reached.

In a television receiver, the vertical resolution is almost entirely a function of the number of lines used, in this case 525. The horizontal resolution, on the other hand, is dependent upon the response and performance of the receiver RF, IF, and video-frequency stages and this is important to the serviceman. Hence, the vertical wedges are examined to determine where the lines blend, and the reading at this point is recorded as so many lines, say 300. This means that up to the number 300 in the test pattern the lines are separate and distinct but beyond this they run together. From experience, most servicemen know that a resolution of 300 lines is close to a 4.0-mc band pass in the receiver, but they possess no accurate method of determining the system response for other values of lines resolution. With the aid of the following formula, the conversion from the number of lines to frequency response can be readily achieved.

$$\text{Freq. (cycles)} = 12,500 \times N$$

where N = number of lines as read from the test pattern. For example, if the lines merge at 300 lines, the receiver response is: $\text{Freq.} = 12,500 \times 300 = 3,750,000 \text{ cycles} = 3.75 \text{ mc.}$

When the receiver system is overcompensated at the high frequencies, so that a definite peak results, then a process known as "ringing" will take place. We check for ringing with the two vertical wedges. If each wedge is followed by multiple lines, somewhat similar to ghost images, then ringing is present. As a further test, it should be possible to tune out the multiple lines by rotating the fine tuning control, if the test signal is passing through the front-end stages of the receiver.

When only slight overpeaking is present, it can be detected by examining the black horizontal bars at the bottom of the image. At the left-

hand edge of these bars, the margin will be excessively black, whereas at the right-hand edge there will be a short, excessively white margin following these bars. The total effect is to outline the bars, and to make them more sharply defined.

B. Low-Frequency Response. The three black horizontal bars located at the bottom of the test pattern are for the purpose of checking the low-frequency response. When the system's low-frequency response is poor, the reproduced edges of the horizontal bars will be sharply defined but they will change from black to an excessive white, with a streamer shading from this white back to the normal background. This visual effect is one of smearing, with the smearing going from left to right because that is the path of travel of the electron beam.

We have just seen how useful a properly constructed test pattern can be in evaluating the performance of a television receiver. At one time, when commercial television broadcasting was just getting started, television stations all over the country would broadcast these patterns for several hours each day. Now, however, sponsored programs have grown to such an extent that very little time is left for transmitting test patterns and this source of testing is no longer available to the serviceman.

However, because test patterns are highly useful service devices, it is important that each technician have access to such signals. It is here that the Television Analyst excels, because irrespective of local broadcasting conditions the serviceman always has a test signal available through his Television Analyst.

Furthermore, when we combine the utility of a test pattern with the flexibility of the Television Analyst, we come up with an instrument that enables us to perform tests on a television receiver that would otherwise require a host of separate units.

You might question, at this time, why an oscilloscope and an "off the air" signal could not be used to troubleshoot a receiver instead of using the Television Analyst. The answer is easily seen by the following typical example.

A television receiver comes into the shop with a "smeared" picture. This smear could be introduced in either the video amplifier, detector, video IF, or the tuner stages. In order to determine in which stage the

smear is introduced we would have to examine individually each section of the receiver. Using an oscilloscope with the necessary demodulator probes we would find that the scope pattern would be the same at all points, whether the smear was present or not (see Fig. 22B and 22D).



FIGURE 22A

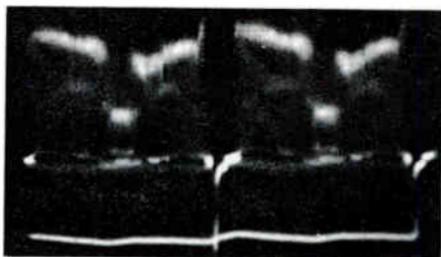


FIGURE 22B



FIGURE 22C

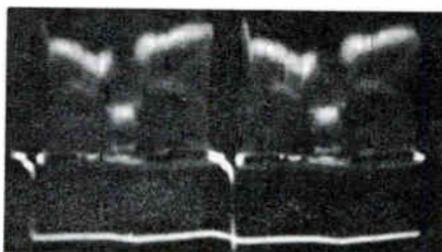


FIGURE 22D

FIGURE 22A, 22B, 22C, 22D

- A. Smeared picture as seen with test pattern on TV set.
- B. Oscilloscope display of video signal of smeared picture in A.
- C. Clear picture with no smear as seen on TV set.
- D. Oscilloscope pattern of video signal of clear picture in C.

As you see the oscilloscope patterns for both the good picture and the smeared picture are the same. It is evident that "conventional" signal tracing would fail for these types of troubles.

Using the Television Analyst to inject signals stage by stage, it would immediately be evident in which stage the smear is being introduced as you will actually see a smear test pattern as soon as you inject the signal into the stage which is causing the smear.

There are many other examples of the ease with which a trouble can be diagnosed by viewing the result directly on the face of the TV receiver instead of trying to interpret the patterns that would appear on an oscilloscope.

SECTION V

USING A TEST PATTERN SIGNAL FOR SERVICING

To develop a test pattern signal, the B-K Television Analyst takes the unique approach of using a positive transparency with the test pattern on it. This is slipped into the cabinet in an opening provided for it. See Fig. 23. From this strip of film, a test pattern signal is developed and made available in RF, IF, and video signal form.

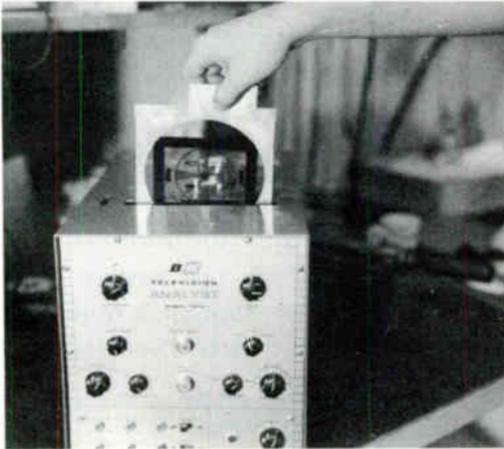


FIGURE 23

The positive transparencies used by the Television Analyst are inserted in the instrument as shown above.

Now let us see how this signal would be used for servicing.

Let us suppose that we have a television receiver whose performance

we wish to check. The first step would be to set the receiver up for reception of a signal, preferably on one of the lower VHF channels. Let us assume that channel 3 is selected.

The next step is to take the Television Analyst and place it in operation, with the test pattern transparency mounted in the film holder. A coaxial cable connector then is attached to the "RF, IF OUTPUT" terminal of the Analyst. The other end of this cable connects to the input terminal of the receiver.

With both units in operation, adjust the "RF Tuning" control of the Analyst until a test pattern image appears on the receiver screen. Look at the pattern carefully. Note its overall appearance.

Are the vertical edges substantially straight or are they badly bent? This may be due to overloading by the signal or it may reveal a defective AGC system or hum in the signal.

What is the frequency response of the system through which the video signal is passing? This is revealed by the point where the lines in the vertical wedges come together.

Is there any smearing of the large rectangular blocks in the lower left-hand corner of the screen? If there is, it indicates poor low-frequency response.

Is the large central circle round or egg-shaped? Any departure from a perfect circle indicates non-linearity in the deflection waveform, either in the vertical or horizontal systems.

Thus, from the appearance of the test pattern after it has passed through a television receiver, we can get a fairly good idea what is wrong with the signal circuits in that receiver.

As a matter of fact, we can frequently go even one step further with an instrument like the Television Analyst.

Suppose we pass the test pattern signal through the entire receiver and obtain the test pattern image shown in Fig. 24. The frequency response, as revealed by the vertical wedge, is only a little over 2.0 mc. This is generally less than we would ordinarily find in most receivers, and consequently, something appears to be at fault.

In order to isolate the section where the trouble lies, let us take the signal probe from the Television Analyst and place it at the control grid of the first video IF amplifier. (The ground lead remains attached to the receiver chassis.) The signal frequency is shifted from the RF to the IF range.

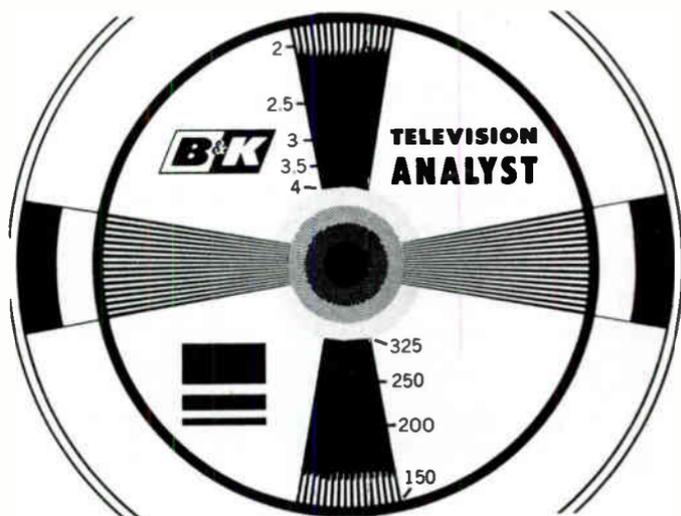


FIGURE 24

The test pattern shows that the frequency response of the receiver under test is only 2 mc.

Now let us examine the test pattern image we obtain on the receiver screen. Is the frequency response still the same (as indicated by the two vertical wedges) or has it improved? If it has improved noticeably, then it indicates that the RF stages could stand realignment.

Or it may be that the image, which in the previous check showed signs of overloading, now appears quite normal. This may indicate that perhaps the AGC system is not functioning properly.

Hence, a comparative test is often very revealing and it is only with a test pattern of the type shown in Fig. 18 that a quick check is possible.

The same comparison check can be made on the video detector. Here the video signal itself (without any carrier) is required from the Television Analyst and this is available from a separate terminal. The sig-

nal is injected in the output circuit of the video detector while the ground lead from the test instrument goes to the chassis of the receiver.

The same test pattern should appear on the picture tube screen. If the image is reversed, the polarity of the video signal should be reversed.

Again, check the vertical wedges of the test pattern. This will reveal the extent of the frequency response of the video system. Check also for low-frequency smearing.

Here are reliable, accurate tests which can be performed in less time than it takes to describe them. And they will reveal important information concerning the circuit under test.

So far we have considered only the signal system — from the antenna to the picture tube. But the two deflection systems (vertical and horizontal) are important, too, and they can also be checked out with a test pattern signal.

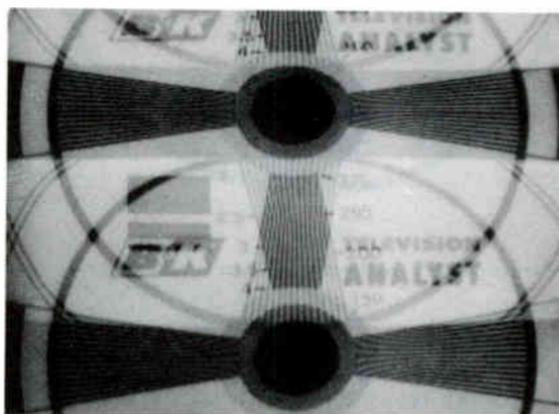


FIGURE 25

Loss of vertical synchronization.

For one thing, the signal contains vertical and horizontal sync pulses and these will serve to lock-in the vertical and horizontal sweep oscillators. If a stationary picture cannot be obtained, indicating lack of synchronization, then a number of possible troubles may be afflicting the receiver.

For example, suppose you feed a test pattern signal to a receiver and obtain the image shown in Fig. 25. The picture appears to be held in horizontally, but lacks vertical synchronization.

What does this mean?

It means that horizontal sync pulses are reaching the horizontal sweep oscillator and, furthermore, that the entire horizontal system is functioning normally. Since it is common practice to have both the horizontal and vertical sync pulses pass through the same sync separator, it is safe to assume that the vertical pulses are passing through this stage (or stages) in normal fashion.

This already cuts down the number of stages that we need to check.

As a next step, we can rotate the vertical hold control and note whether the image travels up and down as we change the vertical frequency. If it does, then we can assume the vertical sweep oscillator is operating properly.

Evidently, then, the vertical sync pulses are being lost somewhere between the sync separator and the vertical oscillator. This narrows the defect location considerably — certainly much more than if we did not have a test pattern.

This, in turn, means that **less** time will be needed to isolate the actual trouble.



FIGURE 27

The effect on an image of a heater-to-cathode short in one of the signal tubes.

And if, to the test pattern, we add such conveniences as separate vertical and horizontal driving pulses, we can begin to appreciate the servicing time saver that an instrument such as the Television Analyst can be.

One further word about the servicing effectiveness of the test pattern before we evolve a quick, direct method of isolating over 90 per cent of the troubles found in television receivers.

In addition to revealing poor frequency response, non-linearity, mis-adjustment of the aspect ratio, and troubles in the deflection systems, a test pattern is also a very sensitive indicator of image distortion.

For example, consider the horizontal distortion in Fig. 27. This usually is due to a very gassy tube or a heater-to-cathode short in a tube. The exact isolation of the tube causing the trouble can be made with a test pattern generator such as the Television Analyst. Again, this is something we will come back to presently.

SECTION VI

HOW TO USE TELEVISION ANALYST FOR GENERAL TROUBLESHOOTING

The Television Analyst, as we saw briefly in Section III, develops a test pattern signal at RF, IF, and video frequency. That means that the signal can be injected directly at the antenna terminals, in the IF system, and beyond the video second detector.

In addition, a frequency modulated sound signal is also generated so that the sound section can be checked as fully as the video sections.

Finally, for the deflection systems, there are vertical and horizontal driving pulses. This means that every important section of a television receiver is capable of being checked under normal operating conditions — which is the **only** way to completely check a circuit.

In the sections to follow, the use of the B-K Television Analyst to troubleshoot specific portions of a television receiver will be considered in considerable detail. At the moment, however, we want to demonstrate how to use the Television Analyst for general troubleshooting.

