NRI NEWS

VOL. 19, No. 1 February-March, 1960

Published every other month by the National Radio Institute, 3939 Wisconsin Ave., N.W., Washington 16, D. C. Subscription $1.00 a year. Printed in U.S.A. Second class postage paid at Washington, D. C.

J. E. Smith

Efficiency Is Not Enough

If someone asked you, "Why do you work?," you would probably answer, "I work because I must—to feed and clothe myself and family—provide for the necessities of life." This is a logical, straight-forward answer.

But do you ever stop to think that besides earning your daily bread, your work provides you with the real zest for living? It gives you personal satisfaction, offers opportunity for self-expression, and makes your rest and leisure more meaningful.

Have you ever noticed how a house painter stands back and admires his work? Or have you ever watched how carefully a carpenter fits lumber together when building a house.

A fellow named John Zeigler was just such a carpenter. "I never cut a board short in my life," he used to say proudly. But one day he did just that, or so it appeared at the time. The board he'd just cut didn't fill up the space he'd intended it for. But John was a proud craftsman. He hunted around the house and soon spotted another opening where the "short" piece fitted exactly. "Like I always say," he nodded with satisfaction, "I never cut a board short in my life!"

If you seek happiness through your work —and where else are you to find it?— you must accept a new role. As a working man, you're not a sheltered individual— not an infant or invalid. You alone must decide what your attitude toward your work will be, what your purposes are, and

(*Page two please*)

AGC SYSTEMS

By Art Widmann
NRI Technical Staff

Automatic gain control circuits are in common use in both radios and television receivers. In radios, these circuits are usually called automatic volume control (AVC). The use of "volume" instead of the more accurate word "gain" arose from advertising reasons. The set-buying public might not know the meaning of gain of an amplifier whereas they readily understand the word volume. Inasmuch as the gain of a receiver does affect the volume, avc is descriptive of the effect on the operation of a radio. In a television receiver however, the gain of the receiver affects both audio volume and picture contrast. The circuits providing automatic gain control in television receivers are almost always correctly labeled agc.

AVC and AGC circuits all work on the same basic principle—the gain of one or more stages is automaticallly varied in accordance with the strength of the received signal.

The need for automatic gain control is readily apparent when you consider that the received signal strength may vary from 1-microvolt from distant stations to one million microvolts from strong local stations. If the gain of the receiver is constant, the strong stations will cause annoying "blasting" when you tune across the band. Also, if the receiver gain is sufficient to bring in distant stations, the strong local stations will cause overloading and distortion. Automatic gain control will overcome both of these difficulties. In addition, agc will correct for

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"The future of the servicing industry is extremely bright and profitable but your share of that future depends on what you do NOW to prepare for it."
Donald H. Kunsman
President, RCA Service Co.

(*Editorial—from page one*)

how strongly you desire the happiness you seek.

To have ideals, to seek wise advice, to apply common sense, to admit the necessity of discipline, to be broad-minded, to believe in and practice fairness and to do honest work efficiently. These are traits *just as important* to personal satisfaction and contentment on your job as skill and knowledge. Remember, your job may feed you but your attitude toward your work keeps you *"alive."*

J. E. Smith
Founder

(*AGC Systems—continued*)

variations in signal strength due to fading.

AVC Systems in Radios

Let's review the basic principles of a typical avc circuit by referring to Fig. 1. This partial diagram shows the rf stage and the second detector where the avc voltage is developed. The i-f signal at the output i-f transformer causes the diode to conduct each time the signal swings positive at the plate of D1. Current through the diode also flows through the secondary winding, through R1 and R2 to ground and back to the cathode of the diode. C1, R1 and C2 filter out the i-f, producing a negative voltage at point A that is varying at the audio rate.

