DECEMBER - JANUARY, 1950
VOL. 1 No. 6

KEN-RAD
RADIO TUBES

# Techni-talk
## on AM, FM, TV Servicing

# *D-C RESTORATION AND SWEEP CIRCUITS*

The video signal at the input to the detector is an a-c signal with the modulation envelope appearing equally, both above and below the zero axis. Either the positive or the negative variations of this signal are detected and applied to the video amplifier.

This signal contains an a-c component, a d-c component and the synchronizing and blanking pulses. The d-c component represents the average value of the camera signal in relation to the black level as illustrated in A and B of Fig. 1. The line scanned in A contains the same picture information as B except at a different level of brightness. The scene scanned in A would represent a well lighted scene and B would represent the same scene with the illumination reduced. The average level would be the d-c component for each line. This d-c component may be introduced manually at the studio by monitoring the video signal, or by the use of a phototube in the camera which maintains the signal at the correct level of brightness.

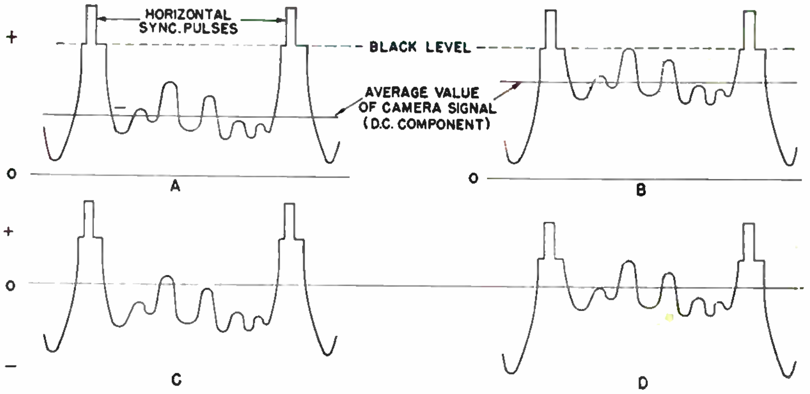


**Fig. 1. A and B illustrate a typical TV signal for one horizontal line having two levels of background illumination. C and D represent the same signals after passing through a resistance-capacitance coupled amplifier.**

At the output of the detector the black level and synchronizing pedestals for each horizontal line would all be lined up at the same relative level above the zero axis. If direct coupling is used between the detector and the video amplifier and also between the video amplifier and the picture tube, this same level would be maintained as illustrated in A and B of Fig. 1. A circuit of this type was used in the G. E. Model 801 receiver and is shown in Fig. 2.

If however the signal passes through a resistance-capacitance coupled amplifier, it becomes an a-c signal with equal portions above and below the zero axis. This means that the two signals shown in A and B of Fig. 1 would look like C and D at the input to the picture tube. The wave shape has not been changed but the synchronizing and blanking pulses are on different levels, also the average brightness levels have changed and are too close to each other for proper contrast. If the brightness control is adjusted for the correct blanking of the signal in C the level would be too high for the signal in D resulting in visible retrace lines. Also the portion which reached the black level in B would now be considerably below this level and would appear gray. The brightness control could be readjusted manually so that the black level would bias the picture tube to cut-off with each change in the background illumination level, but this is obviously impractical. The same result can be obtained through the use of a d-c restorer circuit.

There are several methods which can be used for d-c restoration; one of the simplest is the circuit shown in Fig. 3. The output stage is operated at zero fixed bias with no signal applied to the grid. When a signal is applied, grid current will flow during the time the signal is above the zero level. This causes condenser Cc to charge negatively to a value represented by the peak amplitude voltage of the synchronizing pulse. The bias for V1 will therefore vary, as the positive portion of the signal varies, changing the amplification of the tube. This results in all of the synchronizing pulses being lined up to a common level at the output of V1.

A number of d-c restorer circuits are used in TV receivers incorporating either a diode tube or a germanium diode. Fig. 4 illustrates a typical basic circuit using a diode tube. Any variations of the video signal extending below the a-c axis would result in a current flow through V2 charging capacitor Cc to the peak level of the applied voltage. During the positive portions of the signal the charge accumulated on Cc will discharge through resistor R1 to ground. The time constant of the Cc, R1 combination is long enough so that the voltage on Cc remains practically constant throughout each horizontal line. This places a bias on the picture tube in series with the picture signal which varies with the height of the pulse peaks. This results in all of the pulse peaks being lined up at the picture tube grid.