Suppose a receiver is brought into the shop with the complaint that no sound or video is present. However, there is a raster on the screen and in this respect the set appears to be normal.

What do you do?

The first step, whether a Television Analyst is being used or not, is to check the tubes along the incoming signal path. This includes the following stages: RF amplifier, RF mixer, RF oscillator, all video IF tubes, video detector, and video amplifiers.

“Why not the sound section tubes or those in the deflection systems?” you may ask.³

The answer is quite simple and is based on the way the circuit operates.

Since both sound and video are missing, whatever is causing the trouble is affecting both signals at the same time. The sound system is concerned solely with the sound signal and it is probable that the trouble does not exist here. (We will show later how we can uncover a trouble in the sound system that **does** affect the video. However, for the initial step, we can safely disregard the sound system.)

We can also initially overlook the two deflection systems because a normal raster is observed on the screen.

Let us suppose, then, that we test the tubes indicated above and all are good.

What is the next step?

The next step is to take the Television Analyst and set it up to produce a test pattern. Then, let us start at the grid of the video amplifier. (We are assuming the receiver has only one such amplifier.) Since a video-frequency signal is needed here, take one of the test leads (that come with the instrument) and plug it into the terminal marked, “VIDEO OUTPUT.” A second lead is connected to the ground terminal and it is attached to the chassis.

With the test instrument and the receiver in operation, a test pattern image will appear on the receiver screen if the circuit is normal from the grid of this video amplifier to the picture tube.³

³With a quick tube checker, such as the B & K Model 650, the serviceman may want to check all the tubes in a receiver. This can be done in about 10 minutes for the average set. It is advisable for this reason. Shop service generally means a “complete overhaul” to the customer. Any failure or defect in the set after shop service is blamed on the serviceman. Complete testing of all tubes will greatly reduce the possibility of any set failure after delivery.

³You will notice that in all of our analyzing with the new “signal injection” method we are testing the circuits from the point of signal injection all the way to the picture tube and speaker. In the conventional signal tracing method the circuit being tested is from the antenna to the point at which the signal is being picked off and displayed on the oscilloscope.

If a negative picture is observed, the polarity of the video signal is reversed by means of the slide switch located next to the "VIDEO OUTPUT" pin jack.

In the present instance, a normal picture is obtained on the receiver screen and we conclude that the circuit from the signal injection point to the picture tube is okay.

If the receiver has two video amplifiers, then the signal from the Television Analyst should be fed to the grid of the stage closest to the video detector.

The next step is to apply the video signal at the output of the video detector. When this is done, nothing appears on the picture tube screen.

Evidently, the signal cannot travel from the detector to the grid of the first video amplifier.

In short, the path between these two points is open.

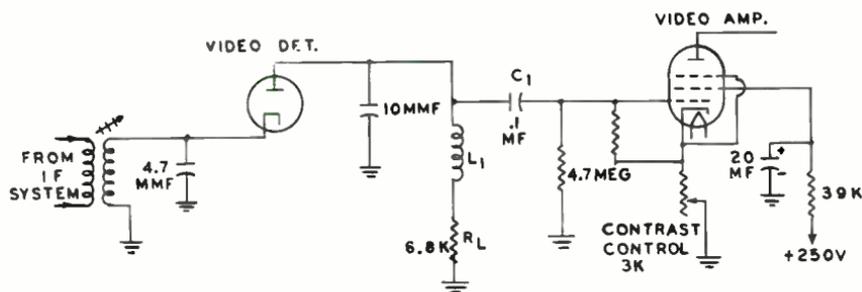


FIGURE 28

Typical trouble in video circuit.

The next problem is to try and localize the seat of the trouble more closely. To show how this is done, let us look at the actual circuit involved in this servicing problem. This is shown in Fig. 28.

Note that the video detector has its usual peaking coil (L_1) and load resistor (R_1). Also, there is a coupling capacitor, C_1 , between the video detector and the following video amplifier.

If we place our signal lead at the grid of the video tube, the image reappears on the screen. From this point to the picture tube, everything is fine. However, when the video signal is injected at the detector

plate, nothing happens. From this behavior, we must conclude that capacitor C1 is open because injecting the signal to the right of it produces an image while injecting the signal to the left of it does not.

When C1 is replaced, the set returns to normal operation.

Here is an actual servicing case history that was resolved in about five minutes. By any other method, isolation of C1 could have taken an hour or more because a single defective capacitor is an exceedingly difficult component to pinpoint.

However, the directness of the Television Analyst approach uncovered the trouble in a logical, easy-to-carry-out approach.

Two general rules can be formulated from the foregoing discussion.

1. Always check tubes first. For the sake of efficiency and time saving, use a quick-test tube checker, like the unit shown in Fig. 1.
2. In case of doubt as to the section in which the trouble is located, always start at the grid of the video amplifier closest to the picture tube. Gradually work your way toward the antenna terminals stage-by-stage until the picture is lost.

We will have occasion to use this procedure again. However, it is simple to remember because it approaches a service problem in a commonsense, straightforward manner.

Although the above servicing problem was solved when the trouble was uncovered in the video detector, the same step-by-step check of the various video IF stages could have been made as easily as the check of the video amplifiers.

Even the RF stages can be subjected to the same process had it been necessary to extend the tests this far.

As we will see in succeeding sections, no stage in a television receiver is immune. It is this ability that makes the Television Analyst such a powerful test instrument.

SECTION VII

HOW TO USE TELEVISION ANALYST TO TROUBLESHOOT AUDIO SYSTEMS

A complete television receiver possesses a sound system as well as a video system. Hence, to perform a complete servicing analysis, it is important that the serviceman be able to check out the sound system as well as the video section.

As a start, let us see what type of signal would be required to perform such a check. The block diagram of a typical sound system is shown in Fig. 29. The signal output is obtained from the video detector or, at most, the output circuit of the first video amplifier (if more than one stage of video amplification is employed.)

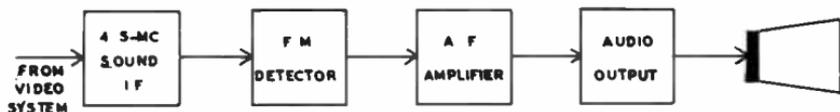


FIGURE 29

The sound system of a television receiver.

At this point, the sound signal is frequency modulated and possesses a center frequency of 4.5 mc.

This signal is amplified by one, sometimes two, 4.5-mc amplifiers then fed to an FM detector where the audio intelligence is obtained from the signal. Thereafter, there is an audio amplifier, a power amplifier, and, beyond this, a loudspeaker.

From this analysis, it is evident that two types of sound signals are needed to test fully the sound system.

First, we need a frequency-modulated 4.5 mc signal. Second, we need an audio signal.

In the B-K Television Analyst, we have both such signals. For the 4.5 mc signal, 400-cycle modulation is employed. When we apply this 4.5 mc signal to the front end of the sound system, a 400-cycle note is heard in the loudspeaker.

And, when an audio note is required, the Analyst provides just the 400-cycle voltage.

Now, let us use this combination to track down a defective sound system. The symptom was no sound output on any station, although a picture did appear. Inspection of the picture showed it to be normal.

The first step, as always, is to check tubes. If the serviceman wishes, he can check all the tubes, although in the present instance, only those tubes in the sound section actually need checking. The rest of the receiver appeared to be functioning satisfactorily.

The tube check showed all the sound tubes to be okay. Obviously, these were not the source of the trouble.

The Television Analyst is now brought into the servicing picture. Its signal can be injected at one of two points; either at the 4.5 mc amplifier at the start of this section or at the grid of the audio output tube, at the end of the system.

The best place to start is at the audio output tube closest to the loudspeaker.

The reason for this is quite simple. We know that a defect exists at some point in this sound system. Therefore, injecting a signal at the head of the system will not produce an output sound and we will know no more from this action than when we started.

On the other hand, if we start with the tube closest to the loudspeaker, the chances are good we will get an output indication. And if we do not, then we have essentially narrowed the trouble down to this stage — or the loudspeaker.

It is for these reasons that we **always** start with the tube closest to the loudspeaker.

For the test, we need an audio signal. This is obtained from the Television Analyst from the pin jack labeled, "400-CYCLE AUDIO TONE". A test lead is connected to this jack and to the grid of the audio output

stage in the receiver. See Fig. 30. At the same time, to complete the circuit, a lead connects the ground pin jack of the Television Analyst to the receiver chassis.

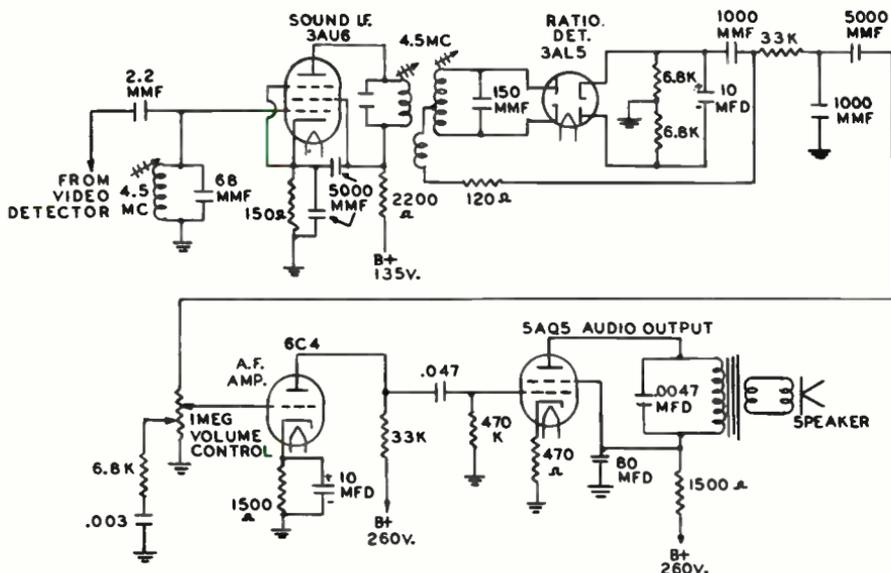


FIGURE 30
Audio system being analyzed.

If the circuit from the grid of the 5AQ5 to the loudspeaker is working normally, a 400-cycle note will be heard. In this case, the sound was heard.

The next logical step is to inject the signal at the grid of the 6C4 audio amplifier. Again the same output sound will be heard — only louder — if the signal can get through to the speaker.

Let us say, for the sake of illustration, that no sound is heard when the latter test is made. What does this tell us?

It tells us that somewhere between the last test point, the grid of the 5AQ5, and the present test point, the signal path is broken.

How do we find that point? We know, for example, that the 6C4 tube is okay because we had previously tested it. That leaves a component other than a tube as the culprit.

Let's see how we can track it down. From Fig. 30, we note that the plate of the 6C4 is connected to the grid of the 5AQ5 by a .01 mfd capacitor. To check this component, place the signal lead from the Television Analyst at the plate of the 6C4. This does not produce any sound in the loudspeaker.

However, when we touch the signal lead to the grid of the 5AQ5, a sound is heard. This is fairly conclusive evidence that the capacitor is defective (open).

At this point, the reader may wonder, how we could uncover a defective resistor, such as R1 (33K resistor), should this be open. Here is how this would be done.

Following the above procedure exactly, we would find that injecting the signal at the plate of the 6C4 **does** produce an output sound in the speaker. Hence, we know that the .01 mfd coupling capacitor is okay. Still, when the signal lead is moved back to the grid of the 6C4, nothing is heard.

This leaves only one conclusion to be drawn: the tube is not amplifying. A natural next step would be to check the plate voltage (with a voltmeter) and this would immediately bring the defective R1 to light.

The entire foregoing test procedure would hardly take three minutes, including the voltage check at the plate of the 6C4. This is certainly a record difficult to beat.

A continuation of the foregoing process would enable the serviceman to uncover a defective component in the stage preceding the detector or even in the FM detector itself.

To illustrate, suppose we encounter the symptoms outlined above. That is: no sound, but normal video. We follow the test procedure outlined above, applying a 400-cycle signal first at the grid of the 5AQ5 and then at the grid of the 6C4. In each instance, a 400-cycle note is heard from the loudspeaker indicating that the signal is passing through the system, from the point of application to the loudspeaker.

The next step is to check the FM detector, here shown to be a ratio detector (Fig. 30). How is this done?

In the B-K Television Analyst, an FM signal with a frequency of 4.5 mc is available from a front panel pin jack. This voltage is applied to

the plate of the 3AU6 sound IF amplifier. To complete the circuit, the ground terminal of the Television Analyst is attached to the receiver chassis.

Now, if the FM detector stage is functioning normally, the same 400-cycle note will be heard, without distortion, in the loudspeaker. A mis-adjusted FM detector will cause the sound to be distorted. However, since the symptoms indicate a complete lack of sound, chances are no distortion would be obtained. (The distortion, however, is mentioned because distorted sound is a frequent complaint and the foregoing method of tracking down circuit troubles would reveal distortion as well as a complete failure.)

Let us assume that a 400-cycle note is heard when the 4.5 mc signal is injected at the plate of the 3AU6. Then the next step is to shift the signal to the grid of the 3AU6. If, now, no sound is heard in the loudspeaker, we know that the trouble is localized in this stage and a voltage and/or resistance check will bring it to light.

The overall pattern of tracking down a defect thus remains the same whether it is in a low-frequency sound stage or a high-frequency sound stage. All we actually do is alter the frequency of the applied probing signal.

For all this, the Television Analyst is admirably suited. In fact, this is one of its prime features. It is possible, by using a number of signal generators, to develop the wide variety of signals required to check out the many circuits found in television receivers. In the B-K Television Analyst, all of the required signals are brought together in one instrument.

The extreme accuracy of the 4.5 mc signal developed by the Television Analyst makes it eminently useful for adjusting the FM detector. Probably the quickest way to do this with the circuit of Fig. 30 is as follows. Feed the 4.5-mc signal, modulated by the 400-cycle tone, to the grid of the 3AU6 sound IF amplifier. Purposely misadjust the secondary core of the FM detector transformer by rotating it one to two turns.