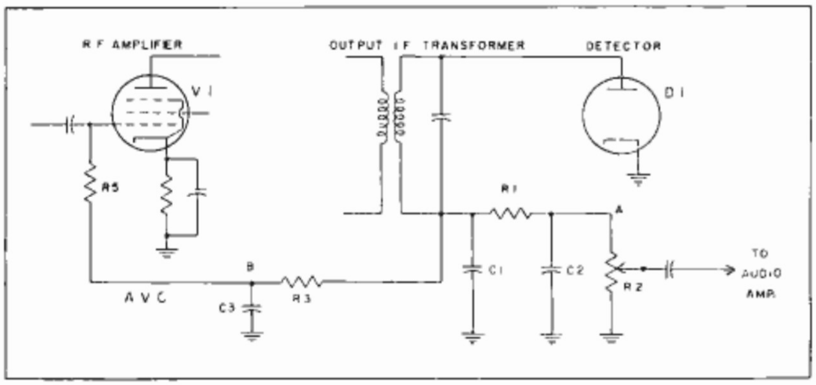

Fig. 1. Typical AVC system used in a Radio receiver.

Resistor R3, and capacitor C3 make up another filter network that removes the audio signal and produces a pure negative avc voltage at point B. The strength of this negative AVC voltage is directly proportional to the i-f carrier signal.

The time constant of the avc filter must be long to filter the lowest frequency of the audio signal. On the other hand, too long a time constant will prevent the circuit from responding to rapid changes in signal strength such as occur with fading. A compromise is made using a time constant of about 1/10 to 1/5 of a second.

The filtered avc voltage is applied to the control grid of V1 through resistor R5. The negative avc voltage decreases the gain of the rf stage and tends to hold the output of the receiver constant with changes in rf signal strength. The avc voltage cannot hold the output perfectly constant because it requires a change in output to produce a change in avc voltage. Most receivers have at least two avc controlled stages to give a greater range of control. These are usually the i-f and rf stages. In sets having no rf stage, the avc voltage is applied to the rf grid of the converter stage.

Notice that the avc voltage always decreases the gain of the receiver. Even a very weak station will develop some avc voltage. In order to have the receiver run wide open on weak signals, circuit variations have been devised to prevent avc from taking effect until a certain size signal is received.

Delayed AVC. To prevent development of an avc voltage when receiving weak signals, the avc voltage is delayed. This does not refer to a time delay but rather to the amplitude of the signal. No avc is developed until the average value of the IF carrier signal exceeds a pre-determined value.

Fig. 2 shows a typical second detector, delayed avc, and first audio stage. Diode D1 is the second detector while diode D2 produces the avc voltage. The triode section of the tube is the first audio amplifier stage.

The i-f signal is rectified by D1 and the audio signal is developed across C2-R1. Notice that diode D1 will conduct on weak signals because its circuit is returned to the cathode. The ac signal path for diode D1 is from the plate of D1 through the transformer winding, through C2 to the cathode of the tube. Thus even very weak signals will make the plate positive with

(*Continued page sixteen*)

(*Continued from page two*)
respect to the cathode causing the diode to conduct and to produce an audio signal.

This audio signal is coupled through C4 and developed across R5. From the arm of R5, the audio signal is coupled directly to the grid of the triode section of the tube where it is amplified and coupled out through C6. The triode section of the tube is biased Class A by the drop across cathode resistor R2.

The voltage drop across R2 also provides the avc delay. The i-f signal is coupled through C1 to diode D2. Diode D2 will not conduct until the amplitude of this i-f signal is larger than the drop across R2. When the i-f signal is large enough to make the plate of D2 positive with respect to the cathode, diode D2 conducts and electrons flow from the plate of D2 down through R3 developing a negative voltage at the top of R3. This voltage is filtered by R4-C5 to produce the avc voltage. This delay in producing the avc voltage assures that the receiver will be operated at maximum sensitivity on weak signals. On strong signals, the delayed avc voltage affects the receiver in the same manner as ordinary avc.

