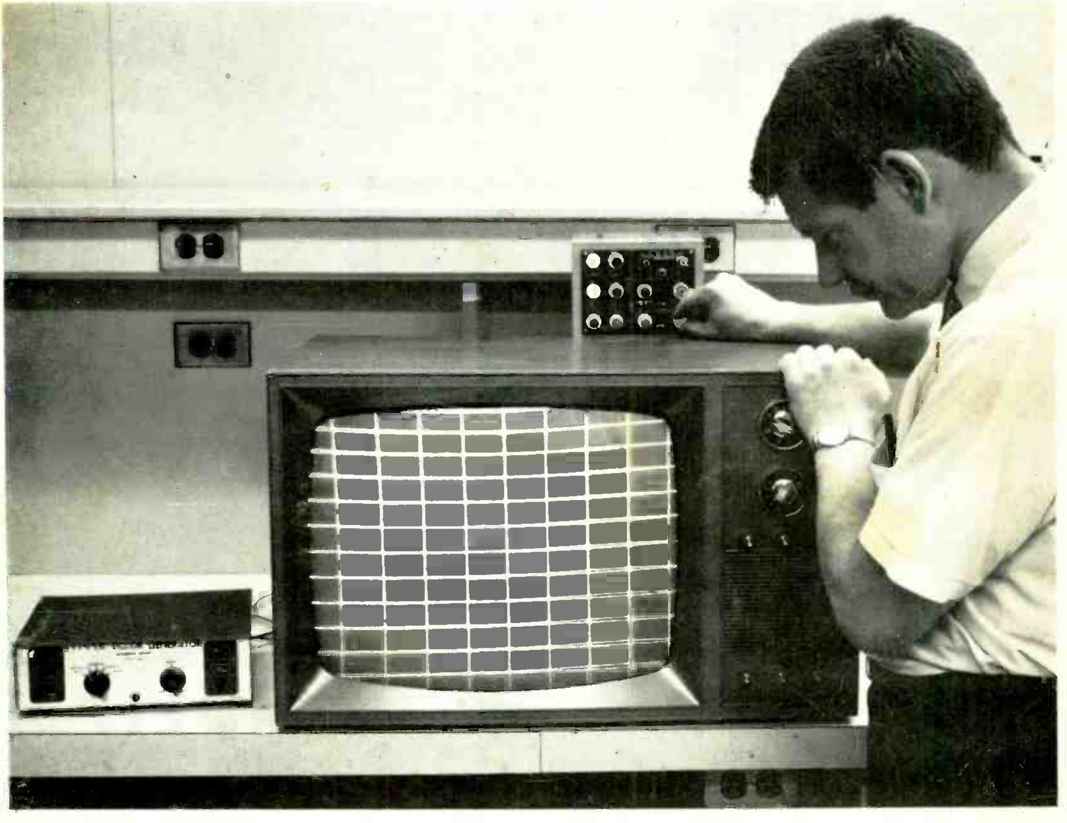
nri journal

May/June 35 Cents



IN THIS ISSUE

COLOR IS HERE...FOR KEEPS

RESISTANCE, REACTANCE, IMPEDANCE

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INTEGRATED CIRCUIT

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Full vertical line pattern
Full horizontal line pattern
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1 type 2N555 PNP power transistor
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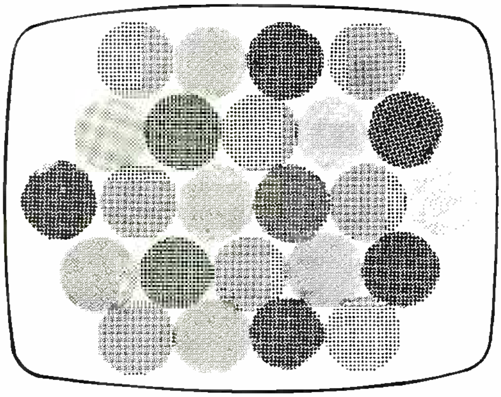


COLOR IS HERE – FOR KEEPS

BY WILLIAM F. DUNN

In the late 1940's and in the early 1950's, many radio servicemen who had been in business for many years suddenly found themselves confronted with television servicing. As the public began buying black-and-white television receivers, they began bringing them to the serviceman for repair and adjustment. Most servicemen had had no previous experience with television; in fact, many were extremely hazy on exactly how a TV receiver worked.

The practicing radio servicemen immediately divided themselves into two groups. The servicemen in one group decided that they did not want to be bothered with television servicing. After all, they had made their living for years servicing radio receivers. There would be radio receivers around indefinitely, television was not going to replace radio, it was simply a new type of broadcast service.

So far, their thinking was and is entirely logical. We know today that television has not replaced radio; in fact there are more radio stations on the air today than there were at that time, and there are many more radio receivers in use.

However, their reasoning continued that as long as there were radios around to be serviced they would continue to get their share of the repair business and their businesses would continue to prosper.

The other group of radio servicemen decided that television presented a new opportunity. Not only was it an opportunity for them to learn about this new electronic marvel, but it also was an opportunity for increased business opportunities.

Therefore, they decided that they would learn how to service television receivers. The public began bringing television sets to them for repair; they took the sets in and fixed them. In the beginning it was tough going for many servicemen, because they did not know as much about television as they should have, and each repair job presented a real challenge. But by continued study and taking in repair jobs, they both learned about television and got practical experience at the same time.

This second group who took in television repair work also found that their radio servicing work increased. The reason for this is obvious. If the person took his television receiver to his former radio repairman to have it fixed and the repairman told him that he did not do any television work, he would have to hunt up a new repairman who did do television

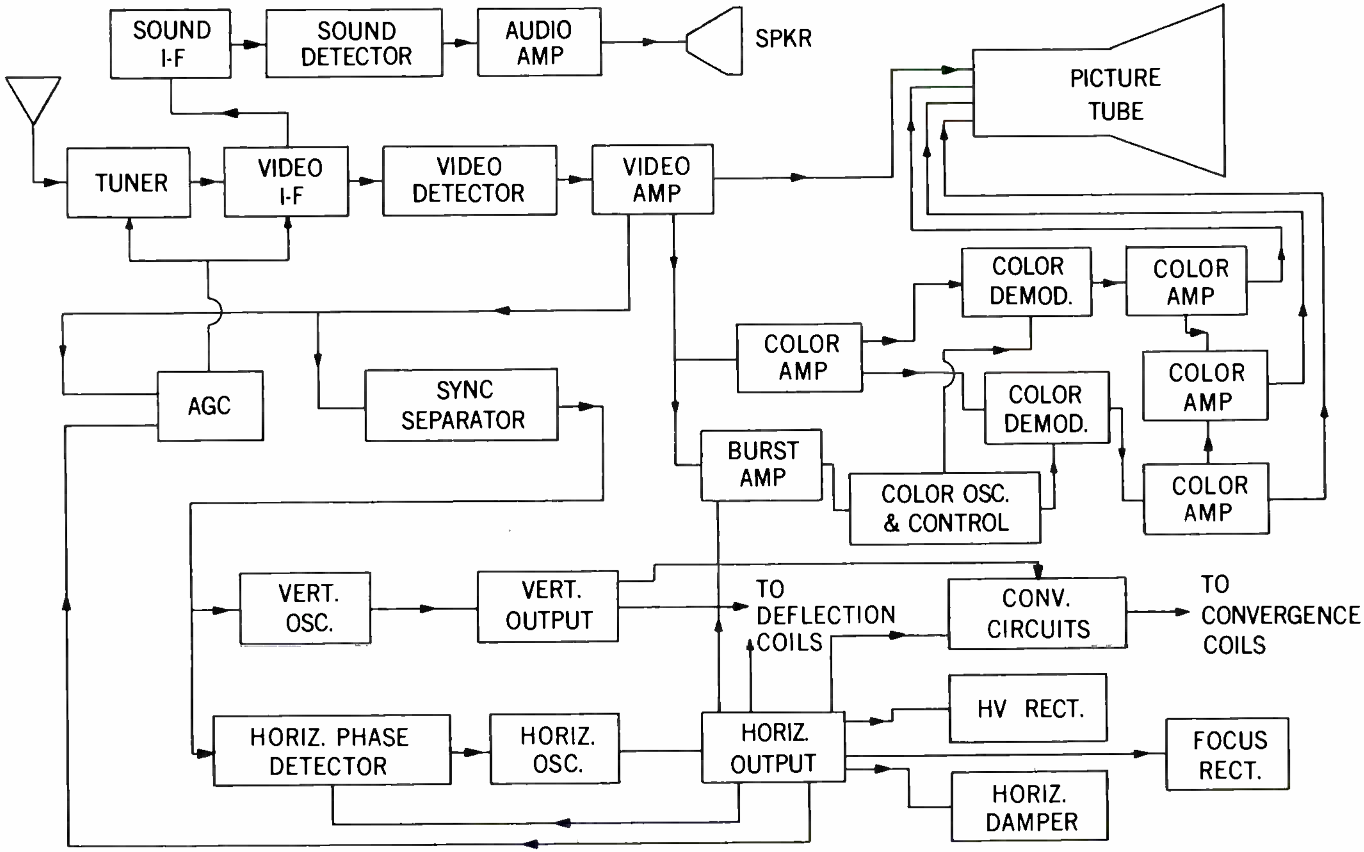


Fig. 1. Simplified block diagram of a color TV receiver.

work. If the repair work was done satisfactorily, as in most cases it was, then the next time a radio needed servicing the chances were he would take it to the repairman who fixed his television receiver. He would just naturally assume that the repairman who could repair television receivers would be more competent in radio repair work than the man who admitted he could not fix a television receiver.