Now, adjust the primary core for the loudest 400-cycle tone from the loudspeaker. Then slowly rotate the secondary core until the sound output drops to a minimum. Repeat the secondary adjustment once or twice to make certain the best minimum point is attained.

SECTION VIII

HOW TO USE TELEVISION ANALYST TO TROUBLESHOOT VIDEO IF SYSTEM

One aim of most television servicing books is to develop in the reader the ability to determine, from an examination of the distorted image and listening to the sound output, where the trouble is approximately located.

For example, with both sound and video missing, but with a raster present on the screen, it is generally true that the trouble is located before the sound take-off point.

Or, with the picture distorted on local signals, but normal with weak signals, a good starting point is the AGC system.

There are other illustrations of this deductive technique and if you possess this ability, then, by all means, use it. But, with a Television Analyst, inability to pin-point immediately a certain section as the one containing the defect will not hinder you to any great extent.

By following the logical procedure outlined previously, you will isolate the trouble just as surely as any deductive method. As a matter of fact, given any normal assortment of defects that occur in television receivers, your chances of locating the defect with a Television Analyst is better than with conventional testing methods.

This has been demonstrated repeatedly by men with a variety of abilities in servicing television receivers from the most skilled technician to the man who is just commencing television servicing.

One of the sections in a television receiver that gives many technicians considerable trouble when it becomes defective is the video IF sys-

tem. Two to four stages are employed here, with the operating frequency either in the 20-mc range (21.25 to 25.75 mc) or in the 40-mc range (41.25 to 45.75 mc).

In this section, AGC voltage is always employed in at least one stage, the first, and frequently at the second stage as well, in order to obtain the desired gain control range. Finally, the interstage coupling network is tuned, generally provided by a bifilar transformer with an adjustable inner core.

All of these components can be seen readily in the typical 3-stage video IF system shown in Fig. 31.

Let us suppose that the trouble in the video IF system is a gassy tube which causes the stage to overload when a normal signal is received. The resulting effect on the image is shown in Fig. 32. Sound is normal.

How would we go about tracking down this trouble?

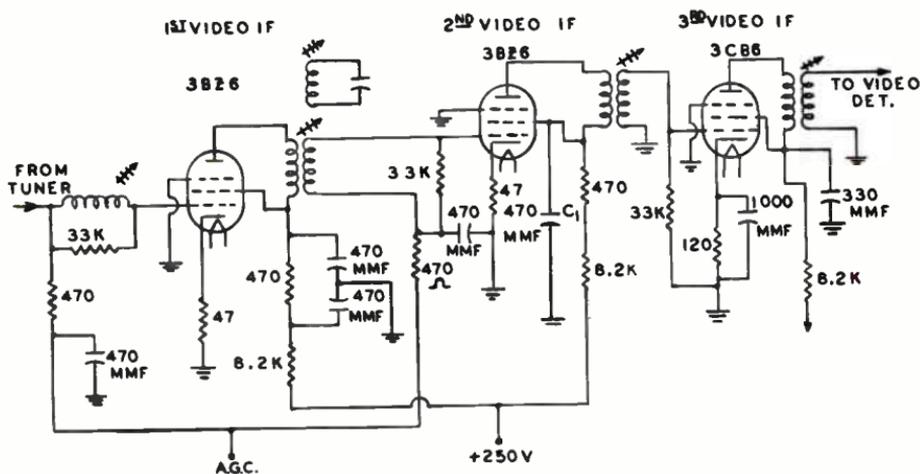


FIGURE 31

A typical 3 stage video I.F. system.

The first step in any intelligent approach to a service problem would be to check the tubes. It might be supposed that this would automatically bring the gassy tube to light.

Unfortunately, this is not always true because many tube testers are not equipped to perform a **sensitive** check on gas.⁴ Where such a facil-

⁴The B & K Dyna-Quik tube tester, Model 650, possesses a very sensitive gas test circuit.

ity is present and the serviceman uses it correctly, then a gassy tube will be uncovered.

But the average tube tester will not reveal many of these gassy tubes and it is not unreasonable to assume that the gassy tube—on which this case history is based—will pass by unnoticed.

Let us see how the Television Analyst will show you where the trouble lies.

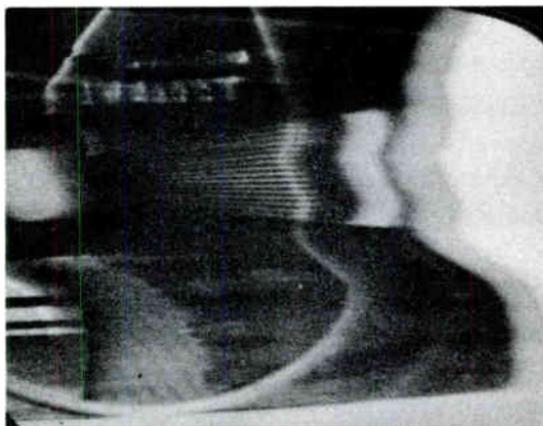


FIGURE 32

The appearance of an image produced when one of the video I.F. stages has been overloaded.

The first step after tube checking is to apply a test pattern signal, in its video form, to the grid of the video amplifier closest to the picture tube. When this is done in the present instance, a normal presentation is obtained on the screen. This tells us that the signal path from the grid of the video amplifier to the picture tube is OK.

It also informs us that the sync pulses from the test signal are reaching the vertical and horizontal sweep systems and locking these two systems in. Thus, we know that a substantial portion of the receiver is working normally.

When only one video amplifier stage is present in a receiver (i. e., the usual practice), the next step might be to check out the video detector in the following fashion. Obtain a modulated video IF signal from the Television Analyst, either in the 20-mc or 40-mc range, and apply

this signal at the grid of the final video IF stage. The ground lead from the Analyst connects to the receiver chassis.

A normal test pattern will be obtained if everything in the circuit is normal from this stage to the picture tube. In the present instance, such a picture was obtained.

When either the video detector or the final IF stage is bad, the signal will be prevented from passing through or a distorted or weak output will be obtained. Under these conditions, additional checking in these two stages is indicated.

We might pause here and note that after a technician has been working with the Television Analyst for a while, he will frequently check out the entire video amplifier system and the video detector at one time. He does this by skipping the first step outlined above and going immediately to the second step.

This is perfectly all right. The Television Analyst is a flexible instrument and there are many short-cut methods in its use. As the user applies the unit to more and more service jobs, he will develop many short-cuts suited to his own way of doing things.

Returning to the case history described above, we see that we are now in the video IF system and all we have to do is continue a stage-by-stage approach.

Thus, the signal probe is moved, in turn, to the grid of the 2nd IF tube, finally, to the 1st IF tube. In each instance, we would observe the test pattern on the screen and note the appearance of the image. When the probe is placed at the grid of the 2nd video IF stage, a distorted image is obtained. The trouble, then, lies in this stage.

Now, let us see how we can pin-point the trouble as residing in the tube. (Remember, we had previously checked this tube in a tube tester and a good indication was obtained. We are thus assuming that it is a good tube, unaware that it contains enough gas to produce the distortion.)

As a first step in checking this 2nd video IF stage, we can apply the signal probe to the plate of the tube. Since the signal does **not** have to pass through the defective tube, a normal picture will be obtained on the TV picture tube.

However, this is the only place where this action takes place. Applying the signal either at the control grid or cathode will produce a distorted image because in each instance the signal must travel through the tube.

Still assuming the tube to be OK, the serviceman can make voltage measurements in this circuit. If he does this, he will find here that the plate voltage is very slightly lower than normal⁵ while the cathode voltage is somewhat high. Finally, the grid voltage will be less negative than it should be.

If the tube is pulled from its socket, the grid and plate voltage will be normal and the cathode voltage will be zero. If the serviceman is still in doubt as to the cause of his trouble, he can shut all power off in the receiver and measure the various resistors in this circuit. All will be found to be normal.

In this way he will be led to the conclusion that perhaps the tube is bad and another one should be tried. When he does this, the trouble will clear up.

At first glance, this might appear like a considerable amount of work. But note that with the Television Analyst, you located the faulty stage quickly and directly. Without this guidance, the entire video IF system would have been open to question and the job of actually isolating the defective second stage might have taken hours.

Also, with the Television Analyst, the plate circuit of the second stage was removed from suspicion and it was definitely established that the signal **had to** pass through the tube for the distortion to appear. Here was another explicit clue as to the source of the trouble.

Or, let us suppose that the bypass capacitor in the screen-grid circuit (C1 in Fig. 31) opened up. An open bypass capacitor may result in stage oscillation, although generally only when a signal is passing through the receiver.⁶

The tracking down of this trouble follows the previous procedure in

⁵The decrease may not be noticeable because of the extremely low resistance of the plate tuning coil.

⁶If the stage does not oscillate, the open by pass capacitor will cause its gain to decrease considerably.

essentially all respects. The start would be made in the video amplifier section, with the signal probe gradually being moved toward the front end of the set. When the signal is injected at the grid of the 3rd video IF tube, Fig. 31, a normal image is developed on the screen. However, when the injection is made at the control grid of the 2nd video IF amplifier, the distorted image is obtained, immediately signaling to the technician that here is the stage containing the trouble.

To uncover the defective bypass capacitor, the following procedure is quite effective. Since we know that injecting the signal at the grid of the second video IF stage produces a distorted image, the signal probe is moved to the plate terminal of the tube. A normal image will be obtained, although it will not be as strong as it should be. This, however, will probably not be too evident to the serviceman and for that reason this indication is not being considered.

The signal probe is shifted now to the screen grid. Ordinarily, with the bypass capacitor OK, any signal applied to the screen grid will be shunted to ground and no image will appear on the picture-tube screen.⁷ In the present instance, however, the bypass capacitor is open and the signal at the screen grid **will** produce an image on the picture-tube screen. This is because the signal voltage can now modulate the electrons traveling from cathode to plate of the tube and thereby produce a signal in the plate circuit. From here, the signal travels through the system and appears on the screen.

Thus, when the signal probe is applied to the screen grid **and** an image is obtained at the picture tube, it tells you the screen-grid bypass capacitor is open.

In some circuits, separate bypass capacitors are employed in the plate and screen-grid circuits. See Fig. 33. For this arrangement, the screen-grid bypass would be checked as above.

To check the plate circuit bypass capacitor, we would apply the signal probe to point A, Fig. 33. If the bypass capacitor is normal, the signal will be shunted to the ground and **no** image will be seen on the screen.

But, if the capacitor is open, an image will be obtained on the screen.

Every experienced serviceman knows that detecting open bypass ca-

pacitors is one of the toughest jobs he can be given. Yet, in many cases, the procedure just outlined will bring such defective units to light in short order.

Notice that if the "conventional signal tracing" method was used with any of these troubles it would have been almost impossible to detect any difference in the oscilloscope patterns between the "good" signal and the signal after the open screen bypass condenser. The "conventional method" therefore would be completely useless in this case even though the customer had a legitimate complaint of a "degraded" picture.

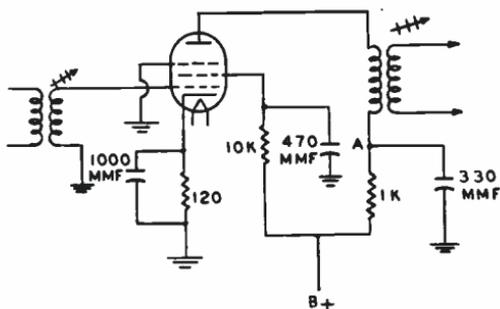


FIGURE 33

Screen by-pass capacitor can be checked with TV analyst.

It should be noted that as we follow the procedure of moving the signal probe stage-by-stage toward the antenna input terminals, we are adding more amplifier stages between the point where the signal is applied and the picture tube. This means that the picture should become stronger with each added stage.

This is a good point to keep in mind. Because if you should find that the signal level does not increase, or that it actually decreases, then you have uncovered a stage that is not amplifying. This may be due to a weak tube or low element voltages. The most common cause for the latter condition is usually a resistor whose value has increased.

It may also be due to excessive AGC voltage on that tube—which, of course, indicates a defect in the AGC system. If this is the trouble, it

¹A very weak, snowy image may appear. This is still an indication of a good bypass capacitor.

can be verified quite easily. Connect a small battery of 3 or 4 volts across the AGC line. Attach the negative terminal of the battery to the line and the positive terminal to the receiver chassis.

If the stage returns to normal operation by this process, we definitely know that the AGC system is at fault. But if the stage gain remains low, then the AGC line is not the cause of this particular difficulty.

Note that in order to obtain a stronger signal, we must pass the signal through a tube capable of amplifying. Detectors and mixers generally do not provide any amplification. Hence, when the signal travels from the final video IF to the video detector, it generally suffers a loss and this should be expected because it is normal.

Another place where there is practically no amplification is in the mixer stage of the front-end tuner. Here the RF signal is converted to the IF level. When triodes or pentodes are utilized for the mixing function, some gain may be obtained although the increase may not show up readily on the picture-tube screen. When a diode is employed for this purpose, there is a definite signal drop.

Heater-To-Cathode Leakage. A common defect which frequently gives servicemen more trouble than it should is heater-to-cathode leakage in one of the video IF tubes. This will introduce some 60-cycle a-c voltage into the signal path which, if not too strong, will produce the visual effect shown in Fig. 34. Part of the picture is light and part is dark, and since this 60-cycle frequency is the same as the vertical picture frequency, the two frequencies may or may not lock-in.

If a lock-in is achieved, the dark and light portions of the screen will remain fixed in position. However, if the phase of the 60-cycle a-c voltage changes with respect to this vertical frequency, the dark portion of the picture will move vertically at a slow rate.

Another visual effect of heater-to-cathode leakage, particularly when it is not small, is shown in Fig. 27. The 60-cycle voltage, in with the video signal, causes the amplitude of the various sync pulses to vary considerably. When this variation in pulse amplitude reaches the horizontal sync system, it will disrupt oscillator operation sufficiently to cause the picture to pull.