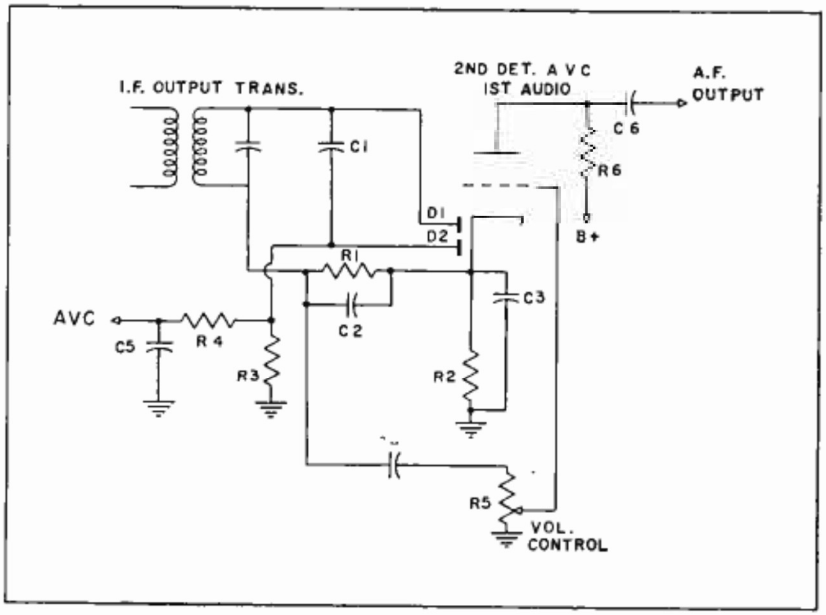

Fig. 2. Delayed AVC.

AVC For 12-Volt Tubes. The avc system in an automobile radio must be very good to compensate for changing signal levels caused by the auto moving past obstructions. Also automobile receivers have an rf stage so the over-all gain of the set is higher than most ac-dc home radios. Therefore, the avc system must be able to reduce the gain a great deal to handle the large signals from local stations. Car radios, using conventional tubes, use avc systems similar to the one just discussed. However, when 12-volt tubes are used, the effective range of avc is limited because only a few volts change of grid voltage drives the tube from saturation to cut-off. A novel circuit arrangement allows the avc voltage to completely cut-off the rf tube reducing the gain of that stage to zero.

Fig. 3 shows a partial schematic of the rf stage of an automobile receiver using 12-volt tubes. The avc voltage is appiled through resistors R2 and R1 to the control grid of the rf tube. A small avc voltage reduces the gain of this stage in the usual manner. At the same time, the avc voltage is applied to the suppressor grid which is connected to the junction of R1 and R2. The avc voltage on the suppressor grid further reduces the gain of the stage. When a large received signal produces a large avc voltage, the tube cuts off and the gain of the tube is reduced to zero.

The tube is still able to pass the rf signal through the inter-electrode capacitance between the suppressor grid and the plate. The rf signal across the grid tank circuit is coupled through C1 and developed across R1 and R2. A small part of this signal appears across R2, and is felt by the suppressor grid. With the tube cut off, this signal is coupled through the inter-electrode ca-

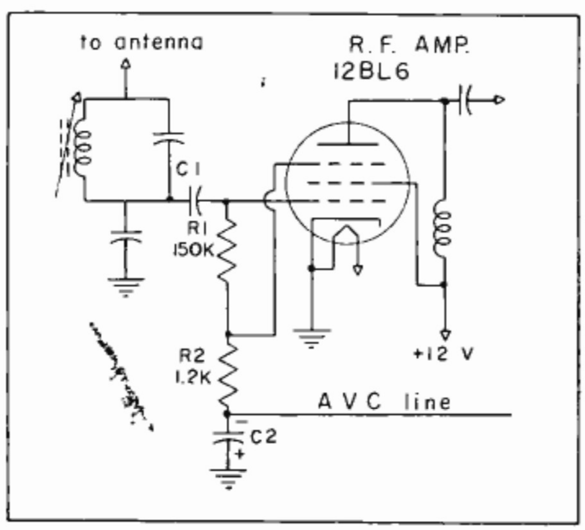

Fig. 3. AVC applied to 12-volt RF stage.