Today a similar situation is facing many television servicemen. There are over ten million color television receivers in use today and the number is growing by several million each year. Color television servicing represents a sizable portion of the total service work being done today. Therefore it is essential that the TV serviceman who has been doing black-and-white television servicing and expects to stay in business be prepared to do color television servicing.

IT'S NOT ALL NEW

Actually, there is a great deal of similarity between a monochrome television receiver and a color television receiver. Many of the circuits in the two are practically identical. Many of the defects that occur in a color television receiver occur for exactly the same reasons that similar defects occur in monochrome receivers. The servicing techniques used to locate and eliminate these defects are identical.

In Fig. 1 we have shown a simplified block diagram of a color television receiver. You will notice that the signal picked up by the antenna is fed to the tuner. The tuners in monochrome and color television receivers are practically identical. You'll find the same stages in both receivers.

In the UHF tuner you'll find a mixer and an oscillator stage, and in the VHF tuner an rf stage, a mixer and an oscillator stage. While the manufacturers may have taken some extra care with the tuners used in the earlier color TV sets, the chances are that in the later model receivers the same tuner is being used in both color and black-and-white television receivers.

From the tuner the signal is fed to the video i-f amplifier in both color and monochrome receivers. From the video i-f, the picture signal is fed to the video detector in both types of receivers.

There is a small difference in the video i-f amplifier and the video detectors of monochrome and color TV receivers. In color TV receivers, the sound signal is taken off from the last video i-f amplifier and fed to a separate diode. In the diode the sound and picture signals beat together to produce a 4.5-mc sound signal which is then fed to a sound i-f amplifier. (See Fig. 2 and Fig. 3.)

In monochrome receivers the two signals, the sound i-f and video i-f signals, are both fed to the video detector, where they beat together to produce the 4.5-mc sound signal. The sound signal is then taken from the video detector and fed to the sound i-f.

The reason for this difference is that the sound i-f and the color subcarrier i-f signals differ by only 920 kc. If both signals are allowed to reach the video detector in a color receiver, they will beat together and produce a 920 kc interference pattern.

Since this signal is well within the bandpass of the video amplifier, it will be amplified and fed to the picture tube. Therefore in a color receiver we prevent the sound signal from reaching the video detector to avoid this type of interference.

However, as far as the actual sound system in the two receivers is concerned, they are identical. There is usually a sound i-f amplifier followed by the sound detector, and the audio signal is then fed to an audio amplifier and from there to the speaker.

A common defect that you will run into

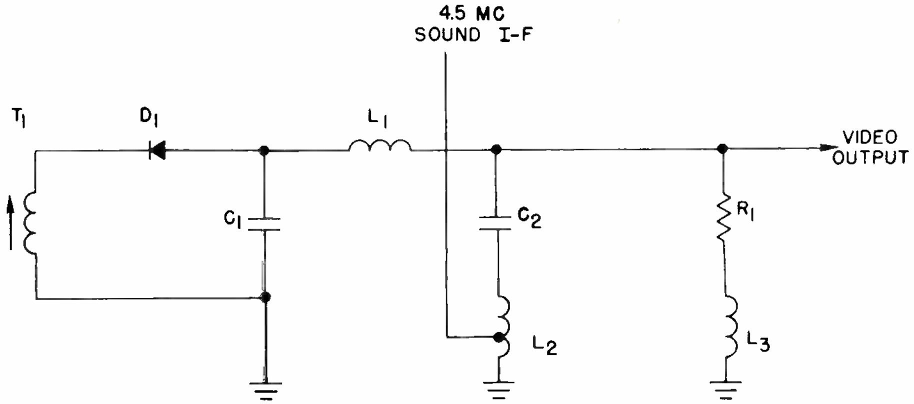


Fig. 2. A typical video detector from a monochrome receiver.

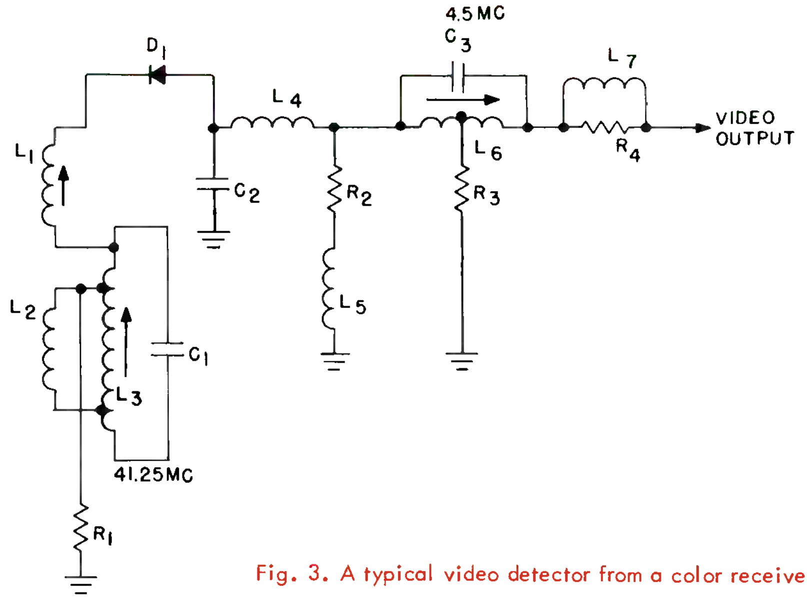


Fig. 3. A typical video detector from a color receiver.

in TV servicing is a situation where you will have a raster on the face of the tube but neither sound nor picture. Immediately this points to a defect in a circuit common to both the sound and video signals. You will know by this that the trouble may be in the tuner or in the video i-f amplifier in both color and monochrome receivers.

In a monochrome receiver the trouble may also be in the video detector, where in a color receiver it is not likely that the problem is in the video detector because the two signals are separated before they reach the video detector. You would use the same procedure in servicing a receiver with this type of complaint, whether the set is a color receiver or a black-and-white receiver.

There is a small difference in the video amplifier in the color receiver from that found in a monochrome TV receiver. A delay line (Fig. 4) is inserted in the video amplifier of the color receiver. The color signal which must be processed by additional stages reaches the picture tube a little behind the video signal.

To prevent this and have both signals arrive at the picture tube at the same time, we insert a delay line in the video amplifier. Otherwise, the video amplifier of both types of sets is usually identical. You run into the same problems, defects that completely prevent the video signal from reaching the picture tube, and also defects that will cause smearing or loss of high-frequency detail.

Fig. 4. Photograph of a delay line.

The servicing procedures used on both types of video amplifiers is identical. The only additional problem that you are likely to encounter in a color set is with an open delay line. This type of defect can be checked quickly by using an ohmmeter check for continuity through the delay line.

In both color and monochrome television receivers we must separate the sync pulses from the video signals and then use these pulses to control the horizontal and vertical oscillators. The sync separator performs the same function in both receivers and for all practical purposes the same circuit is usually used.

The output from the sync separator is then fed to the vertical oscillator to control the vertical oscillator frequency, and the signal from the vertical oscillator drives the vertical output stage which in turn drives the vertical deflection coil.

The signal from the sync separator is also fed to a horizontal phase detector. This stage compares the incoming sync pulses with a signal from the output of the horizontal sweep, and makes any correction for any phase or frequency differences between the two signals. The horizontal oscillator stage produces the horizontal oscillator signal, which in turn drives the horizontal output stage. The output from the horizontal stage is fed to the horizontal deflection coils that provide the horizontal sweep.

In both monochrome and color television receivers, the high voltage for the picture tube is derived from the horizontal sweep circuit. The rapid collapse of the horizontal field, as the electron beam is swung rapidly from the right side of the picture tube back to the left side of the tube, produces a very high voltage which is rectified by the high-voltage rectifier, filtered and then applied to the picture tube. In color TV receivers you will find a high-voltage regulator of some type to keep the high voltage constant with changes in load (Fig. 5). Such regulation is not necessary in monochrome TV.

In color television you will probably find a focus rectifier, in addition to the high-voltage rectifier. This focus rectifier is used to provide a voltage of about five thousand volts to focus the electron beams in the picture tube. This stage will not be found in a monochrome receiver, but it should present no separate problem. If you have normal output from the high-voltage rectifier, but no output from the focus rectifier, the chances are that the focus rectifier is defective.