The tracking down of this trouble is straightforward with a Television Analyst. Simply start at the video amplifier before the picture tube and proceed to check the signal path, stage by stage, back toward the



FIGURE 34

This image contains 60 cycle hum in the video.

antenna terminals. At each step a normal image will be developed on the screen until the grid of the tube where the leakage is occurring is reached. At this point, the 60-cycle a-c voltage will combine with the signal and the visual effect will become immediately obvious.

SECTION IX

HOW TO USE TELEVISION ANALYST TO TROUBLE SHOOT FRONT END TUNERS

The front end tuner is frequently one of the most difficult items in a television receiver to service. The entire tuner is encased in a metal housing which is highly compact. Some of the components are fairly easy to get at, but many are positioned behind other units or in hard-to-reach corners. Finally, because of the high frequency of operation of tuner circuits, even slight changes in parts position can have a very noticeable effect on operation. This means that the technician must proceed with considerable care when using conventional servicing techniques.

And such caution usually slows the servicing pace to several times its normal length in other sections of the receiver.

By avoiding the inside of the television tuner as much as possible and sticking principally to the outside of the tuner, servicing time can be reduced substantially. Signal injection, using a test pattern, lends itself admirably for this purpose because it enables the serviceman to deal with each stage in the tuner on essentially an individual basis.

This permits us to isolate any stage that is defective in a matter of minutes. Thereafter, only the d-c measurements of voltage or resistance need be made.

Of the two checks, only the resistance measurement requires an "inside the tuner" probing. Voltage measurements can be made directly from the tube side of the socket by means of an adapter such as that shown in Fig. 35.

Every tuner currently in use consists of three stages. These are: the RF amplifier, the mixer and the RF oscillator. See Fig. 36. The RF amplifier receives the incoming signal, amplifies it, then forwards it on to the mixer. Here the RF signal combines with a signal developed by the oscillator, producing a sum frequency, (which is of no use) and a difference frequency, which represents the IF signal.

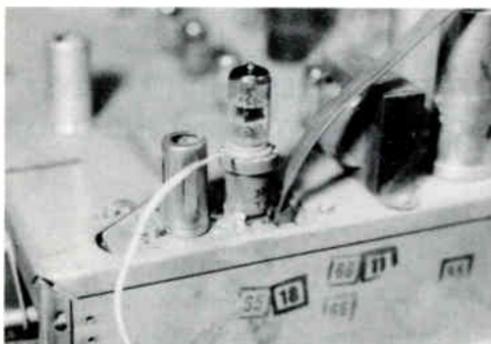


FIGURE 35

A tube adaptor, as shown will permit voltage measurements to be made directly from the topside of the chassis.

If the RF amplifier becomes defective, no signal (or very little) will reach the mixer and no IF signal will be produced.*

If the local oscillator should cease to function, the RF signal reaching the mixer will be unable, by itself, to produce the necessary IF signal.

Thus, in the event of failure of either the RF amplifier or the RF oscillator, no IF signal will be developed.

Finally, if the mixer becomes defective, then no matter what the other two stages do, nothing will reach the video IF system and no image will appear on the screen. It is evident, therefore, that all three stages must be operating in unison to produce a good picture and failure at the one point will disrupt the sequence of events.

Armed with this knowledge, let us see how we can readily apply the

*It is possible that some RF signal will pass through the RF tube by capacitive coupling between the tube elements. If this happens, it will produce a very weak, snowy image on the screen.

output signals of the Television Analyst to quickly uncover a defective tuner stage.

Let us assume that the receiver is operating normally up to the tuner. This means that we can apply the test pattern signal—at the proper IF frequency—to the grid of the 1st video IF stage and produce a normal test pattern on the screen.

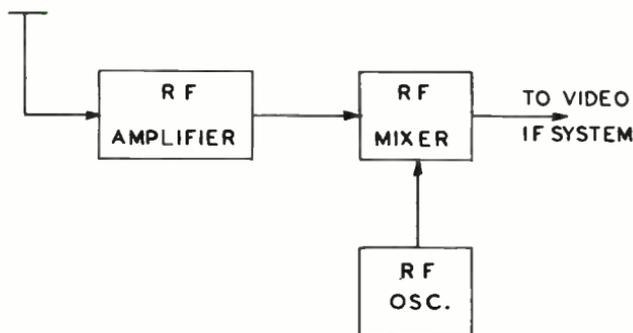


FIGURE 36

The stages in a television tuner.

To check the mixer stage of the tuner, and this stage only, place the IF signal probe in the grid circuit of this stage. If the mixer is normal, a test pattern will appear on the screen with about the same intensity as the image produced when the same signal is applied to the grid of the 1st video IF.

The reason for this stems from the fact that since IF signals are developed normally in the mixer, the stage will pass an IF voltage injected at its grid. Ability of such a signal to pass through the tube demonstrates it is operating as it should.

The fact that the picture intensity remains unaltered means that the mixer provides very little gain. This is characteristic of mixer operation in general and was noted previously. However, if there is a noticeable drop in gain, then the mixer may be suspected of being faulty.

At this point the reader may wonder how it is possible to perform the above signal injection without going inside the tuner. The reason this is unnecessary stems from the common practice of providing a mixer grid test point on the top-side of the tuner assembly. See Fig. 37.

By connecting the signal probe from the Television Analyst to this terminal, we can inject the necessary signal into the mixer grid circuit.

The next step, which is just as simple, is to test the operation of the RF oscillator. The signal probe is left at the mixer grid, but now the signal frequency is altered to an RF value and the tuner set to operate at the same frequency. A good channel to use is No. 6. It is best to avoid using channel 2 because its frequencies are close to the 40-mc IF band. Also, it is best to use a channel that is not utilized locally for broadcasting.

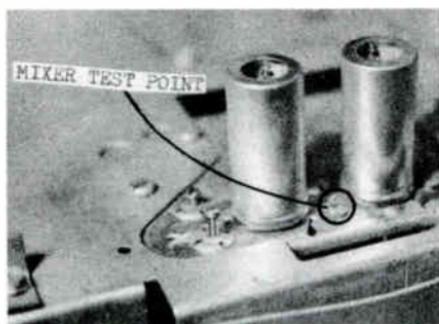


FIGURE 37

Nearly all TV tuners possess an outside terminal which connects to the mixer grid.

If the oscillator is working, the RF signal will be converted down to the IF frequency and passed through the receiver. However, if no picture is displayed on the receiver picture tube, the local oscillator is not functioning normally.

The beauty of the foregoing test lies in its simplicity and thoroughness. Not only is it easy to carry out, but it checks the local oscillator under **normal** operating conditions. If the oscillator combines with the test pattern signal from the Analyst to produce a normal screen image, it will combine with an externally-received signal to produce a similar result.

If desired, this check can be made on several channels but, generally speaking, if it functions properly on one channel, it will do the same on

all other channels. In a turret type tuner where only one channel is defective however, the test should be made with the tuner set to that particular channel.

The final remaining stage in the tuner is the RF amplifier. To test this stage, an RF signal is applied to the antenna terminals. A stronger picture should now be displayed on the picture tube screen than when the RF was applied to the mixer grid. This, of course, is due to the additional amplification of the RF stage.

If no noticeable increase in gain is obtained, the RF amplifier circuit is not functioning properly.

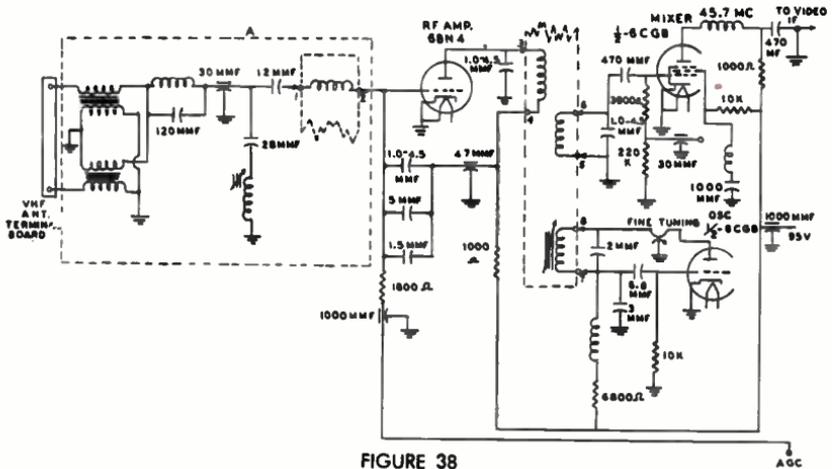


FIGURE 38
TV tuner being tested.

When a defective stage is found, the tube should be checked, if this has not been done already. If the tube is found to be good, voltage at the various tube elements should be measured next. This can be done quite readily by inserting an adapter between the tube and its socket. The lugs extending from each adapter pin then enable the serviceman to measure the voltage at each element.

The presence of these lugs also permits the signal to be injected directly at various elements. For example, when the signal is applied to the antenna terminals, it must pass through the network enclosed in the dotted rectangle labeled "A" in Fig. 38 before it reaches the control grid of the RF amplifier tube.

If some component in this network is defective it will prevent the signal, totally or partially, from reaching the tube. By means of the adapter, we can inject the signal directly at the grid of the tube and thereby determine the condition of the network between the grid and the input terminals.

A similar check can be made of the circuit between the plate of the RF amplifier and the grid of the mixer. Apply the signal at the grid of the mixer. If the circuit, from this point to the picture tube is normal, a test pattern will appear on the screen.

Now, shift the signal to the plate pin of the RF amplifier, using an adapter.

If the circuit between the plate of the RF amplifier and the control grid of the mixer is functioning as it should, the same test pattern will appear on the screen. (The image may be somewhat weaker because of losses incurred in the connecting circuit.)

If there is a defect in this interstage network, it will weaken the signal considerably or may even kill it completely.

In this way, we can employ the B & K Television Analyst to check not only complete stages, but partial interstage networks as well.

It is important to remember that the RF signal must be adjusted to the setting of the tuner resonant circuits. Failure to observe this precaution can lead you to suspect trouble when no trouble actually exists.

Although there are a number of different tuners on the market, each with its own peculiar circuit arrangement, the testing procedure outlined above will apply to all of them. This is one of the basic advantages of the signal injection method.

SECTION X

LOCATING AGC DEFECTS WITH THE TELEVISION ANALYST

To appreciate the manner in which the B & K Television Analyst is utilized to reveal AGC troubles, it is first important to understand the relationship of the AGC network to the signal path.

Consider the block diagram of a typical television receiver shown in Fig. 39. The AGC voltage is fed to the RF amplifier, the first IF amplifier and the second IF amplifier. The third and final IF amplifier is an independent stage, operating with its own bias.

Any signal entering the receiver via the normal path from the antenna will find itself subjected to the influence of the AGC voltage right at the RF amplifier. The same influence will again be felt at the 1st and 2nd IF stages.

Thus, if the AGC voltage is too high (i.e., too negative) or too low (i.e., not negative enough), it will disturb the normal functioning of the controlled stages. When the AGC voltage is too negative, it will reduce severely the gain of the controlled stages and the signal passing through them will emerge much weaker than it ordinarily would.

As a matter of fact, if the gain is cut down enough, no signal at all will be obtained from the IF system.

Conversely, when the AGC voltage is too low, and the set is running wide open, it readily can happen that the incoming signal will receive too much amplification and overload one of the stages in the video IF system. This will completely distort the picture, and disrupt horizontal and vertical lock-in. (The latter occurs because, in the process of distorting the signal, the vertical and horizontal sync pulses are either com-

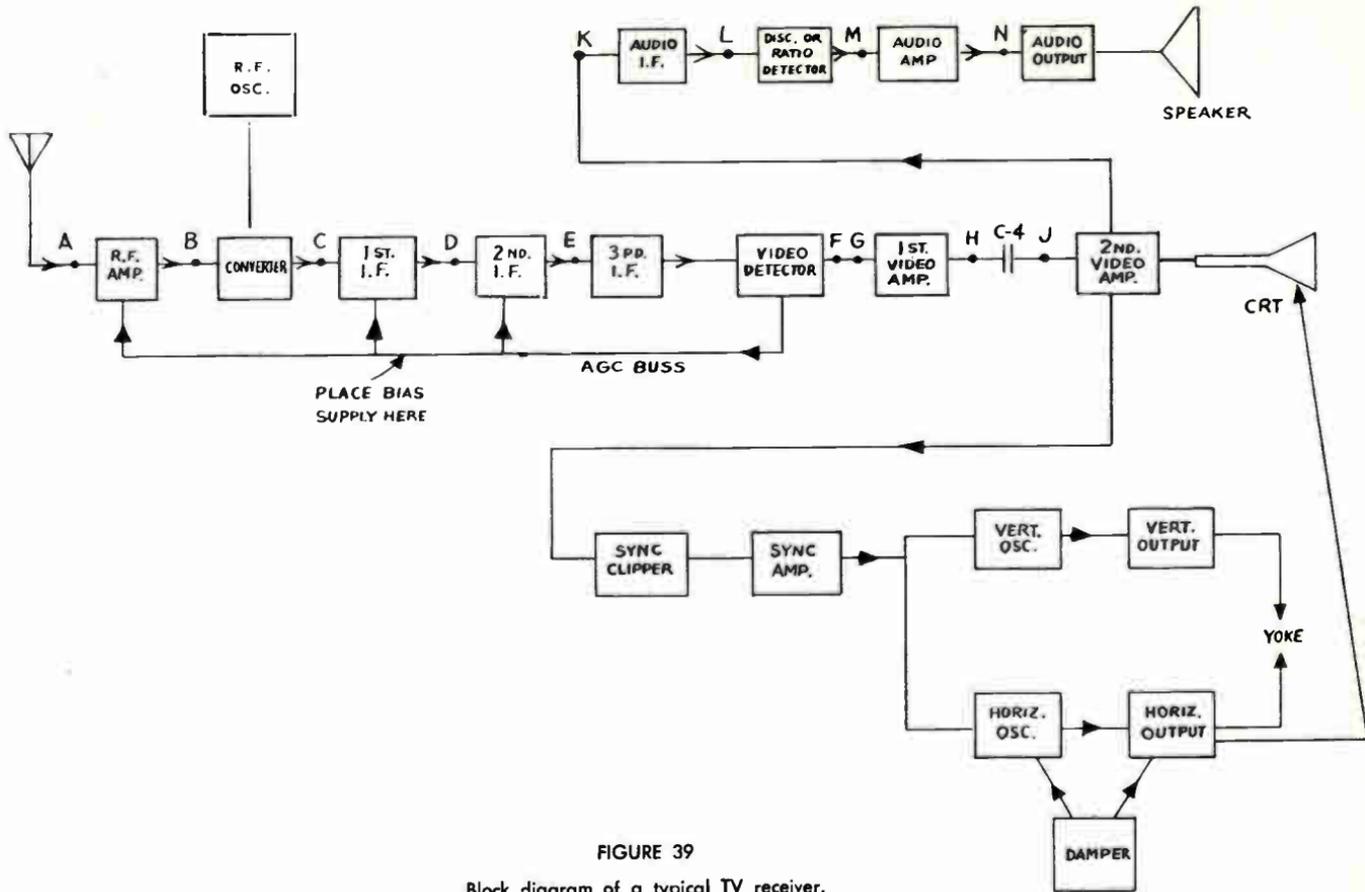


FIGURE 39
Block diagram of a typical TV receiver.

pressed or clipped off entirely. This prevents effective synchronization of the sweep oscillators.)