In Fig. 5 the germanium diode is not placed across the entire output of V1 but only across the portion obtained from R2. The function of Cc and R1 in this circuit is the same as in Fig. 4. R3 is used to isolate the diode from the cathode of the picture tube so the diode capacity will not reduce the high frequency response of the video output.

The wave forms shown at the input to the picture tube in Figs. 3, 4 and 5 do not reflect the brightness level changes at the input to V1. They are shown only to illustrate that the synchronizing pulses are all lined up at this point.

Due to d-c restorers only maintaining correct background illumination, defective restorer action probably will not be apparent unless there is a considerable change in background during a program. The usual complaint is that the brightness control must be continually readjusted. Due to the simplicity of the circuit any defect can be readily located and corrected. Try a new tube first then check the resistors and condensers.

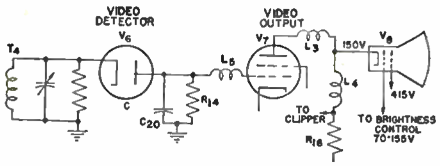


**Fig. 2. A direct coupled video amplifier as used in the G-E Model 801 receiver.**

### SWEEP CIRCUITS

Up to this point we have only been concerned with the picture signal as it passed through the various circuits from the antenna terminals to the grid of the picture tube. This signal modulates the grid voltage which in turn varies the flow of the electron stream from the cathode to the picture tube screen.

If this beam is not deflected, it will appear as a bright spot on the face of the picture tube. In order to produce a picture it is therefore necessary to move this stream of electrons both horizontally and vertically in step with the electron stream in the camera tube. The circuits which deflect the electron beam and thereby produce the scanning raster or picture will be discussed first, and then the circuits which keep this raster in step with the transmitter will be reviewed.

The raster is produced by the combined effect of two saw-tooth wave forms one of which moves the electron beam horizontally; and the other moves the beam vertically. The horizontal oscillator produces a saw-tooth wave having a frequency of 15750 cycles per second and the vertical oscillator produces a saw-tooth wave having a frequency of 60 cycles per second. These waves are fed in electrostatic type tubes to the deflection plates, and in electromagnetic type tubes to the deflection coils.

One of the easiest ways to produce a saw-tooth wave is to charge and discharge a capacitor, as illustrated in Fig. 6. If S1 is closed with S2 open, capacitor C will charge from A to B. This represents the peak of the voltage applied by the battery through resistor R. The time required for the condenser to charge depends on the time constant of the RC combination. If S2 is closed and S1 opened, the condenser will discharge rapidly from B to C as indicated. The lower 10% of the charging curve from A to X is fairly linear and is the portion usually