In both types of receivers we have a horizontal damper stage, and as you know, this stage is used to prevent the

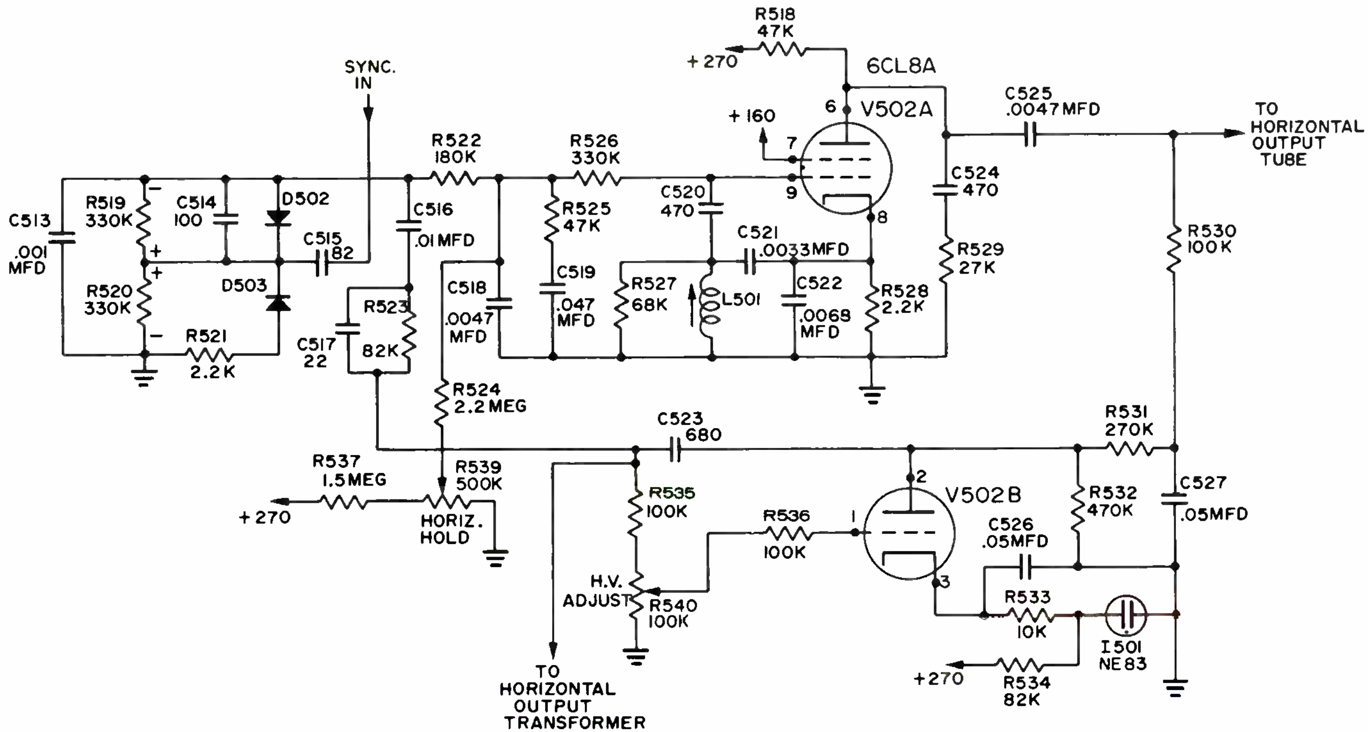


Fig. 5. The horizontal oscillator and high-voltage control circuits.

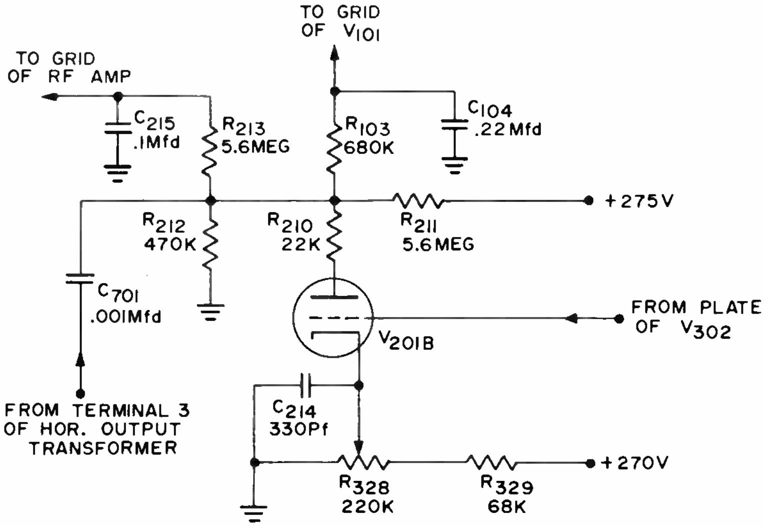


Fig. 6. Diagram of a keyed agc amplifier stage.

horizontal sweep circuit from going into oscillation after the electron beam has been moved rapidly at the end of one line at the right of the screen to the beginning of the next line at the left of the screen. The dampers perform the same function in the two sets and identical circuits are usually used.

Automatic gain control is used to control the gain of the rf stage in the tuner, and one or more stages in the video i-f amplifier. Modern television receivers use a keyed type of automatic gain control that is turned on only during the horizontal sync pulse interval. The automatic gain control circuit (Fig. 6) is turned on by a pulse from the horizontal output stage.

The amount of control voltage produced by this stage, to control the gain of the rf and video i-f stages, depends upon the amplitude of the sync pulse arriving at the agc stage.

If you check off the circuits we have discussed so far in Fig. 1, you will see that you have a large number of the blocks checked off. With the exception of the focus rectifier, all these blocks we have discussed so far are common to both color and black-and-white television receivers. The defects that occur in these stages are the same in both types of sets.

For example, if we lose synchronization in both the horizontal and vertical sweep circuits we would immediately suspect a defect in the sync separator. On the other hand, if the horizontal oscillator remains in sync but we lose vertical synchronization, we know that we have a problem in the vertical sweep circuit rather than in the sync separator.

Similarly, if we lose horizontal synchronization, but the vertical oscillator remains in synchronization, once again we know that the problem is in the sweep circuit rather than in the sync separator.

These problems occur in both monochrome and color receivers. The techniques used to isolate the defect to one stage are identical in both receivers and the servicing procedures for pinning the defect down to one circuit and finally to the defective part are identical for both types of receivers.

The symptoms that these defects produce

are the same for both types of receivers, and since the majority of the stages in the receivers are common to both monochrome and color TV receivers, as you might expect most of the defects encountered in color television receivers are similar to the defects encountered in monochrome receivers.

THE COLOR CIRCUITS

Now let's discuss the color circuits shown in Fig. 1. The color signal, which is a 3.5-mc signal, is taken off from the video amplifier and fed to the color amplifier. The color amplifier is simply an i-f amplifier designed to operate at 3.5 mc. The amplifier is designed to have a passband of about 500 kc above and below 3.58 mc so that all the required sidebands of the color signal will be amplified by the amplifier.

At the same time, the color signal is fed to a stage called the burst amplifier. On the back of each horizontal synchronizing pulse an eight-cycle 3.58-mc color burst signal is transmitted by the transmitter. The purpose of this pulse is to enable us to lock the 3.58-mc oscillator in the receiver exactly in phase with the 3.58-mc oscillator in the transmitter.

The burst amplifier stage is biased so that it is cut off during the entire horizontal line, except during the interval when the 3.58-mc color burst is being transmitted. This is accomplished by feeding a signal from the horizontal output stage to the burst amplifier. This signal occurs during the horizontal retrace interval, which of course, corresponds with the time that the color burst is transmitted.

This pulse signal from the horizontal output stage is used to turn the burst amplifier stage on, so that the color burst transmitted once each line will be amplified by the burst amplifier. At the same time, since the burst amplifier is turned off during the rest of the line, none of the color information, other than the burst, is amplified by the burst amplifier.

Shock-Excites Signal.
The 8-cycle color burst which is amplified by the burst amplifier is fed to a group of stages that we have labelled color oscillator and control. Actually, sometimes the burst signal is fed directly to the color oscillator (Fig. 7) and simply shock-excites it into maintaining oscillation at the correct frequency and phase.

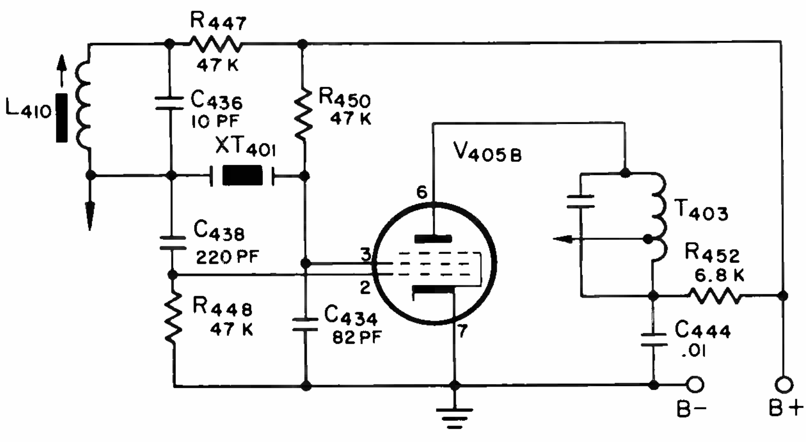


Fig. 7. Schematic diagram of a color oscillator.

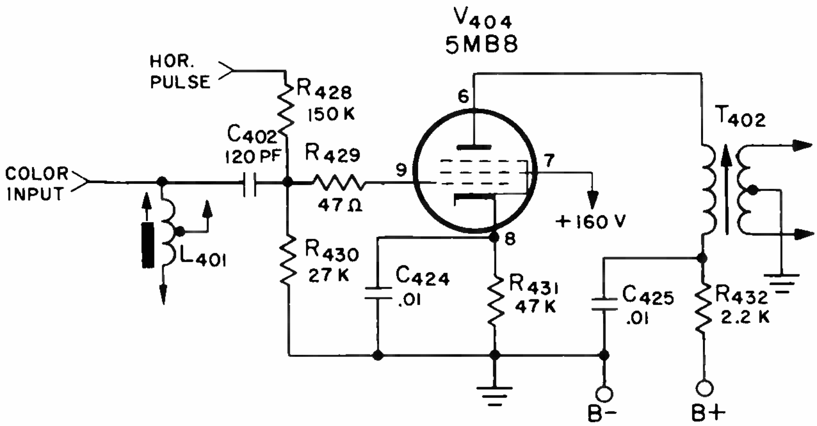


Fig. 8. Schematic diagram of a burst-gate amplifier stage.