Now, assuming that some troubles exist in the AGC system and it is not functioning properly, there is an effective approach that will bring this to light.

Inject an RF signal from the Television Analyst at the antenna terminals of the receiver and tune both to an unused TV channel. Now turn the RF attenuator on the Analyst completely counterclockwise, producing a weak output signal.

If the only thing wrong with the set is the AGC system, a normal test pattern will appear on the screen. This is because the incoming signal is below the threshold level of the AGC system and this network does not come into operation.

As the RF signal level is increased by slowly rotating the attenuator, the picture will come out of the snow and remain normal for all positions of the RF attenuator above a certain level. But if the system is defective, the picture will become distorted. If, as is generally true, this distortion occurs because no AGC bias is being developed and the controlled stages are running wide open, then the signal is overloading one of the video IF stages.

It is also possible that the AGC system may develop too much bias, in which case the signal will never be able to produce a normal image on the screen.

There are several ways of verifying that it is indeed the AGC system which is at fault when the foregoing behavior is encountered. This verification is needed because while we may suspect the AGC network, the foregoing tests do not definitely establish this.

One test is to render the AGC inoperative by connecting a small bias battery (or bias voltage) across the AGC line. This will place the normal bias voltage on the line (for signals of normal or moderate intensity). It will also inactivate the AGC system because the latter network possesses a high impedance and the battery (or bias supply) has a low impedance. When two such impedances are placed in parallel, the low one completely dominates the situation.

Now, with the AGC system effectively cut off from the signal circuit, normal operation should be obtained when a normal signal from the Television Analyst is applied to the receiver. This will be true at every stage along the path and should hold whether we work toward the front end of the set from the picture tube or move from the antenna terminals to the picture tube.

Another test which is frequently useful in establishing definitely that the AGC network is defective is as follows. Connect a VTVM across the AGC line and apply an RF signal from the Television Analyst to the antenna terminals of the set. With the RF attenuator set to its minimum signal output position, note the VTVM reading.

Now slowly increase the signal fed to the receiver. If the AGC network is functioning properly, the negative voltage will increase as the signal amplitude rises. But if the system is defective, the AGC voltage will hardly change at all or, if it does change, will do so abruptly.

Either test is useful, although the bias substitution check is perhaps the better of the two.

Note that a defective AGC system will ordinarily have no effect on the stage or stages in the video IF system that are not tied into the AGC line. For these stages, injection of the test pattern signal will produce a normal picture on the screen.

Some of the common symptoms of a defective AGC system are:

1. Negative Picture. This is an inversion of the signal caused by one or more stages (RF or IF) being overdriven.
2. No Sound or Picture. There is a raster on the screen, but sound and picture are missing completely. This occurs usually only with keyed or amplified AGC systems.

This symptom is perhaps the most inconclusive of all those listed here because it can easily be caused by other defective components which are not related to the AGC system.

3. Loss of Synchronization. This results from overloading due to a low AGC voltage. The sync pulses become distorted in the overloaded stage and are incapable of properly locking-in the horizontal and/or vertical sweep oscillators.

The Television Analyst is particularly useful in helping you uncover defective AGC systems because you can observe how the set operates at various signal levels. In a normally-acting receiver, the input signal (at the antenna terminals) may vary over a wide range without distorting the image on the screen, other than perhaps to become darker.

On the other hand, if the AGC system is not normal, picture distortion—or complete loss of the image—will occur at a fairly low input level.

Once you have definitely established that the trouble lies in the AGC network, the next job is to check the various components found here. This will include resistors whose values have changed, open or shorted capacitors, and defective tubes (in keyed or amplified AGC circuits).

SECTION XI

HOW TO USE TELEVISION ANALYST TO TROUBLE SHOOT THE SWEEP SYSTEMS

Every television receiver possesses two sweep systems. One system, the horizontal, moves the electron beam back and forth across the screen 15,750 times a second. In addition, the same system also develops the high voltage required by the picture tube for its operation.

The second system, the vertical, moves the electron beam up and down 60 times a second. This is its only function. Since this is the simpler of the two systems, let us consider its trouble shooting procedure first.

A. THE VERTICAL SYSTEM. When trouble develops in the vertical system, its effect on the screen is evident in several ways, depending on the nature of the trouble. The most decisive symptom is complete

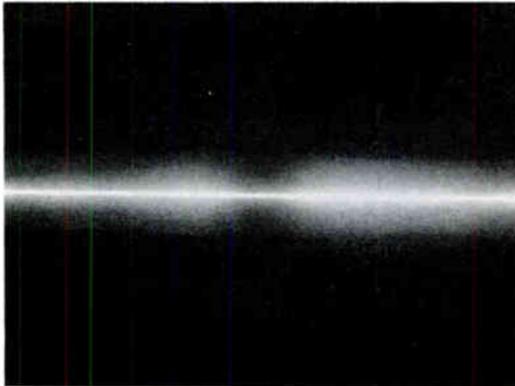


FIGURE 40

An image lacking a vertical deflection.

absence of any vertical deflection at all. Visually, this appears as shown in Fig. 40. The thin horizontal line shows that the horizontal system is functioning, but the absence of any upward or downward spread indicates that no vertical deflection voltage is being developed.

Another indication of a defective vertical system is the appearance of the image shown in Fig. 41. Here the image has a vertical spread, but what does appear is completely distorted. The image appears to be elongated at some points and compressed at others.

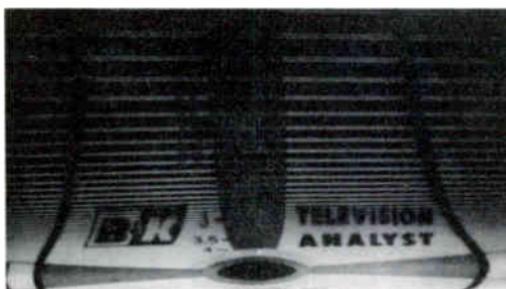


FIGURE 41
Vertical distortion.

Still another form that vertical distortion may take is illustrated in Fig. 42. The image is rolled up at the bottom, resulting in a white line or bar. This, too, is a form of non-linearity, although it stems from a source different from the one which caused the distortion in Fig. 41.

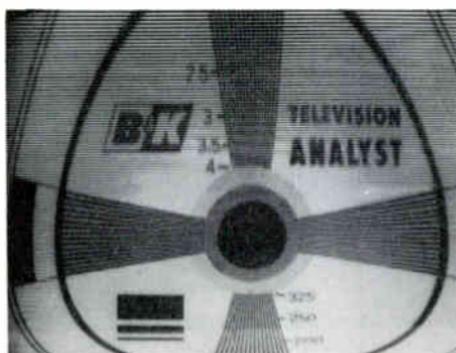


FIGURE 42
Another form of vertical distortion.

When any of these symptoms, or variations of them, appear, the first step is to test all of the tubes in the vertical system. It will be found generally that the complete absence of any vertical deflection is due to a defective tube. The other symptoms, however, are more likely to stem from defective components than defective tubes and here the Television Analyst can be of considerable assistance.

To date, three different types of vertical deflection system circuits have been employed. The first of these, and one of the simplest, is shown in Fig. 43. This has an integration network, a blocking oscillator, and a vertical output amplifier. The integrating network permits only the vertical sync pulses to pass through it to synchronize the blocking oscillator. The oscillator, in turn, develops a sawtooth deflection waveform which is then amplified by the output stage and applied to the vertical windings of the deflection yoke through a transformer or autotransformer.

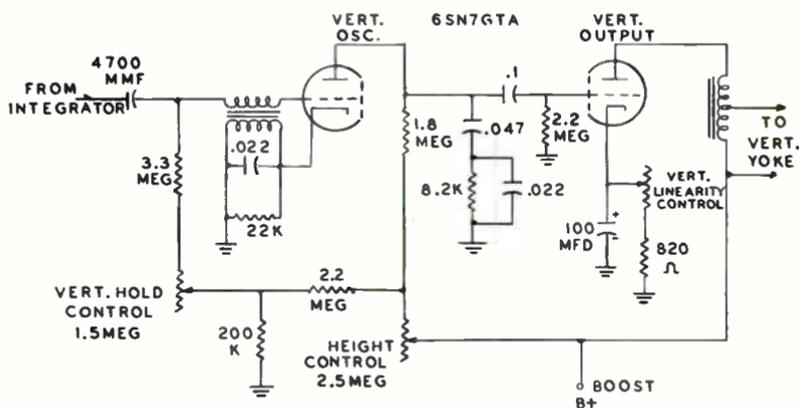


FIGURE 43

One type of widely used vertical deflection system.

To check out this system, assuming a distorted image (vertically) or no vertical deflection at all, we would proceed as follows.

First, all the tubes in this section of the receiver would be checked. (Hereafter, we will assume this step has been taken before any further tests are made.)

If the tubes are OK, a vertical driving pulse would be obtained from the proper pin jack of the Television Analyst. This pulse would be applied to the control grid of the vertical output tube. (It is desirable, for this test, to remove or otherwise incapacitate the vertical oscillator. If the oscillator tube cannot be removed from its socket, connect a short circuit between grid and cathode. This is done to prevent the oscillator and Analyst pulses from combining and producing conflicting results.)

If the vertical system, from the grid of the vertical output tube to the yoke, is normal, vertical deflection of the image will occur. The sweep may not be completely linear, but by adjusting the vertical driving pulse control, the sweep will almost always completely fill the screen.

Hence, we can quickly determine with a high degree of assurance whether the vertical output stage is functioning properly or not.

If the stage is operating normally, then we know that the defect must lie before this point. If the set exhibited no vertical deflection at all prior to this test, these results would indicate that the oscillator is inoperative, or, the pulse from the oscillator is not reaching the output amplifier. A voltage and a component check will then pin-point the cause of the trouble.

If the image was distorted, and the foregoing test revealed no such distortion, then we know that the defect must be located prior to the vertical output tube. Again the oscillator circuit is indicated.

Finally, if injection of the vertical driving pulse at the grid of the output tube produces an image with the same form of distortion as the set possessed originally, then the trouble is located in the output stage. The most likely suspects are, the cathode by-pass capacitor, the deflection yoke and the vertical output transformer.

The second vertical deflection system which has been used widely is shown in Fig. 44. This contains an integrating network, a vertical multivibrator and a vertical output amplifier. The vertical multivibrator, using two tubes, performs the same function as the blocking oscillator in the previous system. However, because of the difference in the two circuits, it is possible to use the Television Analyst vertical driving signal to check the operation of this multivibrator.

Here is how this is done.

With the multivibrator made inoperative, the vertical driving signal from the Television Analyst is applied to the control grid of the vertical output stage, Fig. 44.

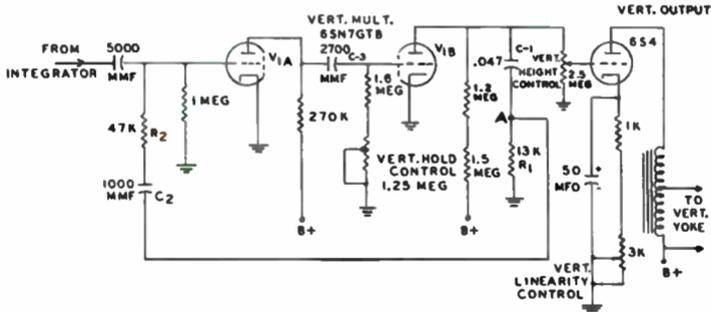


FIGURE 44

A vertical deflection system using a multi-vibrator and a vertical output amplifier.

If the circuit from this grid to the deflection yoke is OK, the image will have a vertical sweep. As noted before, the sweep may not be linear and the picture may not fill the screen vertically, but it can be judged qualitatively. If the result is satisfactory, we know that the trouble must lie elsewhere in the system.

The next step is to check out V_{1B} and its immediate circuit. This is the second section of the multivibrator. For this test, the multivibrator is made operative again. However, now, we want to render V_{1A} inoperative and this can be done easily by connecting a short circuit between its grid and cathode.

Now apply some 6.3 filament voltage to the grid of V_{1B} . The driving pulse from the Television Analyst cannot be applied here because it would reach the grid of the vertical output stage with incorrect polarity and no vertical deflection will be produced. However, the 6.3 volt filament voltage works fine.

If the circuit from this point to the deflection yoke is functioning properly, the image will show a vertical sweep. The sweep will not be fully linear, but it will demonstrate whether a signal can pass through V_{1B} . At the moment, this is the important consideration.