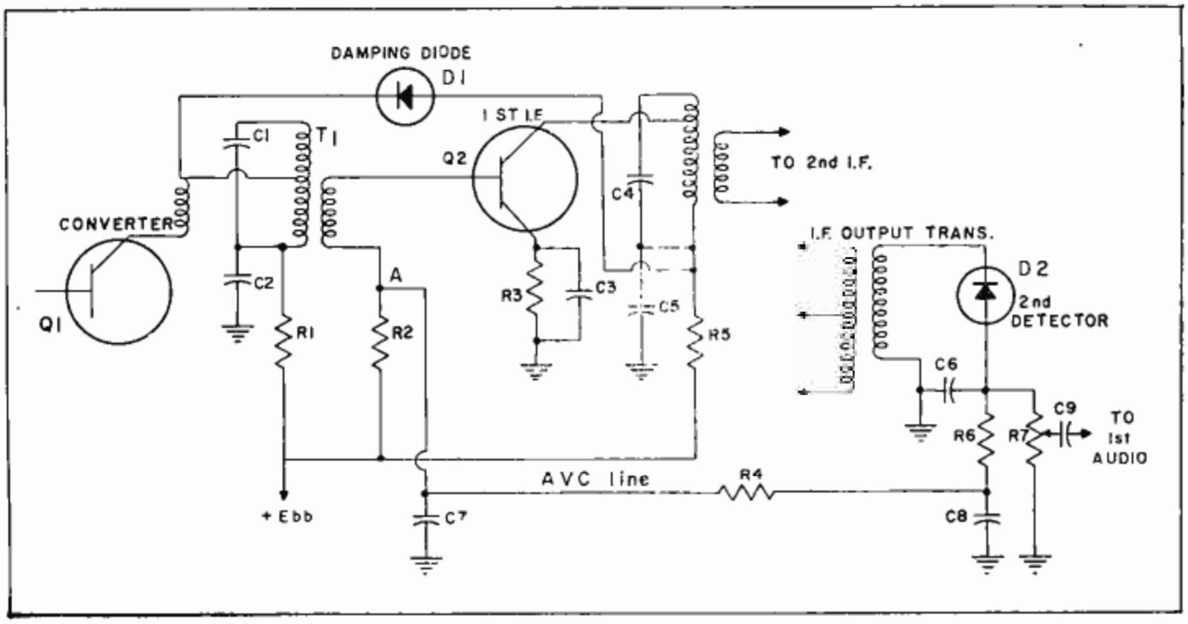

Fig. 4. AVC in transistor Radio and damping diode.

pacitance to the plate where it is developed across the tuned plate circuit. In this way, the rf stage is effectively removed from the circuit when receiving very strong signals. The tuned circuits in the grid and plate circuit still perform their usual functions of frequency selection and image frequency rejection.

Additional avc action is sometimes produced in sets using 12-volt tubes by applying an avc voltage to the first audio amplifier stage. The audio amplifier tubes such as the 12F8 is a remote cut-off pentode. By applying a small amount of avc voltage to the control grid of this tube, the gain is varied and some avc action is effected. The avc action produced in this stage is particularly effective against sudden signal strength changes.

Numerous circuit variations are used to provide avc in radios. However, it is always easy to locate the avc circuit. Simply trace the grid return from the rf stage or the rf grid of the converter if no rf stage is used. This grid return will lead you through the avc filter to the circuit that develops the avc voltage. While most prints have the avc circuit labeled, it is usually not difficult to figure out where the voltage is developed and how the circuit works. This is fine for radios using tubes, but when transistors are used, the circuits are a little different.

AVC In Transistor Radios

Tranistor radios develop the avc voltage in the same manner as tube radios, but the characteristics of transistors must be taken into consideration when applying the avc voltage to the transistor stages. The most practical method of controlling the gain of a transistor stage is by emitter-current control. The emitter current is reduced by applying the avc voltage in such a way as to oppose the foward bias on the transistor. Reducing emitter current affects the gain of the transistor in two ways. First, reduced emitter current reduces the current gain of the stage by decreasing the collector current. Second, reduced emitter causes a change in the impedance match of the transistor to the input and output circuits. This impedance mis-match further reduces the over-all gain of the stage.

Fig. 4 shows a typical avc circuit in a partial diagram of a transistor radio. The avc voltage is developed by the second detector diode D2. The i-f signal from the i-f output transformer causes current to flow down through diode D2 and diode load resistor R7 which also acts as the volume control. The detected audio signal is then filtered by R6, C8, R4 and C7 to produce a negative avc voltage at the top of C8.

The filtered avc voltage is applied to the base circuit of the first i-f transistor Q2. The foward bias for Q2 is supplied from +Ebb through R2, through the secondary winding of T1, to the base of Q2. The avc line is connected to point A at the junction of R2 and the secondary winding of T1. Thus the negative avc voltage opposes the foward bias and reduces the emitter-base current of Q2. As previously explained, reducing the emitter current reduces the gain of the stage. This tends to keep the output of the receiver more nearly constant.