In other circuits the color burst (Fig. 8) from the amplifier is fed to the phase detector where the color burst is compared with the signal from the 3.58-mc color oscillator in the receiver. If there is any phase or frequency difference between the two signals, a dc correction voltage is developed and this voltage is fed to a reactance tube which shifts the oscillator frequency and/or phase to lock it in with the 3.58-mc oscillator at the transmitter.

The 3.58-mc color signal transmitted by the transmitter is a double-sideband, suppressed-carrier signal. In other words, in a transmitter the color information is used to modulate a 3.58-mc color subcarrier. The color information then produces sidebands of 3.58 mc, and these sidebands are transmitted by the transmitter. However, by using a balanced modulator, the 3.5-mc carrier signal can be suppressed; in order to demodulate the signal we must reinsert this 3.58-mc carrier. The signal from the color oscillator (Fig. 9) is fed to the color demodulators for this purpose

The output signal from the color i-f amplifier is also fed to the color demodu-

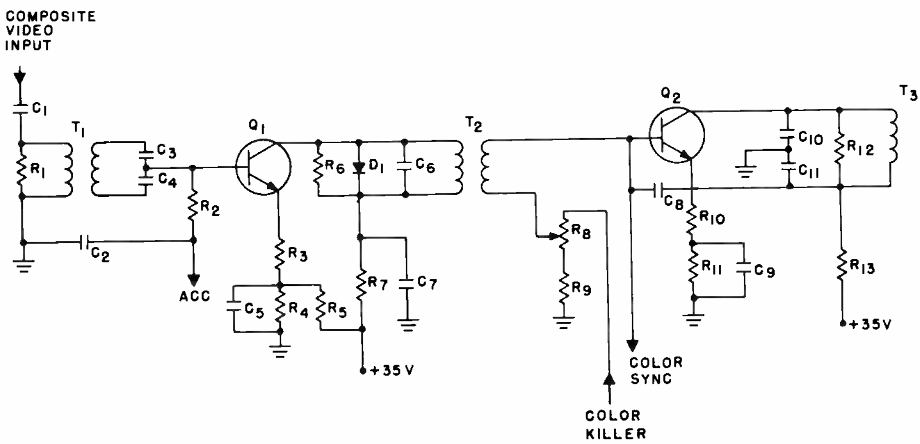


Fig. 9. A two-stage transistor color i-f amplifier.

lator. The color demodulator will demodulate two of the color signals, and these signals are fed to color amplifiers and from color amplifiers to the picture tube. At the same time, the correct proportion of the signals from the two color amplifiers are taken and matrixed together to produce the third color signal. This signal is amplified by the third color amplifier and fed to the picture tube.

Most sets have a stage called the color killer. The purpose of this stage is to bias the color amplifier beyond cut-off when a black-and-white transmission is being transmitted, so that no video information can get through the color amplifier to produce color specks or regions on the face of the picture tube.

This group of stages, which we refer to as the color stages or color section of the receiver, constitute the basic difference between a color set and a black-and-white receiver.

There is one other group of circuits known as the convergence circuits that are found in color receivers only. These circuits are used to make the three electron beams in the color picture tube fall on the same spot on the face of the picture tube. The beams can be converged in the center of the tube by means of magnets, but on the other edges dynamic convergence is required. Dynamic convergence is simply a form of electrical convergence that varies as the electron beams move over the face of the tube. Both horizontal and vertical dynamic convergence are required, and setting up these convergence adjustments is quite time-consuming.

However, the convergence adjustments have been greatly simplified in modern television receivers. If you have occasion to readjust these adjustments, the best thing to do is to get a copy of the manufacturer's service information and then go through the convergence procedure step-by-step as outlined.

DEFECTS IN THE COLOR SECTION

Normally a defect in the color section of the color receiver will not affect the operation of the receiver on black-and-white reception. Of course, if there is a short in a stage in the color section, and this upsets the operating voltages in the black-and-white section of the receiver, this isn't true. The defect will have some effect on black-and-white reception. However, most defects in the color section simply result in loss of color or incorrect or unstable color.

If you have no color at all, then you should look for a defect in the color amplifier or in the color oscillator. The color amplifier will prevent the signal transmitted by the station from reaching the color demodulator if there is a defect in this stage. If the color oscillator is not working, there will be no detection in the color demodulator stages.

If you have some color, but one or more of the colors is missing, then look for a defect in one of the color demodulators, in one of the color amplifiers or in the matrixed circuit used to produce the third color.

If you have color, but the color keeps dropping out of synchronization, the trouble could be in the burst amplifier. The burst signal may not be getting through this stage. The trouble could also be in the phase comparator stage, the reactance stage or in the color oscillator stage.

If the picture breaks up into separate colors you have a convergence problem. If the picture is broken up into separate colors over the entire face of the screen, then the chances are that the magnets used to set the static convergence at the center of the screen have moved. You will have to reset these magnets. The chances are that when you go through the procedure for resetting them you will have to go through the dynamic convergence adjustments also.

On the other hand, if convergence is good in the center of the screen but the picture breaks apart on the outer edges, this is a dynamic convergence problem. It is usually impossible to get perfect convergence over the entire face of the picture tube. With a little experience, you will soon learn to judge whether the convergence is as good as you can expect it to be or if there is a defect or misadjustment in one of the convergence circuits.

IS MORE COMPLEX

The color picture tube is much more complex than the picture tube used in monochrome TV receivers. A black-and-white video signal is usually fed to the three cathodes of the picture tube. The separate color signals are fed to the three different grids of the picture tube. Since we have three guns inside the picture tube, it is possible for a defect to develop in any one of these guns that will not affect the other two. For example, a grid-to-cathode short in the red gun of the picture tube would make it impossible to modulate the red electron beam.

As a result, the beam would probably be turned on all the time so the picture would have a red background. All the red detail would be missing. You would have the same type of defect in the case of grid-to-cathode in either of the other guns. Fortunately, the manufacturers take great care in the manufacture of color picture tubes and defects are relatively rare. Usually, the only defects you'll encounter are burned-out heaters, cathode-to-heater shorts in the picture tube, and low emission due to the fact that the tube has been in use for a long time.

While we are discussing low emission from the picture tube, this usually shows up in the form of a very dull picture. You simply can't get much brightness from the tube. Before you decide that the picture tube is defective, make sure that the high-voltage is normal. Also check the voltages on the grids and cathodes of the picture tube.

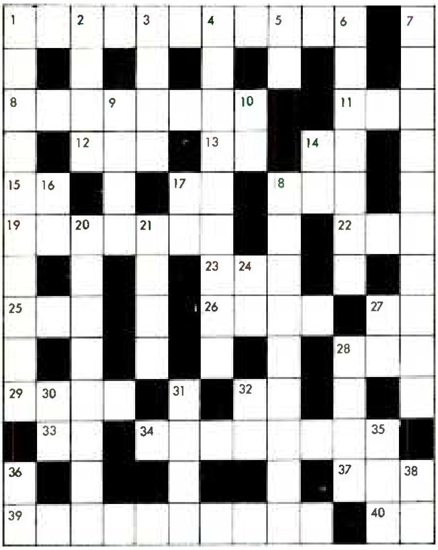
In most receivers direct coupling is used in the video amplifier and in the color amplifier stages. Therefore a defect might occur anywhere in the video amplifier that would upset the operating voltages of the picture tube. A defect might cause higher than normal bias on the picture tube, and this would limit the brightness you could get from the tube. If you run into this type of situation, the chances are that if you correct the video amplifier defect you will be able to get normal brightness from the tube.

If you find that only one of the colors is dull, then look for a defect in the color amplifier used with that particular gun. Once again, a defect anywhere in the amplifier could upset the grid voltage of the tube, resulting in excessive bias and reducing the brightness.

NRI COURSE AVAILABLE

In this brief discussion of color TV servicing we have only hit the highlights. The important thing to realize is that if you are doing black-and-white television servicing, it is only one small step to take on color television servicing. NRI has an advanced color television servicing course available for black-and-white TV servicemen who want both training in modern color television receivers and also practical color television servicing experience. If you are interested in this training program be sure to write for full details. Above all, don't miss the boom in color TV servicing. There is a tremendous shortage of competent color television servicemen, and the opportunities available today are greater than ever before.

ELECTRONICS CROSSWORD PUZZLE



by James R. Kimsey

(Solution on page 27)

ACROSS

1. An LC resonant circuit. (2-wds)
8. A device used to change dc to ac.
11. Encompassing on all sides. (abbr.)
12. Wood-cutting device.
13. Midwestern state. (abbr.)
14. 3.1416
15. Southern state. (abbr.)
17. Most extensively used crystal cut in radio frequency transmitters from 4500 to 10,000 kc.
18. Bar.
19. End section of a transistor.
22. Snakelike fish.
23. Grow old.
25. Hotel.
26. Close.
27. Abbreviation for the center tap of a coil winding.
28. Ghostly sound.
29. A square-wave voltage which switches a circuit on or off electronically, by energizing the grid or cathode of the control tube.
32. Common initials to show that a debt has been discharged.
33. Physician. (abbr.)
34. An insulated terminal used for connecting a number of parts together. (2-wds.)
37. Performed, as work.
39. In secondary radar, the undesired triggering of a transponder by its own transmitter. (2-wds.)
40. Power frequency.