If vertical deflection does appear, the circuit from V_{1B} to the yoke is normal and we must move farther back into the system.

Before we do this, however, let us briefly consider the way multivibrators operate. A multivibrator is basically a two-stage amplifier in which the output from the second stage is brought back to the grid of the first stage. This is what causes the circuit to oscillate.

In Fig. 44, the feedback is performed by C_2 and R_2 . If this feedback path is open, the system will not oscillate. In the previous test, we inactivated V_{1A} by placing a short circuit between its grid and cathode. This prevented any feedback voltage from reaching V_{1A} .

Now, to check out V_{1A} , this short is removed. If the circuit is not oscillating and V_{1B} is OK, then either the feedback path is open or V_{1A} and its circuit is defective. We can check V_{1A} by applying the vertical driving pulse to its grid. If the picture develops vertical sweep, the deflection wave is passing through the network and reaching the yoke. This leaves only the feedback path as the culprit.

If no vertical sweep develops on the screen, the tube may be bad, it may not be receiving any plate voltage, or coupling capacitor C_3 may be open. The latter item can be readily checked by injecting the driving pulse at the plate of V_{1A} . This avoids V_{1A} , but it does reveal whether the signal can pass through C_3 .

The feedback path can be checked out just as readily. Apply the vertical driving pulse to point A and then, with an oscilloscope, note whether it appears at the grid of V_{1A} . If it does appear, with the same form, then R_2 , C_2 are OK. If it is greatly reduced in amplitude or cannot be obtained at the grid, then the capacitor and resistor should be checked.

In this way, we can effectively isolate every portion of this deflection system and localize the trouble to just a few components. These can then be tested individually or good units substituted for them.

The third type of vertical deflection system is shown in Fig. 45. In this circuit, both V_1 and V_2 function as the first and second tubes in a multivibrator circuit. In addition, V_2 also serves as the output amplifier. Thus, this system accomplishes the same purpose as the previous circuit, but does it with one tube less.

To track down a defect in this network, we proceed as follows. Tube V_1 is rendered inactive by connecting a short circuit between the grid and cathode. Then the vertical driving pulse from the Television Analyst is applied to the grid of V_2 . If the results appear normal, as previously indicated, this portion of the circuit is working satisfactorily.

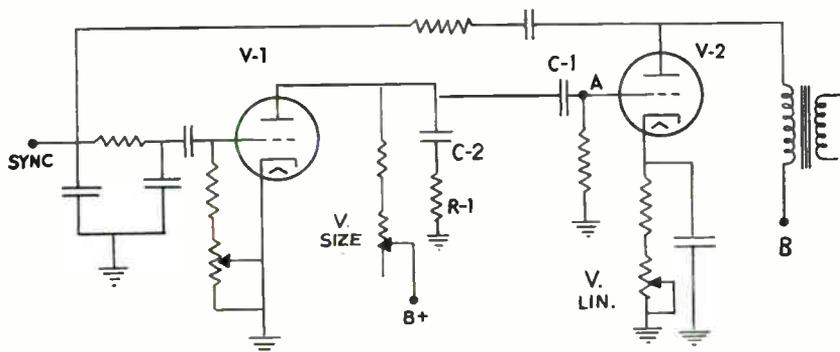


FIGURE 45

A popular vertical deflection system.

The next step is to check out V_1 , after removing the short circuit. This would be done using the 6.3 filament voltage as indicated above. After this, the feedback path would be tested by applying the vertical driving pulse to the plate of V_2 and noting, with an oscilloscope, whether it appears at the grid of V_1 .

Thus, the circuit of Fig. 45 is no more difficult to analyze than either of the two previous circuits.

From time to time, a set will lose vertical sync and no setting of the vertical hold control will make the picture lock in. To determine whether sync pulses are reaching the vertical oscillator, inject the vertical driving pulse from the Television Analyst at the last sync separator stage preceding the oscillator. If lock-in is now achieved, then some defect **prior** to the sync separator is preventing the signal pulses from reaching this stage. However, if the picture still refuses to lock-in, then the trouble is located either in the sync separator stage or the integrator network that follows it.

In performing this test, it is sometimes necessary that the vertical driving pulse from the Analyst be passed through one stage of ampli-

fication (i.e., such as the sync separator above) before it is applied to the vertical oscillator. If this precaution is not observed, the driving pulse may not possess the proper polarity to sync the oscillator.

B. THE HORIZONTAL SYSTEM. In many respects, the trouble shooting procedure for the horizontal deflection system is similar to that employed for the vertical system. This is because both systems are essentially similar, employing an oscillator and an output amplifier.

A typical horizontal oscillator and output amplifier circuit is shown in Fig. 46. The oscillator is a multivibrator, developing a sawtooth deflection wave which is fed to a beam-power horizontal output amplifier and, from here, to the output circuit.

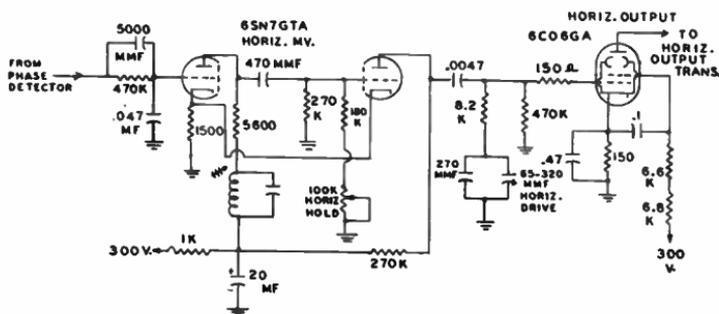


FIGURE 46

A typical horizontal deflection system.

Part of the output circuit is devoted to the development of a high voltage for the picture tube. Consequently, when anything goes wrong in the horizontal system, it frequently affects the high voltage, either reducing it or killing it completely. The result is a completely black screen or one that has only a faint raster or image.

To check out the horizontal system, the horizontal driving pulse from the Television Analyst is applied to the grid of the output amplifier. If the picture intensity reappears and the image (or raster) fills the screen, then we know that the horizontal system from the grid of the output tube on is working satisfactorily.

We also know from this action that the boost B+ circuit is functioning normally. In almost every horizontal deflection circuit, the energy

that remains in the horizontal deflection yoke, after the beam has been swung back to the left side of the screen, is converted to additional B+ voltage. This is then added to the set's normal B+ voltage to provide what is called a boost B+. The conversion occurs in the damper tube circuit.

Now, if the boost B+ network is defective and the additional voltage is not being developed, then the horizontal output stage and any other stage receiving this voltage will not function as it should. To determine the condition of this circuit, we can proceed as follows. Apply the horizontal driving pulse from the Analyst to the grid of the horizontal output stage. If the picture intensity reappears and the image (or raster) fills the screen, then the boost B+ is OK. If there is any doubt about this, it can be measured.

Knowing the condition of the boost B+ is an important piece of information because this voltage is frequently used to power the horizontal oscillator. Thus, when the horizontal deflection system becomes inoperative because the output amplifier is not being driven, we do not ordinarily know whether the trouble stems from a defective oscillator or because the oscillator is not receiving the proper boost B+ voltage. By the foregoing test, the boost B+ circuit can be quickly checked out.

Thus, by a test that takes longer to describe than to do, we can check out a substantial portion of this deflection circuit.

If the results of the above test show the output stage is working normally, we can be certain that the oscillator is inoperative or the coupling capacitor between the oscillator and amplifier is open. It is quite easy to check the capacitor condition. Simply apply the driving pulse first to one terminal (i. e., plate) of this capacitor and then the other. In Fig. 46, an open capacitor will reveal itself by an absence of any screen indication when the driving pulse is applied to the left-hand capacitor lead.

However, an image will be obtained when the pulse is injected at the right-hand capacitor terminal. A good capacitor, on the other hand, will produce the same image at both injection points.

If the oscillator is found to be inoperative, voltage and resistance measurements in this one stage will easily bring the trouble to light.

SECTION XII

USING THE TELEVISION ANALYST FOR INTERMITTENTS

Intermittent troubles are the most difficult to uncover of all the troubles that afflict a television receiver. An intermittent will show up after the receiver has been in operation, last for a while, then disappear for a time. There is no set pattern to the rapidity with which an intermittent will appear, nor any guarantee that it will remain equally long when it does show up again.

This is one reason why intermittents are so difficult to track down. Also, it is not unusual for an intermittent to disappear the moment the serviceman starts to look for it in the circuit.

The Television Analyst, through its ability to provide a variety of test signals, is an ideal instrument for the tracking down of intermittents. This is best illustrated by several case histories.

A set was brought into the shop with the complaint that the picture and sound would both disappear for a few seconds approximately every ten minutes. The serviceman who brought in this set noted that when this occurred, the raster was still visible. This eliminated the possibility of a-c power failure, or d-c power supply trouble. Since both video and audio are lost when the intermittent trouble appears, it is apparent that the trouble must lie somewhere in the RF tuner, IF amplifier, video detector, video amplifier or AGC circuits.

Now let us see how the Television Analyst can be used to pinpoint the trouble. The signals available from the instrument will be injected into the receiver at various points, and by a process of elimination, the trouble will be narrowed down to one stage.

First, it is necessary to disable the AGC circuits by connecting a bias supply to the AGC buss which feeds AGC voltage to the tuner and IF amplifier stages. It is interesting to note that by doing this, we remove the AGC network as a source of trouble. If the trouble does reside in this section of the circuit, it will be brought to light at once by its absence.

Feed an RF signal to the antenna terminals, point A of Fig. 47. A test pattern image will appear on the screen and sound will be heard in the loudspeaker. If the intermittent is not in the AGC system, it will periodically appear.

When the intermittent shows up, move the signal to the grid of the mixer. This is point B in Fig. 47. If the intermittent still persists, it demonstrates two things. First, it shows that the intermittent is **not** in the RF amplifier, since the signal injected at point B does not pass through the RF amplifier.

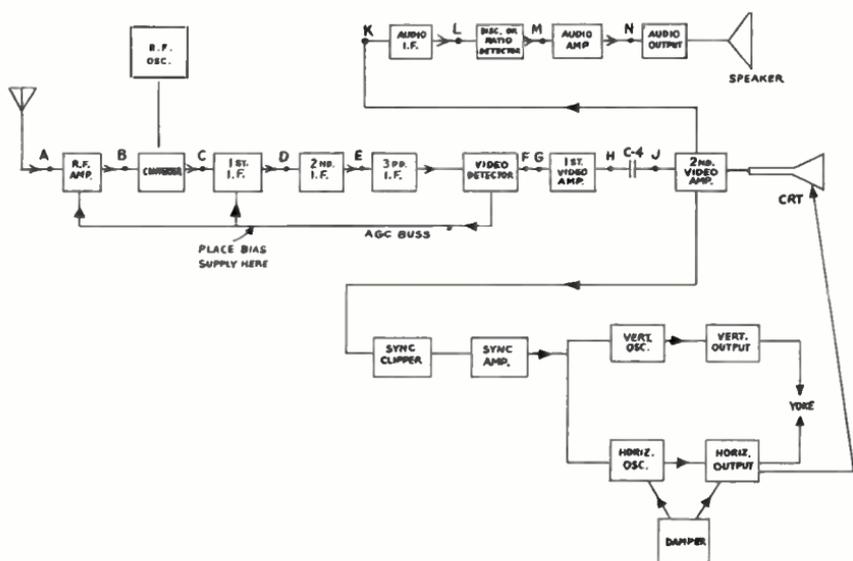


FIGURE 47

Block diagram of typical TV receiver.

Second, it reveals that the intermittent is somewhere between point B and the picture tube and speaker.

Now change the frequency of the signal to an IF value, but let the probe remain at the grid of the mixer. If the intermittent trouble appears, the RF oscillator is absolved from blame. This is because the RF oscillator does not enter into this operation.

It is interesting to observe that if the intermittent does **not** appear now, a finger of suspicion is directed right at the oscillator stage.

Note that when the intermittent is not present, that the serviceman can be working on some other set nearby. Thus, unproductive time is kept at a minimum.

We continue with the test procedure, injecting the IF signal at points C, D and E, Fig. 47, each time waiting for the appearance of the intermittent. When it appears, the signal probe is advanced to the next point.

In this way we can check through the RF and IF stages quite easily, with the definite knowledge that a section of the circuit, once passed, does not contain the intermittent. This assurance is of tremendous help to the technician as it continuously narrows the remaining receiver circuits where the trouble can be located.

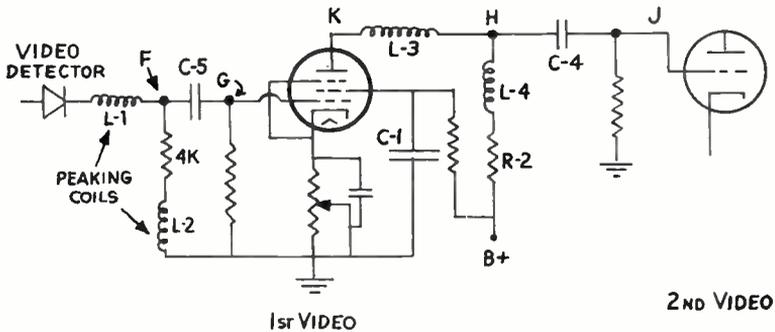


FIGURE 48
Video section of typical TV receiver.

Thus far, in our illustrative example, we have checked through the RF and IF stages without isolating the trouble. The next step would be to go into the video system. The Television Analyst signal output is switched now to video and the signal is injected at the video detector load, point F. See Figs. 47 and 48.

If the intermittent still appears, and we will assume that it does, then the video detector has been eliminated from suspicion and the video signal is injected at point G. The intermittent still shows up at this point.

The next step is to skip to the grid of the second video amplifier. This is point J. Here we find that no intermittent trouble is encountered. This pin-points the trouble either to the 1st video tube, L_1 , or C_1 . C_1 can be checked by injecting the video signal at point H. When this is done, it is found that the intermittent trouble shows up again. When C_1 is changed, the set returns to normal operation.