Unlike vacuum tubes, transistors cannot be completely cut-off by a large negative base-to-emitter voltage. There is always a small collector leakage current. Also the inter-element capacitance in transistors is large. The base to collector capacitance is enough so that even with a large negative avc voltage, an appreciable i-f signal is coupled directly from the base to the collector. Both of these factors tend to limit the effectiveness of avc control of transistor stages.

To obtain improved control, many transistor sets use an auxiliary avc diode.

Damping Diode. When operating at high signal levels, enough signal can be directly coupled through the avc controlled transistor to cause overloading and distortion. To take care of these large signal conditions, the damping diode D1 is used in the circuit in Fig. 4.

When receiving normal strength signals, this diode does not conduct because it is back biased by the drop across R1 and R5. As the signal strength increases, the avc system causes Q2 to conduct less and less. The decreased current flow through Q2 decreases the drop across R5. The top of R5 becomes more and more positive until a voltage is reached that forward biases D1 allowing it to conduct.

When D1 conducts, it acts as a low impedance shunt across part of the primary of T1. This greatly reduces the amount of signal coupled through the transformer and prevents overloading on strong signals.

AGC in TV Receivers

As mentioned earlier, the gain of a TV receiver affects both the volume of the audio and the contrast of the picture. Small changes in picture contrast are much more noticeable than small changes in sound level. Therefore, the agc system is very important to the proper operation of a TV receiver. In some early TV receivers, a manual control varied the bias on the rf and i-f stages. This control was usally marked "contrast" and had to be adjusted for each change in signal strength. With the addition of agc circuits the contrast control is placed in the video circuit.

Because small variations in signal strength are so noticeable in the picture, a fast acting agc circuit is needed for a TV receiver. However, the only part of the video signal that is directly proportional to the carrier strength is the sync pulses. The level of the picture portion of the video is constantly changing with picture detail. Therefore, it is desirable to produce the agc voltage from the amplitude of the sync pulses.

A simple agc system for a TV receiver is shown in Fig. 5. Negative going video is fed to the cathode of diode D1 causing the diode to conduct. Current flow through the diode charges C1 to the peak value of the negative sync pulses. Since C1-R2 forms a long time constant at the repetition rate of the sync pulses, the capacitor does not discharge appreciably between pulses. The negative voltage across C1 holds the plate of D1 negative. Thus the diode conducts only when the negative sync pulses drive the cathode negative with respect to the plate. Since the amplitude of the sync pulses is proportional to carrier strength, the agc voltage changes only when carrier strength changes.

Fig. 5B shows two lines of the negative video signal applied to the agc tube. The dotted line between the horizontal sync pulses shows the discharge path of C1 between sync pulses. The discharge path shows that C1 discharges only a small amount between pulses. This means that C1-R2 is a rather long time constant and the agc will not respond to rapid changes of carrier strength. If the RC time of C1-R2 were made shorter, agc voltage would change each time a broad vertical pulse was received. This would tend to cause the receiver to lose vertical sync.

Due to the long time constant of C1-R2, the agc system is not as fast acting as is desirable. Another disadvantage of this simple agc system is that large noise pulses occurring at any time can produce a large agc voltage. Since the time constant of the agc filter is long, the receiver will be slow in recovering from the effect of noise pulses.

To overcome the disadvantages of this simple agc system, many TV sets use keyed agc.

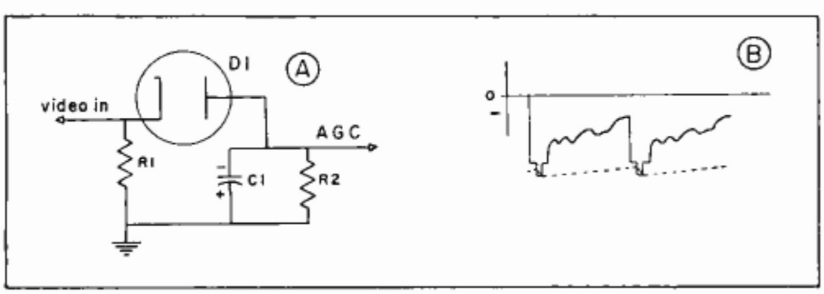

Fig. 5. Simple AGC system.