DOWN

1. The pulsating of a system, such as a multivibrator, into the opposite state of equilibrium.
2. ____ -rho. A long distance continuous wave LF navigation system.
3. The space about which a coil is wound.
4. ______ cavity. A resonant cavity with one or more sections directed inwards. (Hyphenated word)
5. Elevator directions.
6. Instructor.
7. A device used with a signal generator to vary the frequency between two values periodically.
9. A way out.
10. County division. (abbr.)
14. Mass communication system. (abbr.)
16. Common radio band. (abbr.)
17. Is.
18. In a gas tube, a runaway increase in an electrode current.
20. A half-wave mercury-vapor tube used as a high-power rectifier.
21. A sound sensation having pitch.
24. Well known electronic manufacturer. (abbr.)
27. Crystal Oscillator. (abbr.)
28. Limited continuous region which is part of a more extended region.
30. Paid notice. (abbr.)
31. Layer.
32. Kind of mail service. (abbr.)
35. The contact at the end of a telephone type plug.
36. A switch that produces an output signal if a signal appears on any one of the input lines.
38. A radio aid to navigation. (abbr.)

RESISTANCE, REACTANCE, IMPEDANCE

By Robert L. Carlson

NEWCOMERS AND OLDTIMERS ALIKE MAY FAIL TO RECOGNIZE DIFFERENCES AND SIMILARITIES OF THESE HIGHLY IMPORTANT QUANTITIES

Many beginners in the field of electronics fail to grasp the true meaning of the terms resistance, reactance and impedance. As a matter of fact, many oldtimers, while they have used the terms for years, use them incorrectly and are not exactly sure of their differences and their similarities. This article is written in the hope of giving both newcomers and oldtimers a better insight into these three important quantities.

Perhaps one of the reasons why resistance, reactance and impedance are somewhat confusing is that they are all measured in ohms. This might at first lead us to think that they are essentially the same thing. For example, when we are talking about a resistance of 10 ohms, is this the same thing as a reactance of 10 ohms? As we will see, there are similarities, but also there are great differences.

Let's discuss resistance first. It is the easiest of the three quantities to identify, and also the first of the three which we usually encounter.

RESISTANCE

Resistance is the opposition to current flow in a circuit. Current flowing through a wire encounters a certain amount of opposition. This is resistance. Resistance is essentially the same thing in both ac and in dc circuits. A common form of resistance encountered in electric equipment is the resistor. A carbon resistor, for example, will offer exactly the same opposition to current flow in an ac circuit as it will in a dc circuit.

The opposition to current flow in the circuit determines the amount of current that will flow for a given applied voltage. The current that will flow in a circuit is defined by Ohm's Law as:

$$I = \frac{E}{R}$$

This formula can be used in both ac circuits and in dc circuits. If a 100-ohm resistor is connected in a dc circuit with a potential of 100 volts, the current that will flow in the circuit will be 1 amp. If the same resistance is placed in an ac circuit where the applied voltage is 100 volts, the current that will flow in the circuit is 1 amp.

When current flows through a resistor power is used. By power we are referring to electrical energy. Current flowing through a resistor produces heat, and this heat, generated in the resistor, is given off to the air surrounding the resistor.

Another example where electrical energy is converted to heat is in the heating element of a toaster or an iron. Here the current flowing through the resistance element in the iron or toaster causes the element to get hot and this heat is used, in the case of a toaster to toast bread, and in the case of an iron to heat the material being ironed.

Another example, where electrical energy is converted into another form of energy by a resistance-type element, is an electric light bulb. Here the electric current, flowing through the element in the light bulb, causes the filament to heat to a white heat. Most of the electrical energy is given off by the light bulb in the form of heat, but some of it is also given off in the form of light.

by the curve labelled E. On the same graph we have drawn a current waveform showing what the current would look like in an ac circuit containing only resistance.

Notice at the beginning of the cycle as the voltage increases the current also increases. When the voltage has reached its maximum value in the first half-cycle, the current has also reached its maximum value. As the voltage begins to decrease and drop to zero at the end of the first-half cycle, so does the current. Similarly, in the second half-cycle when the voltage polarity reverses, the current flows in the opposite direction and

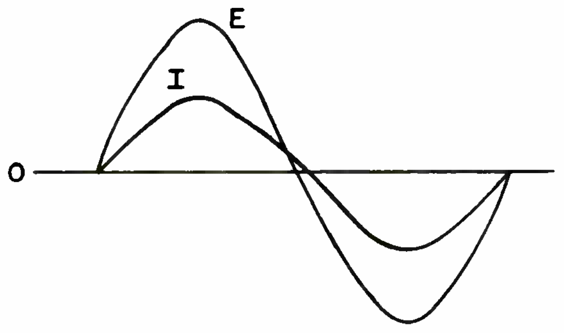


Fig. 1. Voltage and current waveforms are in phase in ac circuit containing only resistance.

The important point to realize from the preceding examples is that the resistance element produces the same effect in both ac and dc circuits. The resistance opposes the flow of current in the circuit. In opposing the flow of current in the circuit, the resistance uses up or dissipates a certain amount of electrical energy. This electrical energy turns up in the form of some other type of energy, either in heat or light in these examples.

When ac is flowing through a resistance type element, the voltage and current in the circuit will be in phase. By in phase we mean that as the voltage changes, the current also changes. In Fig. 1 we have shown an ac sine wave, and we have represented the voltage through one cycle

follows the voltage throughout the remainder of the cycle. Of course, in a dc circuit, since the voltage remains constant the current also remains constant. If we should increase the voltage, the current will also increase, and similarly if we decrease the voltage the current will decrease. Thus the current and voltage follow each other exactly, in a circuit containing only resistance.

Before going on to reactance, let's summarize the important things we have mentioned about resistance. First, resistance is an opposition to current flow in a circuit, and it is the same in both ac and dc circuits. Current flowing through a resistance causes a change in electrical energy to some other form of energy. Current flowing through a pure resistance element usually produces heat so that the electrical energy is transformed into heat energy. We say that electrical energy is used or dissipated.

Now let's take a look at the next quantity, reactance.

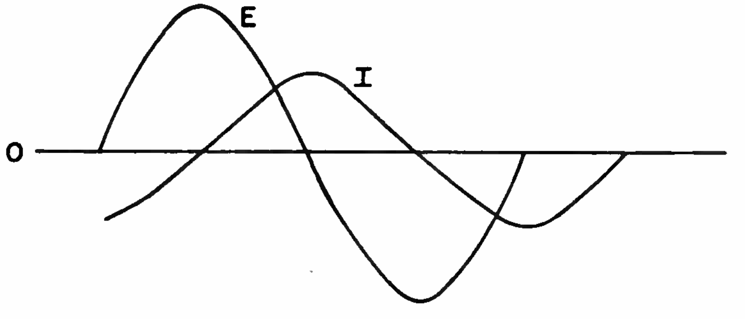


Fig. 2. Voltage and current waveforms in ac circuit containing only inductive reactance.

REACTANCE

Reactance is found only in ac circuits. There is no such thing as reactance in a dc circuit! Thus we have immediately one big difference between reactance and resistance.

There are two types of reactance: One is called inductive reactance and the other is called capacitive reactance. Inductive reactance is the opposition offered to current flow in an ac circuit by a coil or inductance in the circuit. Capacitive reactance is the opposition offered to current flow in an ac circuit by a capacitor.

Thus in both types of reactance, inductive and capacitive, we have a similarity with resistance inasmuch as they both offer opposition to current flow. However, there is a great deal of difference in the type of opposition to current flow offered by reactive components and resistive components.

Let's consider what happens in an ac circuit having a coil in the circuit. As you know, a coil offers inductive reactance. The amount of inductive reactance is given by the formula:

$$X_L = 6.28\ fL \text{ ohms}$$

Inductive reactance is measured in ohms and it is an opposition to the flow of ac current in the circuit. The higher the inductance of the coil, the greater the inductive reactance; in other words it offers more opposition to the flow of current in the circuit. Similarly, the higher the frequency applied to a given coil, the more inductive reactance or opposition it offers to the flow of current in the circuit.

Now let's look at Fig. 2 to get a better idea of exactly what inductive reactance is. We know from Lenz's Law that whenever there is a change in the magnetic field about a coil, a voltage will be induced in that coil that will cause a current to flow to prevent that change. In Fig. 2, as the ac generator starts the cycle at 0 and begins to swing in a positive direction, the rate of change in the voltage is at a maximum value.

At one instant the voltage is at 0 and the next instant it is changing in a positive direction rapidly. At the instant when the voltage is at 0, the field about the coil will be 0. Now as the voltage tries to build up a field rapidly, a voltage is induced in the coil that produces a current that tries to prevent that buildup in the magnetic field about the coil. If the voltage is changing at its maximum rate, the current will be at its maximum value. Instead of the current in the circuit flowing from the generator from the negative terminal to the positive terminal, it will in fact flow from positive to negative.

As the generator voltage builds up to its positive peak value, the rate at which the voltage is increasing decreases. In fact, when the voltage reaches its peak value, for an instant it is not changing at all. As a result, as the voltage builds up, the rate at which the field is changing goes down, so that the current decreases until when the voltage has reached its maximum value, the current is 0.

During the next half-cycle, as the voltage begins to decrease, the current tries to prevent the field about the coil from decreasing and in so doing begins to flow in a positive direction. As the rate at which the voltage drops increases, the current induced in the coil increases. When the voltage reaches 0 and changes polarity, the current will be at its maximum value.