We have followed through this process in detail in order to show exactly how it is done. It is obvious that we could have started at either end of the receiver. It all depends on the technician and his specific preference. Also, some men prefer to skip several stages at a time. The method is completely flexible.

In the foregoing case history, both sound and video were affected. This need not be. If the sound only is affected, while the video remains steady, then the intermittent is situated in the sound system. To check out this portion of the receiver, a 4.5-mc signal, frequency modulated, would be needed for injection at points K and L, Fig. 47. For points M and N, an audio tone will serve as the signal source. Both of these signals are available from the Television Analyst.

Intermittents occur in the vertical and horizontal sweep systems as well and for this section of the receiver, the vertical and horizontal driving pulses can be extremely useful.

For example, suppose the picture collapses intermittently, indicating loss of vertical sweep. To track down the cause of this action, disable the oscillator and apply the vertical driving pulse to the grid of the vertical output stage. This will provide vertical sweep and the receiver can be operated in this condition. If, now, no collapse occurs, then we know that the trouble is located in the oscillator circuit.

On the other hand, if the raster does collapse, then the trouble is in the vertical output stage or the deflection yoke.

In the horizontal system, exactly the same approach can be taken. Feed the horizontal driving pulse from the Television Analyst to the grid

of the horizontal output tube. At the same time, disable the horizontal oscillator. Watch for a recurrence of the intermittent symptom (picture narrowing, loss of high voltage, etc.). If it appears, it is located in the output stage or the output circuit. If it does not appear, the intermittent is most likely in the oscillator.

SECTION XIII

HOW TO SERVICE COLOR-TV RECEIVERS WITH THE TELEVISION ANALYST

Color television receivers are, as yet, very much in the minority compared to black-and-white (or monochrome) receivers. However, the number of such sets is increasing and so is the demand for service calls. To this point, the discussion has been concerned wholly with the use of the Television Analyst on black-and-white receivers. It was recognized, however, that the instrument would be incomplete if it could not completely service a color television receiver. By adding a 3.58-mc crystal oscillator and two appropriate slides, not only can every section of a color receiver be tested, but the very critical adjustments of color convergence and purity on the picture tube can be accurately carried out.

Hence, the Television Analyst is, in every respect, a complete television receiver servicing device.

To appreciate what is involved in the servicing of a color receiver, let us first briefly examine the block diagram of such a set. This is shown in Fig. 49.

Ten general blocks are indicated, with three of the blocks totally shaded and one of the blocks partially shaded. If we disregard the three totally shaded blocks, we have the block diagram of a black-and-white receiver. Thus, much of a color television receiver lends itself to the same servicing procedures previously covered. This fact is of considerable assistance and should do much to dispel any doubt the reader may have concerning his ability to service color television receivers.

Furthermore, with the Television Analyst, the same time saving pro-

cedures can be employed here just as they were so successfully employed with black-and-white receivers. Thus, in spite of the fact that a color television receiver is a more extensive and a more complex device, it need not necessarily be a more difficult unit to service.

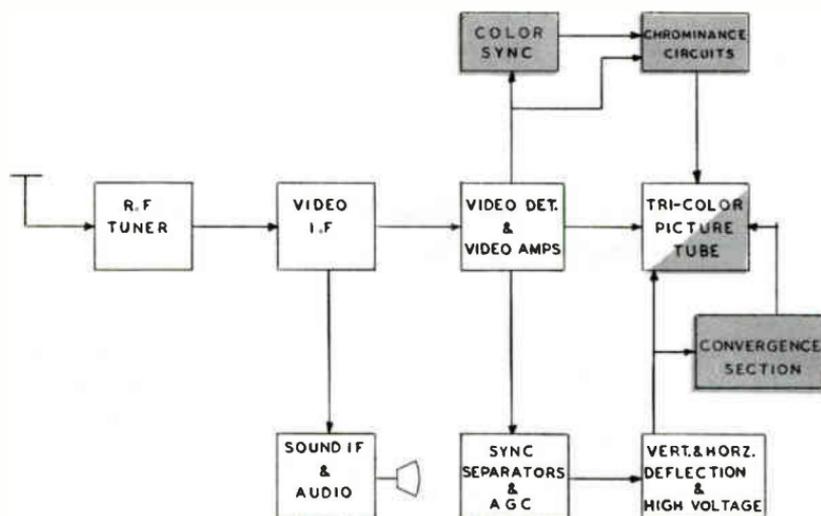


FIGURE 49
Block diagram of a color television receiver.

The picture tube block in Fig. 49 is shown partially shaded because part of its structure is new and part is similar to monochrome tubes. The portion which is familiar includes the way the electron beam is formed and the way it is deflected. However, in the tri-gun color tube, we are not only faced with three guns (and three beams), but each beam must converge to the same spot on the screen at the same time. It is to achieve this latter action that the special convergence section is added and the ability of a color set to perform properly will depend largely on how accurately the convergence circuits have been adjusted.

In the Television Analyst, two special slides are included for these adjustments. For static convergence, which is performed first, there is a white dot slide. For the second and more difficult adjustment of dynamic convergence, there is a white line slide. Each slide has been designed to minimize the difficulties in performing the alignments, thereby improving the accuracy with which they can be carried out.

Here is how these adjustments are made with the Television Analyst.

ADJUSTING COLOR TV PURITY AND STATIC CONVERGENCE

The first adjustment normally made on a color set is purity. It is best to follow the set manufacturers' procedure for purity adjustment. It is, however, most desirable to make this purity adjustment on a blank synchronized raster. This can be accomplished by connecting the generator to the color receiver antenna terminal and tuning in a test pattern. Then remove the slide from the pattern generator and make the purity adjustment on the synchronized blank raster.

For static convergence adjustments, it is necessary to use a white dot generator. The Television Analyst will provide white dots merely by using the white-dot slide. As a matter of fact, it is preferable to use the Analyst because the critical number of dots required for static convergence adjustments is fixed, and therefore is not subject to misadjustment as are the dots on most commercial dot generators. Also, the center dot is surrounded by little squares, making it easy to pick out. This is a great time-saver since it is essential that the center dot location be known. The small squares around the center of the slide make it easier to achieve fine static convergence adjustments, as the sharp corners of the squares show up any misconvergence much more critically than round dots. Make static convergence adjustment at the center of the screen. The red, blue and green dots have a motion as shown in Fig. 50 and should be adjusted so that each dot is superimposed upon the other (to obtain a white dot).

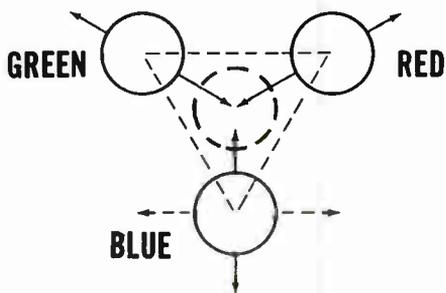


FIGURE 50
Motion of red, green and blue dots.

DYNAMIC CONVERGENCE ADJUSTMENTS

The dynamic convergence adjustments are performed next. Insert the white-line slide in the generator. It is of utmost importance in color convergence that the horizontal frequency is adjusted accurately.

STEP A—Preliminary Adjustment

1. Turn the blue horizontal (parabola or sine - wave) amplitude control to maximum.
2. Adjust the blue horizontal (parabola or sine-wave) phase so that the dip in the horizontal blue bar appears in the center of the horizontal axis of the raster.
3. Readjust the blue horizontal (parabola or sine-wave) amplitude to produce a reasonable straight horizontal bar along the horizontal axis of the raster.

STEP B—Setup of the Vertical Convergence Controls (See Fig. 51.)

1. Adjust the red vertical parabola amplitude and phase control to make the red vertical bar, along the vertical axis of the raster, parallel or coincident with the associated blue bar.
2. Adjust the blue vertical parabola amplitude and phase controls to make the horizontal blue bars, along the vertical axis of the raster, equally spaced or coincident with their associated horizontal red bars. (Since the horizontal convergence has not been completely set up, the associated red and blue horizontal bars will not necessarily appear parallel to each other.)
3. Adjust the green vertical parabola amplitude and phase controls to make the vertical green bar parallel or coincident with the associated red bar along the vertical axis of the raster. (If STEP B, (1) was set up properly, the red and green vertical bars will be parallel and the red and green horizontal bars along the vertical axis of the raster will be equally spaced. If these conditions do not exist, STEP B, (1) and (3) should be repeated.)
4. Insert white dot slides in pattern generator and statically converge the three dots in the center of the raster.

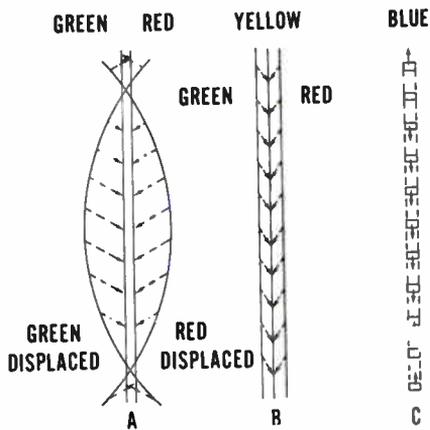


FIGURE 51

Vertical dynamic convergence adjustment.

STEP C—Setup of the Horizontal Convergence Controls (See Fig. 52).

1. Insert the white line slide in Television Analyst.
2. Adjust the red horizontal (parabola or sine-wave) amplitude and phase controls to make the vertical red bars across the horizontal axis of the raster equally spaced or coincident with the vertical blue bars.
3. Adjust the blue horizontal (parabola or sine-wave) amplitude and phase control to make the blue bar, along the horizontal

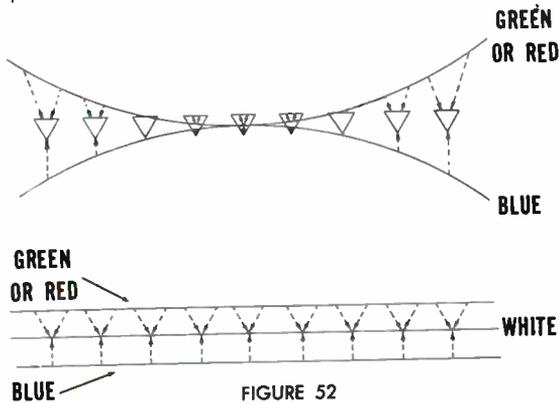


FIGURE 52

Horizontal dynamic convergence adjustment.

axis of the raster, parallel or coincident with the associated red bar.

4. Adjust green horizontal (parabola or sine-wave) amplitude and phase controls to make the vertical green bars, along the horizontal axis of the raster, equally spaced or coincident with the associated red bars. (If STEP C, (2) was properly set up, the associated red and green vertical and horizontal bars will be parallel or coincident. If these conditions cannot be obtained, repeat STEP C, (2) and (4).

STEP D—Insert white dot slide and statistically converge the dots in the center of the raster.

SERVICING COLOR TELEVISION RECEIVERS

In testing a black-and-white television receiver, we found the test pattern of Fig. 18 to be extremely helpful. In a color television receiver, the same pattern can be just as useful when checking the set on black-and-white signals. However, when the color performance of the receiver is to be tested, then a color signal is necessary.

In the Television Analyst, a rainbow display signal is generated and made available in video, modulated RF and modulated IF forms. This enables the signal to be injected at each point along the color signal path and permits each of the RF, IF and chroma (i.e., color) stages to be tested.

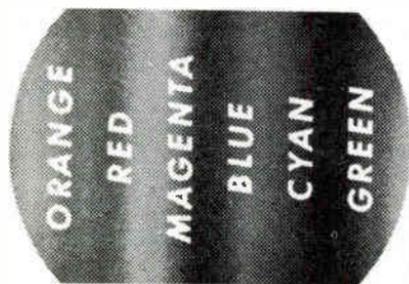


FIGURE 53

The rainbow display pattern produced by the B & K Television Analyst.

The crystal-controlled, full color rainbow display pattern produced by the Analyst is shown in Fig. 53. The colors range from orange at the left to green at the right. When the receiver is functioning properly, all of

the colors of the pattern will be properly reproduced and in the order indicated. Any significant deviation from this condition, such as a gross change in the order of the colors or the absence of some of the colors, indicates either a defect in the receiver or a misadjustment of a control.

In the following discussion, several typical case histories will be examined to demonstrate the use of the Television Analyst in a color receiver.

Case History No. 1. A color television receiver was brought into the shop with the complaint that while black-and-white programs could be received normally, color programs only produced black-and-white images. Color pictures could not be obtained. Sound was normal at all times.

From these symptoms, a number of stages in the receiver can be absolved from partial or total blame. For the purposes of this analysis, we will use the block diagram shown in Fig. 54. This represents a typical color receiver and all the case history discussions will be tied to it.

From Fig. 54, we can conclude that, insofar as the black-and-white signal is concerned, the RF tuner, the video IF amplifiers, the video detector and video amplifiers, the sound system and the entire deflection system are functioning properly. Furthermore, if the image is in register and contains no color fringing, then the convergence circuits are likewise normal.

So much for the black-and-white reproduction. What about the color signal?

We know, from what we have stated so far concerning the operation of this receiver, that all of the stages mentioned are passing all of the signal components of the color signal because a color signal develops a good black-and-white image. The portion of the color signal which opens up the color section of the receiver is the 3.58-mc burst which is sent along with each color line.

If the video IF system is properly aligned, and the 3.58-mc burst is passing through, then the defect lies in the color section. But if the burst is being suppressed in the video IF section, then a realignment of the IF tuned circuits is indicated.

To resolve this question, apply the video color signal to the input grid of the bandpass amplifier. The pattern of Fig. 53 will appear on the screen—in color—if this section of the receiver is functioning properly. It may be necessary to adjust the color phasing control (on the front panel) to bring each of the colors to its proper place on the screen, but aside from this, receiver operation will be normal.

With this indication, we know that the burst is being suppressed in the video IF system and a realignment of this system is called for. Once this is done, the receiver should operate normally on color broadcasts.