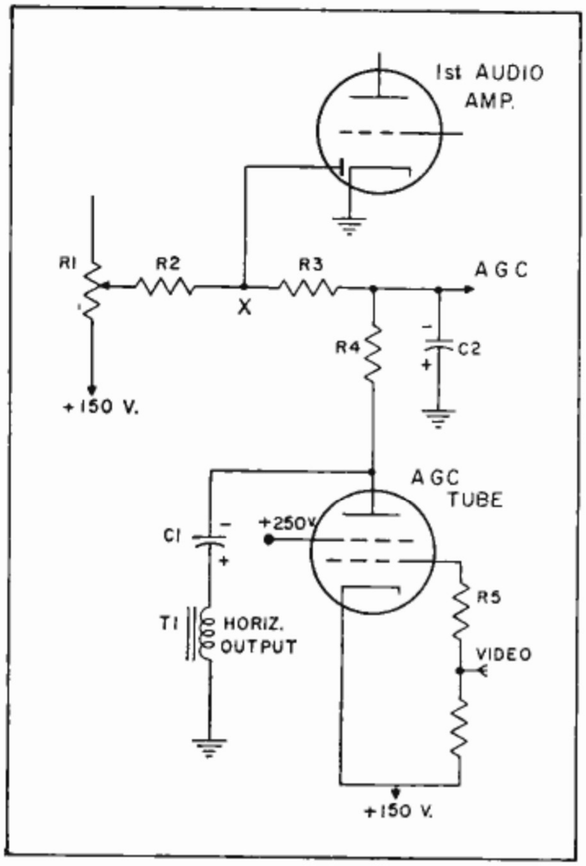

Fig. 6. Keyed AGC.

Keyed AGC. A keyed agc system is designed so that the agc voltage is produced only when horizontal sync pulses occur.

In this way, noise pulses arriving between sync pulses do not produce any agc voltage. Also the system can be made fast acting because there is no chance of picture level or vertical sync pulses affecting the agc operation.

While the exact details of keyed agc circuits vary widely, a typical keyed agc system is shown in Fig. 6. The pentode agc tube is biased to plate current cut-off by the +150 volts applied to its cathode. The screen is supplied by +250 volts. A winding on the horizontal output transformer T1 supplies sharp positive pulses through C1 to the plate of the agc tube. These pulses arrive at the horizontal frequency rate and occur at the same time as the horizontal sync pulses. Each time a pulse is coupled through C1 to the plate, the tube conducts. The amount of conduction depends on the voltage of the control grid during the time the positive pulse is on the plate. A positive going video signal is applied to the control grid through R5. The horizontal sync pulses in this video signal arrive at the same time that the positive pulse is applied to the plate. Thus the amplitude of the horizontal sync pulse determines the amount of conduction of the tube.

The pulses of current arriving at the plate charge C1. This capacitor is small so that it will discharge rapidly and make the agc system fast acting. C1 discharges through R4 and charges C2 to an average negative agc voltage.

Resistors R3, R2 and R1 provide a return path for plate current and determine the "threshhold" of agc. The setting of the threshhold control R1 sets the level of agc voltage. With the entire resistance of R1 in the circuit, the agc voltage will be so negative that the i-f stages are completely cut-off and we lose our picture. This is possible with this circuit because the agc tube will conduct with each positive pulse on its plate even though there is no video on the control grid.

Decreasing the resistance of R1 decreases the agc level. R1 is adjusted while receiving the strongest local station. With contrast control set at about mid-range, adjust R1 for a good contrast picture. The agc system will then compensate for changes in carrier level. The only set adjustment required when changing stations will be setting the contrast control to the preference of the viewer.

The circuit in Fig. 6 has provision to prevent putting a positive voltage on the agc line. Point X between R2 and R3 is connected to a diode in the first audio section of the receiver. If point X trys to become positive, the diode will conduct and clamp the voltage at about zero.

Like radios, TV sets will be found with a wide variety of agc systems. Some TV sets use an amplifier stage in the agc line to increase the receiver response to signal level changes. Many receivers have separate agc voltages for the rf tuner stage. The tuner stage receives a lower level of agc voltage. This allows it to be more sensitive to weak signals. Some sets have a switch or control to select different proportions of agc voltage for the tuner stage.