During the next half-cycle, as the voltage begins to build up with the opposite polarity, the rate at which the voltage is building up decreases until the negative voltage peak is reached. Since the rate of change is decreasing, the current decreases. When the voltage reaches its negative peak the current has dropped to 0. During the next quarter-cycle, as the voltage tries to decrease, the current increases trying to keep the field about the coil from changing. The current reaches its maximum negative value when the voltage drops to 0, because once again the rate of change in voltage is at a maximum at that point.

Now look at the first quarter-cycle. Notice that while the voltage is positive the current is negative. During the next quarter-cycle the voltage and current are both positive. During the third quarter-cycle, the current is positive and the voltage negative, and during the fourth quarter-cycle the voltage and current are both negative.

During the quarter-cycles when the voltage and current have the same polarity, the inductance is taking power from the generator. This power is stored in the magnetic field around the coil. During the quarter-cycles when the voltage and current have the opposite polarity, the magnetic field is collapsing and is putting this power back into the generator. In a perfect coil, the coil will return exactly the same amount of power to the generator as it took from the generator. Thus in a purely inductive circuit, there will be no power taken from the generator at all.

Thus in the case of inductive reactance we have an opposition to the flow of current due to the fact that the coil opposes any change in the magnetic field around it. We also have a device that gives back during one quarter-cycle all the power that is taken during the preceding quarter-cycle. Thus while the inductance opposes current flow in the circuit as the resistance did, it does not actually use any power from the circuit as a resistance did.

Now let's consider what capacitive reactance is. You know that a capacitor is made up of two metal plates separated by some nonconducting material. A capacitor will oppose the flow of current in an ac circuit. This opposition is called capacitive reactance and is given by the formula:

$$X_C = \frac{1}{6.28\ fC}$$

When a capacitor is connected across a generator, we have a current and voltage waveform such as shown in Fig. 3. First, look at the voltage at the start of the cycle. The voltage is 0, and therefore there will be no charge across the capacitor. However, during the first half-cycle, which is the positive half-cycle,

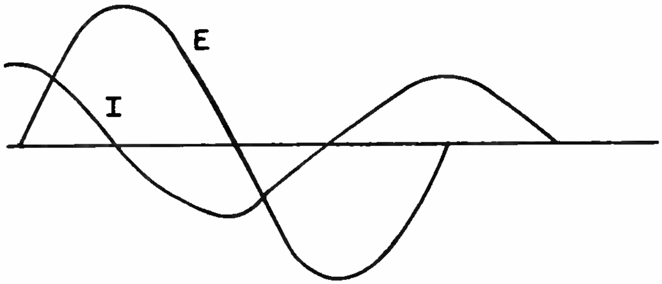


Fig. 3. Voltage and current waveforms in ac circuit containing only capacitive reactance.

as the voltage starts to increase from 0, it is increasing at its maximum value.

To charge the capacitor to the increased voltage, a high current must flow. As the voltage increases to the positive peak, the rate at which the voltage is changing decreases, and as a result, the current flow decreases, because it doesn't have to move electrons into the capacitor so rapidly to keep up with the voltage change. Finally, when the voltage has reached its positive peak the current has dropped to 0 because the voltage is no longer changing across the capacitor.

During the next quarter-cycle, as the voltage begins to decrease to 0, the capacitor must discharge. Therefore current begins flowing in the opposite direction. As the positive half-cycle proceeds from the positive peak to 0, the rate at which the voltage is changing increases until it reaches its maximum rate of change at 0. In order to discharge the capacitor more rapidly as the voltage change becomes more rapid, the current flow must increase until it reaches its maximum value when the voltage drops to 0.

As the voltage then proceeds from zero towards the peak value of the negative half-cycle, the current begins to decrease, because once again the rate at which the voltage is changing begins to decrease. Thus by the time the voltage has reached its negative peak and the capacitor is charged to its negative peak value, the current has dropped to 0 because the capacitor is fully charged and the voltage across it is no longer changing.

During the final quarter-cycle, as the voltage begins to drop from its negative peak to 0, current once again begins to flow in the opposite direction; the capacitor must discharge to the value of the voltage. At first, the current is relatively low because the rate at which the voltage is dropping is low. However, as the voltage approaches 0 and the rate of voltage change increases, the current must increase to get the voltage charge down rapidly as the voltage is changing rapidly.

Once again, notice that we have two quarter-cycles where the voltage and current are in phase and two quarter-cycles where the voltage and current are out-of-phase. During the two quarter-cycles when the voltage and current are in phase, the capacitor will accept power from the generator. The power is stored in the electric field built up in the dielectric of the capacitor. During the two quarter-cycles when the voltage and current are out-of-phase, the capacitor is returning power to the generator.

Thus, in a perfect capacitor the same amount of power is returned to the generator during the two quarter-cycles as is absorbed from the generator during the two quarter-cycles when the voltage and current are in phase.

The capacitor offers opposition to the

(continued on page 23)

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A contributing factor has been the delays and damaged shipments through the U. S. Postal service, and the fact that many suppliers have failed to meet our delivery schedules, often by many weeks. In one case, a supplier - who had been meeting commitments consistently for years - was over three months' late.

By the time you read this issue of the Journal, the extremely heavy winter workload will be over, and we hope you already will have noticed a return to the traditional prompt service which you have every reason to expect -- and of which NRI always had been proud.

NRI President

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(cont. from Page 18)
flow of electric current because the capacitor can only store a certain amount of energy in the electric field. The amount of energy it can store depends upon the size of the plates and the material used between the plates. Generally speaking, the larger the capacitor, the more electrical energy it can store and thus the higher the current will be. Therefore a large capacitor offers less opposition to the flow of an ac current than the small one does. This is the opposite of the inductive reactance where a large inductance offered a higher opposition to the flow of alternating current than a small one did.

Notice the relative phase differences between the voltage and current in the inductive and capacitive circuits. In the inductive circuits, the current was lagging or following the voltage by 90°. In the capacitive circuit, the current is leading the voltage by 90°.

Now once again, let's summarize the important points about reactance. We have two types of reactance, inductive reactance and capacitive reactance. Inductive reactance is the type of opposition offered to the flow of ac in the circuit by a coil, and capacitive reactance is the opposition to the flow of ac current offered by a capacitor. Both inductive reactance and the capacitive reactance are measured in ohms.

In the case of a circuit containing only pure reactance, no power is dissipated in the circuit. Power is taken from the generator during one quarter-cycle and is returned to the generator during the next quarter-cycle.

IMPEDANCE

Impedance is the total opposition to current flow in an ac circuit. Impedance is made up of a combination of reactance plus resistance. The impedance may contain either inductive reactance or capacitive reactance, or perhaps both, along with a resistance. Whether an impedance behaves more like a reactance or more like a resistance depends upon the relative values of the reactive components and the resistive components.

When a circuit contains both a reactive component and a resistive component we cannot get the impedance of the circuit simply by adding the two values together. This is due to the fact that resistance and reactance are not the same thing. We can obtain the total opposition or impedance by means of vectors or by means of a simple formula.

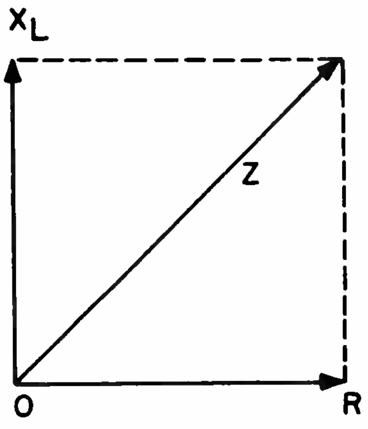

Fig. 4. Vector addition of a 10-ohm resistance and a 10-ohm inductive reactance.

If we have an inductive reactance of 10 ohms in the circuit along with a resistance of 10 ohms, we can find the total impedance in the circuit by means of a vector drawing such as shown in Fig. 4. If we use a scale of 5 volts equals 1", then we would draw the resistance vector, R, 2" long as shown. Next, we draw the reactive vector 2" long and at right angles to it. We do this because the voltage across the two components will be 90° out-of-phase. You will remember that as we said earlier that in a resistance the voltage and current are in phase, but in an inductive reactance the voltage leads the current by 90°.

After the two vectors are drawn, we draw a dotted line parallel to the resistance vector and another dotted line parallel to the reactance vector, as shown in Fig. 4. From the point where the two vectors intersect, we draw a third vector from the center or the 0 point to the intersection of the two dotted lines. This vector will represent the impedance, and if you measure it, you will find it will be approximately 2.8" long. Since we used the scale 5 volts equals 1", then the vector 2.8" long must represent $2.8 \times 5 = 14$ ohms.

Thus the impedance in the circuit would be 14 ohms.

If the reactive component had been a capacitor instead of an inductance, the usual procedure is to draw the capacitive reactance vector pointing down. This is to indicate that the voltage across the capacitor is lagging the current by 90°.

In the situation where you have both inductive reactance and capacitive reactance in the circuit, the two effects tend to cancel each other. In Fig. 5 we have shown how to draw a vector diagram to find the impedance in the circuit where we have a resistance of 10 ohms in the circuit, and an inductive reactance of 10 ohms and a capacitive reactance of 5 ohms.

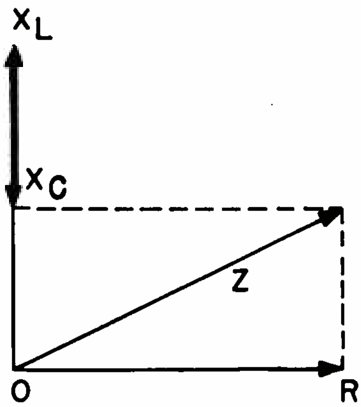

Fig. 5. Vector addition of a 10-ohm resistance, a 10-ohm inductive reactance, and a 5-ohm capacitive reactance.