However, let us suppose that application of the color video signal to the bandpass amplifier does not produce a color image. Then the defect lies in the color section of the receiver.

If there are two bandpass amplifiers and application of the color video signal to the first stage does not produce a color pattern, then the signal should be fed to the input of the second stage. If a color pattern (even a weak one) appears on the screen, we have a fairly good indication that the first bandpass amplifier is defective.

On the other hand, if the foregoing test does not produce any color, then this stage or the color demodulators may be defective. The components in these stages should be checked to find the defective unit.

Case History No. 2. A color television receiver was unable to develop either color or black-and-white pictures. Sound, too, was missing. The screen, however, did display a normal raster which possessed the proper convergence.

Since both monochrome and color images are missing, it is safe to assume that the defect lies in a stage through which the entire signal passes. Furthermore, the absence of sound means that the trouble is located at some point before the sound take-off in the video system.

To locate the defective stage, the Television Analyst is utilized the same way here as it was previously in a completely black-and-white set. Furthermore, since the set is unresponsive to all signals, it is entirely feasible to use a monochrome test signal. When we locate the trouble with this signal, we will also be locating the trouble for the color and sound signals.

Consequently, the Television Analyst is set up to deliver a black-and-white test pattern signal, as previously discussed. With this signal, we can start the search for the defective stage, first in the video amplifier section, then in the video IF section and, finally, in the RF tuner. At each point, the frequency of the signal would be governed by the stages involved. In the video amplifier section, the test pattern signal is in its video form. In the IF system, we would employ the appropriate IF value, etc.

Case History No. 3. A color television receiver was found to operate normally on black-and-white, but the color picture it produced did not possess the full range of colors. Sound was normal.

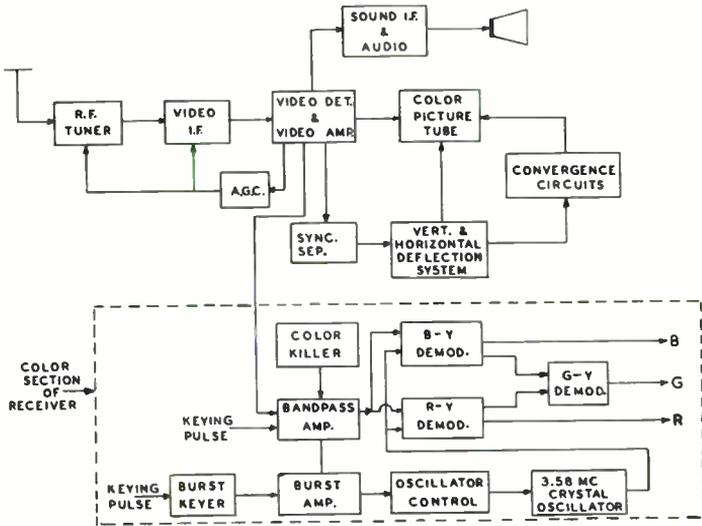


FIGURE 54
Detailed block diagram of a typical color television receiver.

From these symptoms, it appears that one of the color demodulators (Fig. 54) is not operating. In Fig. 54, one of these demodulators, the B-Y, is concerned principally with the blue portion of the spectrum. The R-Y demodulator deals mainly with the red segment of the color spectrum. Finally, the third color demodulator deals with the green portion of the spectrum. Note, however, that unless the G-Y stage receives the

proper signals from the two other demodulators, that it cannot properly produce its signal. Hence, with this set-up, the reds and blues in a color image should be examined first. If these are present, then the presence of the greens should be sought.

To start, the Television Analyst is connected to the input of the receiver and set-up to deliver its color signal. This will produce the pattern shown in Fig. 53.

Note the sequence, starting with reddish orange at the extreme left side of the tube, followed by a gradual transition to red, magenta, blue, cyan and then green. Three of the colors, red, blue and green, are essentially pure primary colors. The remaining colors are formed by the addition of two primary colors. Reddish orange is a combination of red and green. Magenta is formed with red and blue. And cyan is a combination of blue and green.

Now, let us suppose that the R-Y demodulator is defective. This will remove all of the red from the image, plus some of the green since the G-Y demodulator gets part of its signal from the R-Y stage. However, the blue color would be normal, and there would be some semblance of cyan in the image. This result is immediately apparent from an examination of the rainbow pattern and points the way to the defective stage.

A rainbow pattern such as that developed by the Television Analyst is far superior for testing purposes than a broadcast color image. In this color pattern, you know the color of each bar and if any color is absent, it will be evident immediately.

In a color image picked up during a broadcast, you have no **direct** information concerning the color at each point and are therefore unable to spot any missing color readily.

Whatever the sequence of demodulators (and some receivers use a different arrangement from that shown in Fig. 53), the rainbow pattern will always reveal what colors are missing.

In closing, it should also be noted that having a series of known colors is also useful in adjusting the color phasing (or hue) control. This adjustment could be made using a received picture, but it can be done easier and more correctly with a rainbow pattern.

SECTION XIV

OTHER USES FOR TELEVISION ANALYST

In addition to the application for the Analyst outlined in the preceding sections, there are many other purposes which this instrument can serve. Some are quite obvious, such as linearity, size and aspect ratio adjustments. Others, while just as useful, are not as apparent.

In the paragraphs below, we will describe some of these auxiliary applications of the Television Analyst.

1. Linearity and Size Adjustments.

It is difficult to accurately adjust a television image with respect to linearity using any picture but one specifically containing provision for such adjustments. If any reader doubts the validity of this statement, let him attempt such an adjustment using the images picked up during a station's normal broadcasting schedule.

You will find, first of all, that no image remains fixed long enough to permit a complete adjustment of the height, width, vertical linearity and horizontal linearity controls. Second, any image not containing a fairly large circular pattern will not provide you with enough visible markings to establish the desired linearity. You will find that after a seemingly satisfactory adjustment has been made, when a large circle (or circular object) is flashed on the screen, it is not perfectly round.

The B & K Television Analyst makes ample provision for this in its test pattern. Here, there is not only a large circular pattern that touches both the top and bottom of the image, but there are also several smaller circles in the center. When all of these are perfectly round, the linearity of the deflection system is properly adjusted.

Picture size and aspect ratio can be adjusted with the same test pattern. The large black circle should be enlarged until its top edge just touches the upper edge of the screen and the bottom of the circle touches the lower edge of the screen. Horizontally, the test pattern should be widened to fill the screen, from the left-hand edge to the right-hand edge.

2. RF Sensitivity of Receiver.

It is well known that some television receivers are more sensitive than others. It is possible, with fairly extensive equipment, to determine the actual sensitivity of a receiver, but knowing this figure will not really shed any light on a receiver's performance at a certain location unless you know from an actual test (i.e., from experience) just how sensitive a receiver should be for proper reception under existing signal conditions.

In this respect, the B & K Television Analyst can prove exceedingly useful because the amplitude of the output signal can be varied. From your experience, you will know the minimum amount of signal required by a normally functioning receiver to produce a satisfactory image on the screen. Let us say this occurs when the "RF Attenuator" control is set to 6 on its scale. Any other receiver, then, that does not produce a similar picture level on its screen with the attenuator set at 6 or less can be deemed unsuitable for normal signal locations.

In fringe areas, it may be necessary for a receiver to develop a satisfactory image with the "RF Attenuator" control set to 3. Every set designed to be used under these conditions should then be capable of passing this test. If a receiver requires more input signal, then the technician can be reasonably certain this set is not sensitive enough for fringe area use.

It is interesting to note that the same facility of the Television Analyst is useful in checking the operation of the AGC system of a receiver. The purpose of the AGC network is to maintain the signal level at the output of the video detector fairly constant as the antenna input signal varies. The better the AGC network, the wider the range over which it will maintain a constant output signal.

To check the AGC network operation with the Television Analyst, we would proceed as follows.

Connect the RF signal output of the Analyst to the antenna terminals of the receiver, Adjust both to the same channel. Connect the vertical input terminals of an oscilloscope across the output of the video detector (or any point beyond this up to the picture tube).

Now, start with the "RF Attenuator" of the Television Analyst turned completely counterclockwise. Gradually rotate the control clockwise. The video signal will rise to a certain height on the scope screen and then remain substantially at this value as the control is rotated. Then, somewhere near the high end of the control, the pattern will probably start to diminish. This is due to saturation of the tubes from signal overload and their non-linear characteristics near cutoff.

A well-designed AGC system will hold the video signal level constant, without overloading, over a **greater** range of the "RF Attenuator" than a system not as well designed. By noting the level range for a number of receivers, you will soon be able to tell with considerable accuracy which systems function best, which are average and which are poor.

It is this type of information and the ability to perform such tests that enables the serviceman to not only perform a better job but to do it with a greater understanding of receiver capability.

With tests such as these, you **know** when a set is functioning properly. There is no guesswork as there is with many other instruments.

3. Using the Television Analyst for Display Purposes.

There are many places outside the service shop where a controllable pattern or display picture is required. For example, in the installation or servicing of a master antenna system, it is useful to have a modulated RF signal that can be transmitted through the system. The same is true of community TV antenna systems where essentially the same situation exists only over a greater area.

Here is the way the Analyst would be used with these systems.

The unit would be connected to the input of the master antenna amplifier through a suitable matching network. The "Tuning" control of the Analyst would be adjusted for a good picture on the display sets, on an unused channel. The "RF Attenuator" would be set so that overloading of the master antenna amplifier did not occur. Set the "Horizontal"

control for a stable picture. Set the "Video" control for best picture contrast. After these initial adjustments, only the "Video" control will have to be adjusted for the different slides that may be used.

The same set-up would be applicable with a community TV antenna system.

The Television Analyst will transmit any positive and transparent picture or pattern. The only requirement is that the size of the pattern be limited to 3-by-4 inches. Hence, any pattern drawn with a black crayon on a piece of clear plastic or acetate the same size as the slides furnished with the instrument can be used in the slide-holder. One blank acetate slide is provided with the unit.

To display black-and-white photos on a TV receiver, merely have a positive film transparency made and use it in the slide-holder. For best results, the film transparency should be enlarged or reduced so that the picture area is about 3-by-4 inches. The full size of the film transparency should be $5\frac{5}{8}$ by $5\frac{5}{8}$ inches in order to fit into the metal slide-holder properly.

Additional uses of the Television Analyst not yet mentioned include: As an advertising medium to display both pictures and sound messages on the screens of TV receivers in department and retail stores; as the transmitter for video and audio paging systems at conventions, hospitals and other gatherings; and in TV broadcasting stations in place of the usual monoscope or other slide transmitting equipment that is ordinarily used.

Here, then, is the B & K Television Analyst, a miniature television transmitter that will work with any receiver now in use, and which, if properly applied, will cut servicing time by more than 50 per cent.

To the best of our knowledge, it is the most complete test instrument of its kind!

SECTION XV

SUMMARY

This new process of injecting signals at any point in a television receiver, to check out the operation of individual stages or complete sections, opens up a whole new technique in television trouble shooting.

As long as the signal injection point is somewhere along the series path that the signal must travel from the antenna terminals all the way through to the picture tube or loud speaker, this complete signal path can be analyzed in minutes. Included in this series path are all of the series components which are directly involved in passing the signal; for example, inter-stage I.F. transformers, video peaking coils, coupling condenser, etc.

This unique servicing method allows us to find the source of trouble in less time than it usually takes to pull the chassis from the cabinet.

Signal tracing by itself is not a new concept. As a matter of fact, it has been used for many years on radios as well as television. In radio servicing it was particularly effective because the sound which you heard from your signal tracing instrument was the same sound that appeared as the final result in the loud speaker. In signal tracing video circuits, however, there was always this tremendous problem of relating the waveform which you saw on your signal tracing equipment (using an oscilloscope) to the final picture which appeared on the television picture tube. The oscilloscope waveform pattern of a video signal can tell the television engineer many things about that signal, and therefore, these oscilloscope patterns are very useful in designing a television receiver. However, even when designing new sets, it is the final resulting picture on the television set screen which the engineer himself uses to

determine whether he has a good picture or a poor one. In other words, the only real qualitative test of a picture on a television receiver IS the picture itself. Then why not use this picture as your indicator of troubles in the receiver? This is the philosophy upon which this new servicing technique using the Television Analyst was developed.

It might be suggested that capacity pickup of signal from the receiving tubes, using the "conventional signal tracing" technique, permits quicker analysis on television problems because it can be done from the top of the chassis. This would appear to have merit, except that if the techniques as set forth in this book are followed, the tubes have already been checked at this point. Therefore, any additional defects which would cause trouble in a set must be beneath the chassis, and therefore, the chassis has to be removed from the cabinet anyhow. In addition, trying to analyze the oscilloscope waveform requires great skill, experience and judgment on the part of the technician, and therefore, is not only subject to error, but also takes a much longer time than the error free new method using the Television Analyst.

Now with this new technique both the experienced technician and the relatively inexperienced serviceman can easily handle most of the problems encountered in any television receiver.

Revelation in TV Servicing Technique

"TELEVISION ANALYZING SIMPLIFIED"

by **MILTON S. KIVER** Author of "Television Simplified"
"Transistors in Radio and Television" and many other books

Compares servicing methods. Explains newest, simplest, fastest way for even the inexperienced serviceman to spot and correct the exact source of video or audio trouble, after tube changing has failed.

Tells how you can inject your own TV signals at any time. No guesswork. No waveform interpretation. No complicated diagram references. No lost hours.

Shows how new technique enables you to service more sets in much less time, satisfy more customers, and make more money.

"Worthwhile information for every TV service technician."

Albert J. Forman, Editor
ELECTRONIC TECHNICIAN

"Reveals new simplified approach to television servicing."

Verne M. Ray, Editor
PF REPORTER

"Explains latest technique of point-to-point signal injection for TV trouble shooting."

M. Harvey Gernsback, Editorial Director
RADIO-ELECTRONICS

"Tells how to save time and work in pin-pointing TV troubles."

Wm. A. Stocklin, Editor
RADIO & TV NEWS