Separate Tuner AGC. Fig. 7 shows the distribution of the agc voltage in a typical TV receiver. Separate levels of agc are provided for the tuner and i-f stages. A "local" - "suburban" - "distant" switch permits changing the amplitude of the agc voltage. This switch mainly affects the tuner agc voltage and allows the tuner to operate nearly wide open on weak distant stations. Changing the switch when receiving strong local stations supplies more agc voltage to the tuner to prevent overloading.

When the switch is in the local position,
(*Continued page twenty-two*)

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the tuner and i-f stages get the same agc voltage because there is no voltage drop across resistor R4. With the switch in the "suburban" position, a circuit is completed from the agc line through R4, through the switch, through resistor R6 and R7 to ground. Current flow through this circuit produces a drop across R4. The drop across R4 subtracts from the agc voltage leaving a smaller voltage at point X to be applied to the tuner stage. This small agc voltage to the tuner allows it to operate at a high gain.

With the switch in the "distant" position, resistor R6 is bypassed causing even a larger drop across the resistor R4. The agc voltage at point X falls to an even lower value and this small tuner agc voltage allows the tuner to operate at maximum gain.

The additional filters in the grid circuit of each i-f stage perform an important function. These filters prevent feedback that could cause oscillations.

Some type of agc level adjustment is found on many TV receivers. It may be labeled "fringe-local," "D-X range finger," or "agc control." Most of these controls operate to attenuate part of the agc voltage like the circuit in Fig. 7. Sometimes the control adjusts the agc delay. Delayed agc is used in TV receivers in the same way as in radios.

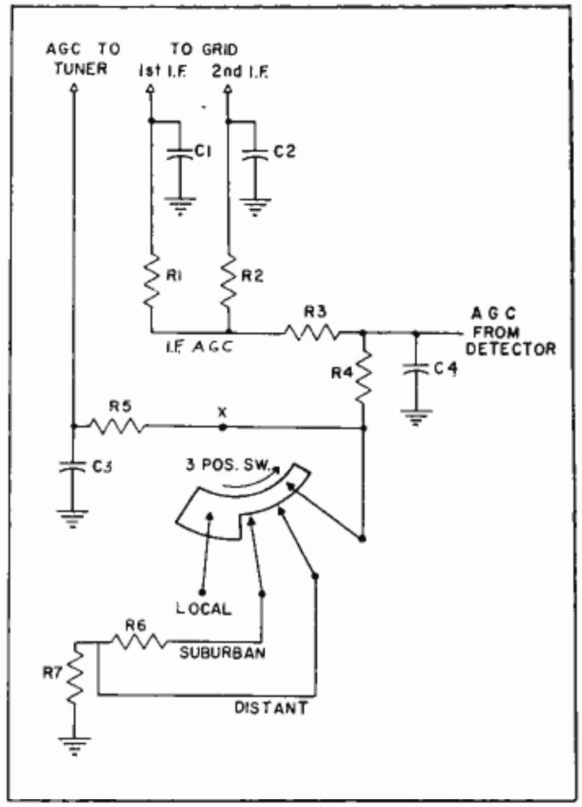

Fig. 7. Distribution of AGC voltage in a typical TV receiver.

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——*n r i*——

Lifting and Leaning

There are two kinds of people on
earth today,
Just two kinds of people, no more
I say.
Not the good and the bad, for it's well
understood
The good are half bad and the bad are
half good.
Not the happy and sad, for the swift-
flying years
Bring each man his laughter and each
his tears.
Not the rich and the poor, for to count
a man's wealth
You must first know the state of his
conscience and health.
Not the humble and proud, for in life's
busy span
Who puts on vain airs is not counted
a man.

No! The two kinds of people on earth
I mean
Are the people who lift and the people
who lean.
Wherever you go you will find the
world's masses
Are ever divided in just these two
classes.
And, strangely enough, you will find
too, I ween,
There is only one lifter to twenty
who lean.
In which class are you? Are you easing
the load
Of overtaxed lifters who toil down
the road?
Or are you a lifter who lets others
bear
Your portion of the worry and labor
and care?

Ella Wheeler Wilcox