Again, using a scale of 5 volts to an inch, we lay off the resistance vector as shown. Next, we lay off the vector 2" long representing the inductive reactance. From the end of this vector we lay off another vector pointing down to represent the capacitive reactance. This vector will be 1" long since the capacitive reactance is 5 volts. Now from the end of the capacitive reactance vector and the end of the resistance vector, we draw the parallel dotted lines. Then joining the center or zero point with the intersection of the two dotted lines gives us the impedance vector, and if we measure this we can determine the impedance of the circuit.

We also mentioned that the impedance could be obtained by means of a formula. The formula is:

$$Z = R^2 + X^2$$

where X^2 may be either inductive reactance or capacitive reactance. If we have both inductive reactance and capacitive reactance in the circuit, we simply subtract the smaller from the larger. In the case where the inductive reactance is the smaller of the two the formula becomes:

$$Z = R^2 + (X_C - X_L)^2$$

If the inductive reactance happens to be larger than the capacitive reactance then you simply subtract the capacitive reactance from the inductive reactance.

You will remember that we pointed out that a resistance element uses or dissipates power, whereas the reactive element does not. Since an impedance is a combination of resistance and reactance, it does dissipate some power. The power is dissipated entirely by the resistive element in the circuit. Thus the current flowing through either the capacitive reactance or the inductive reactance stores energy in these components which is returned to the circuit. The current flowing through the resistance element however, is dissipated and converted into some other form of energy.

We also pointed out that in a pure resistive circuit that the voltage and current were always in phase. In a pure reactive circuit there is a 90° phase difference between the voltage and current. In the case of a circuit containing inductive reactance the voltage leads the current by 90°, whereas in the case of a circuit containing capacitive reactance the voltage lags the current by 90°.

In a circuit containing both a resistance element and a reactance element, we have a voltage and current difference in phase. However, the phase difference will be somewhat less than 90°. If the resistive element is large compared to the reactive element, then the voltage and current will be almost in phase. However if the reactance in the circuit is large compared to the resistance, there will be a phase difference of almost 90°. If the reactance is about equal to the resistance, then the phase difference will be about midway between 90° and 0°, or approximately 45°.

SUMMARY

The important points brought out in this discussion of resistance, reactance and impedance are that all three represent opposition to current flow. We can have resistance in both dc and ac circuits, but we can have reactance and impedance only in ac circuits. A resistance is an element that dissipates or uses power.

A reactive element is an element that opposes the flow of current in a circuit, but stores electrical energy and returns it to the circuit. A coil stores electrical energy in its magnetic field during one quarter-cycle and returns it to the circuit during the next quarter-cycle. A capacitor stores electrical energy in its electric field during one quarter-cycle and returns it to the circuit during the next quarter-cycle. The larger the inductance of a coil, the greater the inductive reactance and the greater the opposition to current flow in the circuit. The larger the capacity of the capacitor, the smaller the capacitive reactance, and the lower the opposition to current flow in the circuit.

Impedance is a combination of resistance and reactance. Impedance may contain resistance and inductive reactance, it may contain resistance and capacitive reactance, or it may contain resistance and both inductive reactance and capacitive reactance.

Remember that all three, resistance, reactance and impedance, represent opposition to current flow in the circuit and are measured in ohms. However, here the similarity ends.

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Robert O. Howell, Cehsapeake, Va.
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Joseph Kukta, Las Vegas, Nev.
Lynn P. Landry, Baton Rouge, La.
Jack Latham, Haughton, La.
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William F. Liston, Portsmouth, Ohio
Eugene Mardis, Greenville, Miss.
Thomas L. Mayse, Clermont, Ind.
John R. Menuis, Cedar Rapids, Iowa
John Mihelich, Hinsdale, Ill.
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Charles L. Morse, South Paris, Maine
James Wesley Mullen, Louisburg, N.C.
Winston F. Nelson, Trinidad, W. Indies
James B. O'Hagan, APO Seattle, Wash.
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Joseph J. Pandolfi, New Britain, Conn.
Frank M. Parise, Nazareth, Pa.
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Agustin Rui, Buenos Aires, Argentina
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Harlan Spangler, Omaha, Neb.
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Stephen N. Toczylowski, Erie, Pa.
Edward J. Walker, Elk City, Okla.
C.B. Williams, Lake Wales, Fla.

Dangerous Chemical Causes Permanent Damage

The danger of using carbon tetrachloride as a cleaning fluid was reemphasized at NRI recently in a letter from Lester E. Ritchie, NRI graduate of China Grove, N. C. Mr. Ritchie was employed at an aircraft plant doing calibration, building and assembling of electronic gear, when he became permanently disabled after using carbon tetrachloride for cleaning parts. Blindness in one eye, blind spots in the other, and "other effects" from the poisoning occurred.

He endorses the warning we give you frequently: DON'T USE CARBON TETRACHLORIDE FOR CLEANING! There are many other reliable, easily available cleaning fluids which remain harmless under ordinary safety precautions.

Solution to Crossword Puzzle

1 T	A	2 N	K	3 C	I	4 R	C	5 U	I	6 T		7 W
R		A		O		E		P		R		O
8 I	N	V	9 E	R	T	E	10 R			11 A	M	B
C		12 A	X	E		13 N	D		14 P	I		B
15 C	16 A		I		17 B	T		18 B	A	N		U
19 E	M	20 I	T	21 T	E	R		R		22 E	E	L
R		G		O		23 A	24 C	E		R		A
25 I	N	N		N		26 N	E	A	R		27 C	T
N		I		E		T		K		28 B	O	O
29 C	30 A	T	E		31 T		32 P	D		A		R
	33 D	R		34 T	I	E	P	O	I	N	35 T	
36 O		O			E			W		37 D	I	38 D
39 R	I	N	G	A	R	O	U	N	D		40 P	F

Alumni News

John Pirrung	President
Franklin Lucas	Vice-Pres.
James J. Kelley	Vice-Pres.
Arthur Howard	Vice-Pres.
E. J. Meyer	Vice-Pres.
T. F. Nolan, Jr.	Exec. Sec.

Thomas F. Nolan, Jr. Is Named Executive Secretary of NRIAA

Mr. Thomas Nolan, Jr., has been appointed Director of the Graduate Service Department and Executive Secretary of the NRI Alumni Association.

Mr. Nolan brings a wide inventory of talents to this position which makes him unique in the abilities which will be available to NRI graduates. He attended Drexel Institute of Technology and came to NRI as a Technical Editor from the position of Chief Engineer of the National Civil Defense Computer Facility at Olney, Md. His hobbies are boating and flying -- he holds a pilot's license -- and for the past twenty years he has serviced all types of electronic equipment in his spare time.

Mr. Theodore Rose, who has held this position since 1956, is relinquishing some of his responsibilities because of his health, but will still be of service to his hundreds of friends in the Alumni Association as Associate Director.

Mr. Thomas Nolan, Jr., Alumni's new Executive Secretary.

CHAPTERS LISTEN TO MANY SPEAKERS, ELECT NEW MEMBERS, & DISCUSS PROBLEMS

Members at Detroit Chapter Have a Busy Evening

DETROIT CHAPTER'S two Olivers, Earl and Milton, gave a very absorbing demonstration of their B and K Test Instrument Calibrator. The voltmeter that the chapter uses at its meetings was checked and the audio analyzer built by Chairman Jim Kelley was aligned.

At the next meeting a warm welcome was given three members of the Flint Chapter who dropped in to visit. They were Andrew Jobbagy, Arthur Clapp, and Clyde Morrissett.

A printed circuit soldering iron was employed in removing a canned electrolytic from a board. Leo Blevins came in with a Hallicrafter resistor decade. Roosevelt Payton, Jr., who travels all the way from Toledo to attend the meetings, brought in a scope that he is building from a kit, and Jim Kelley turned up with a transistor experiment on a board. It was a busy evening, mostly taken up with the members trying to examine all the exhibits.

Professor William DeJenko Visits Flint Chapter to Discuss Color TV

FLINT (SAGINAW VALLEY) CHAPTER was pleased once again to have Professor William DeJenko of the University of Michigan conduct a program in Color TV training. The particular subject this time was how to adjust a Philco Color TV set. The biggest puzzle was why the lights used on Christmas trees should upset color reception -- make it go out of convergence. The answer is still being sought.

The Chapter is buying a used color TV set for the use of the members in practicing troubleshooting and color convergence.

The next meeting was devoted to a program put on by the Sencore Instrument Company, sponsored by the Saginaw Distributors, Inc., Mr. Ernie Holden, Manager.

Professor DeJenko of the University of Michigan conducting a session on Color TV training at a Flint Chapter meeting. Assisting is Andy Jobbagy. Observers: Steve Avetta and Leroy Cockrell.

The program was solid-state servicing, color servicing techniques, and vacuum tube troubleshooting techniques. Also taken up was multiplex servicing and a discussion of field strength meters. The evening was concluded with a chicken dinner.

The officers serving the Chapter for the current year are: Arthur Clapp, Chairman; Jim Windom, Vice-Chairman; Andrew Jobbagy, Secretary; Steve Avetta, Treasurer; Clyde Morrissette, Goodwill Ambassador; Robert Newell, Color TV Education Director; James Burk, Information Director; Robert Poli, Leslie Carley, John Allen, George Maker, Entertainment Committee; Gilbert Harris, Radio Communications; Bere Lee, Sergeant-at-Arms; Leroy

Cockrell, Photography; William Duncan and Charles Wotring, Education Committee; and Henry Hubbard, Membership Committee.

New Members, a Lively Speaker, and Helpful Information

NEW YORK CITY CHAPTER has acquired two new members, and a former member has returned to the fold: Harry Mednick, Henry Wynn, and George Zammit. Our congratulations, gentlemen!

A Paco In-Circuit Capacitor Tester presented by Stephen Cross was raffled off. This same gentleman gave a most interesting account of methods of adjusting and testing the bias and general set-up of a tape recorder with copious illustrations and diagrams. The speaker's enthusiasm for his subject carried over to his audience. Not many of our members know much about this subject.

Willie Foggie gave a most thorough account of the things that go on in the high-voltage section of a TV set. His talks never fail to bring much useful information of a most practical nature to us all. He also brought along his Sencore Scope for chapter members to see.

Additionally, of course, there were the usual discussions of service problems.

North Jersey Chapter Finds Many Things to Talk About

NORTH JERSEY CHAPTER put on a two-hour Howard Sam's slide-tape program on transistor servicing.

Color TV sets and training courses, also transistors, test equipment and programming were discussed. Distortion in a transistor radio was traced to a weak transistor in the audio stage by Walter Kwiczola.

The Chapter is following the practice of permitting members to take home the Chapter's demonstration transistor radio board for study. The members find it interesting and fruitful.

Frank Lucas led a discussion on the use of transistors in TV sets and radios. All members took part in the discussion. This was followed by a troubleshooting session with a harmonic generator on the Chapter's demonstration transistor radio board. A vtvm was used as each trouble was located, to check the voltages before and after the trouble was corrected.

Philly-Camden Chapter Welcomes a New Member

PHILADELPHIA-CAMDEN CHAPTER was particularly pleased to admit Graduate R. I. Sweigard as its newest member. He is with the Marine Corps stationed in Philadelphia, and is working as a computer programmer. He can undoubtedly contribute a great deal of valuable information about computers to the Chapter. A hearty welcome to you, Mr. Sweigard.

Secretary Jules Cohen reports that the Chapter's Color TV Class is doing very well, with Norman Roton and Bill Davis doing the honors, and the members are learning a great deal. It will be much easier when there are guest speakers from manufacturers or distributors, who give the members something to talk about and also to ask questions when called upon. Jules has contacted Bill Heath about attending a meeting as guest speaker and giving the members the latest in Westinghouse Color TV.

Mr. Lause and Mr. McKevey Speak at Pittsburgh Chapter

PITTSBURGH CHAPTER welcomed the opportunity to learn in detail about new test equipment from guest speaker Mr. Dennis Lause, Sales Engineer for the Amphenol Sales Corporation, Cleveland, Ohio.

Guest speaker at the following meeting was Mr. Clement McKevey, who is an oldtimer in Electronics, has taught it for years, and is an advisor to several large companies in the area. The Chapter members are always glad to welcome him as a speaker and learn a great deal from his lectures. His talk this time was on how to use an oscilloscope.

Since the meeting date in July falls on the fourth, which of course is a holiday, no meeting will be held in July.

In Memoriam

Mr. Thomas J. Zieroff, Saginaw, Mich.
Mr. J. L. Shortland, Palm Beach Gardens, Fla.
Mr. Merle Drewer, Chewelah, Wash.

Andrew Jobbagy, Flint Chapter Secretary, on a visit to the San Antonio Chapter. On his right, Robert Bonge, Secretary; on his left, Sam Stinebaugh, Chairman.

San Francisco Chapter Enjoys Talks by P. Salbotti and J. Parker

SAN FRANCISCO CHAPTER members enjoyed a talk and demonstration given jointly by two members, Pete Salbotti and John Parker, on installing vertical blocking transformers. In checking the old transformer the primary was found to be open.

At the next meeting John Parker and Art Ragsdale demonstrated the purpose of a response curve with a sweep generator and oscilloscope.

Springfield Chapter Listens to Lecture Given by Norman Charest

SPRINGFIELD (MASS.) CHAPTER members' attention was held by a lecture given by Norman Charest on horizontal oscillator circuits, which he illustrated by use of the chapter's blackboard.

John Parks also gave a presentation about TV circuits and his experiences with them.

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets 8:00 P. M., 2nd Friday of each month, St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich., VI-14972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 P. M., 2nd Wednesday of each month at Andrew Jobbagy's Shop, G-5507 S. Saginaw Rd., Flint. Chairman: Arthur Clapp, 705 Bradley Ave., Flint, Mich. 234-7923.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month at George Fulk's Radio-TV Service Shop, Boonsboro, Md. Chairman: Robert McHenry, RR2, Kearneysville, W. Va. 25430.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, at Chairman Eugene DeCaussin's Radio-TV Shop, 4912 Fountain Ave., L. A., Calif., NO 4-3455.

NEW ORLEANS CHAPTER meets 8:00 P. M., 2nd Tuesday of each month at Galjour's TV, 809 N. Broad St., New Orleans, La. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P. M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: Samuel Antman, 1669 45th St., Brooklyn, N. Y.

NORTH JERSEY CHAPTER meets 8:00 P. M., last Friday of each month, Players Club, Washington Square (1/2 block west of Washington and Kearney Avenues), Kearney, N. J. Chairman: William Colton, 191 Prospect Avenue, North Arlington, N. J.

PHILADELPHIA-CAMDEN CHAPTER meets 8:00 P. M., 2nd and 4th Monday of each month, K of C Hall, Tulip and Tyson Sts., Philadelphia. Chairman: John Pirrung, 2923 Longshore Ave., Philadelphia, Pa.

PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: James Wheeler, 1436 Riverview Drive, Verona, Pa.

SAN ANTONIO (ALAMO) CHAPTER meets 7:00 P. M., 4th Friday of each month, Beethoven Home, 422 Pereida, San Antonio. Chairman: Sam Stinebaugh, 318 Early Trail, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P. M., 2nd Wednesday of each month, at the home of J. Arthur Ragsdale, 1526 27th Ave., San Francisco. Chairman: Isaiah Randolph, 523 Ivy St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P.M., last Wednesday of each month at home of John Alves, 57 Allen Blvd, Swansea, Mass. Chairman: Walter Adamiec, 109 Taunton St., Middleboro, Mass.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., last Saturday of each month at shop of Norman Charest, 74 Redfern Dr., Springfield, Mass. Chairman: Br. Bernard Frey, 254 Bridge St., Springfield, Mass.

"Boss, make him stop saying 'KA-POW' every time I plug this set in!"

There are just 2 originators of color TV receivers in kit form in America. We are one of them. If you want the only color TV receiver totally engineered for training purposes, there's just one.

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SPECIFICATIONS

Picture Size
18" diagonal measure. 180 square inches of viewing area

Tube, Transistor and Diode Complement
21 tubes, 20 diodes and 3 transistors. Includes 3 compactrons. Picture tube type RE19FMP22.

Tuners
Prealigned VHF tuner and transistor UHF tuner. Tunes Channels 2 through 83.

Video I-F Amplifier
Two stages. Uses high transconductance tubes and preset coils.

Video Amplifier
Three stages. D.C. coupled

Sound Circuit
4.5 mc amplifier. Uses quadrature detector and beam power output stage

High Voltage
22,000 volts, regulated.

Focus
Electrostatic with separate high voltage supply.

Loudspeaker
Front mounted oval type.

Front Controls
VHF tuner, UHF tuner, tint, color, horizontal hold, contrast, brightness, on-off and volume.

Dimensions
25" wide
19" deep
15¼" high

Cabinet
Wood grained vinyl clad steel

Weight
Under 75 lbs.

Power-Requirements
120 VAC 60 cps—275 watts

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AR maintains its extraordinary leadership pace with another first—the ew Custom 600 Color TV Receiver Kit. Here's the first and only color ver kit on the market engineered especially for learning. This means find the Custom 600 tops for simplicity of design and ease of building. Custom 600 is not a copy of an existing receiver "broken down" for lding. It has been designed by CONAR engineers from the chassis up ·ovide the kit builder with a superb color instrument which will give and years of enjoyment.

functional, modular design, combined with the knowledge you gain building, will make it simple to make any needed repairs—and we're ıg to bet you'll make mighty few, for the Custom 600 is the work of a ct team selected from among our own engineers, technical writers and ·s who spent literally years on engineering, design and testing.

Custom 600 uses printed circuit boards for fast, easy assembly and component is of first quality. Its design incorporates the latest advances e art of color receiver construction. In addition to 21 tubes, this all-ıel receiver incorporates a transistor UHF tuner, transistor noise cancel- circuit and sixteen solid-state diodes. The low voltage power supply ins three silicon rectifiers. Everything, but everything, is supplied. is absolutely nothing extra for you to buy. The attractive bronze-toned et with wood tone accents will enhance any room in your home. The er even includes separate gun killer switches which you will build in l you later in making maintenance and servicing easier and more con- ıt, and a built-in cross hatch generator makes it easier for you to t convergence so that you get true-to-life color.

al learning design gives you a receiver kit with many circuit operations y observable through easy-to-get-at test points of novel design. All ıare is engineered for accessibility. More important, circuitry not nor- requiring maintenance is deliberately made accessible. No matter that not taking formal electronic training—just building the kit will give nough experience so that you need never call a service man. Basically the same kit used to train NRI students.

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