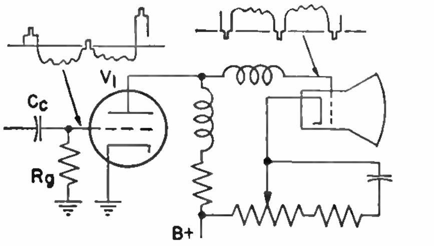


**Fig. 3. A simple circuit using the bias developed across Rg for d-c restoration.**

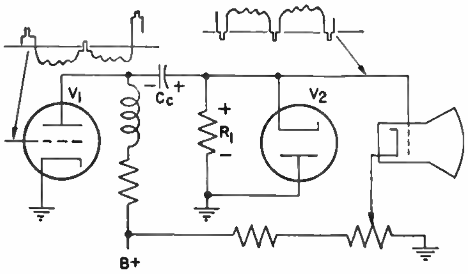


**Fig. 4. A basic d-c restorer circuit using a diode tube.**

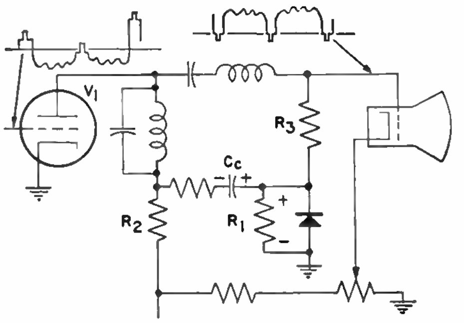


**Fig. 5. Circuit used in the G-E Model 10T1 receiver using a 1N65 germanium diode for d-c restoration.**

used to produce a saw-tooth wave. This part would therefore represent the trace portion of the saw-tooth, and from X to Y the retrace portion. Resistor R limits the current flow and therefore can be used to vary the charging time of C. Likewise, if the capacitance of C is increased, the time required for it to become fully charged would also be increased. Therefore, if the value of either R or C is increased, the charging time will be increased and the height of the saw-tooth represented by the AXY portion of Fig. 6 will be reduced. The importance of identifying these two components in any sweep circuits is obvious because any change in value affects the height of the saw-tooth which represents picture width in the horizontal circuit and picture height in the vertical circuit.

There are three different circuits generally used to produce saw-tooth waves. These are (1) the blocking oscillator (2) the multivibrator and (3) the sinewave type of sweep oscillator. All sweep generators used in TV receivers are free-running and do not require an external pulse to keep them running. They do, however, require a synchronizing pulse which is picked off the received signal to control the speed of the oscillator and keep it in step with the transmitter.

### THE BLOCKING OSCILLATOR

The circuit shown in Fig. 7 is a typical blocking oscillator circuit and is similar in operation to the conventional oscillator having coupling between the plate and grid coils.

In this type of circuit V1 remains cut-off for a considerably longer time than it conducts, and during this cut-off period the charging capacitor $C_2$ is gradually charged up through $R_4$ to form the trace portion of the saw-tooth wave form. The tube draws plate current for a very short period of time, during which $C_2$ is discharged to form the retrace portion of the saw-tooth wave.

The transformer serves as a coupling between the plate and grid circuits and is so connected that an increase in plate current causes the grid to go positive, as shown in the Eg curve. This further increases the plate current until V1 reaches the limit or saturation point as indicated in the Ip wave form. It is during this period that V1 acts as a closed switch, due to conduction, and discharges C2 through the plate winding of T1. This is the retrace portion of the Ep wave form.

As the saturation point is reached the flux in the plate coil starts to collapse, which reverses the grid polarity; making it negative. The electrons which accumulated on the grid side of C1 begin to flow through R1 and R2 making the grid more negative until the plate current is cut-off. This charge carries the grid voltage considerably below the cut-off point as shown in the Eg wave form. The charge on C1 slowly discharges through R1 and R2 resulting in the grid voltage rising toward 0; at the same time capacitor C2 begins to charge again and the process is repeated.

The natural resonant frequency of T1 is much higher than required and the frequency is controlled by the time constant of the C1, R1 and R2 combination. By varying resistor R2 the frequency or speed can be controlled and by varying R4 the charging time or size can also be controlled.

Some receivers use a discharge tube which is a second triode with its grid connected to the blocking oscillator grid. The charging condenser and control resistor are placed in the plate circuit of the discharge tube. In this type circuit the charging condenser discharges directly through the tube without passing through the plate winding of transformer T1. This results in a reduction of the retrace time.

### THE MULTIVIBRATOR SAW-TOOTH GENERATOR

The multivibrator or relaxation oscillator is fundamentally a two-stage resistance-coupled amplifier which has common coupling or feed back between the two stages. This type of circuit will oscillate because the 180° phase shift between the grid and plate of a vacuum tube causes the output of the second tube to supply the first tube with an input voltage that has the right phase to sustain oscillations. By placing a charging capacitor across the output, a suitable saw-tooth voltage waveshape may be obtained.

A cathode coupled multivibrator circuit is shown in Fig. 8. This acts as an electronic switch and performs the same function previously described regarding Fig. 6. This circuit operates briefly as follows: capacitor C2 charges through resistor R4 which results in increased plate voltage and plate current in V2 until V2 conducts heavily and discharges C2. When V2 conducts, the bias on V1 is increased due to R1 being the bias resistor for both tubes. This decreases the plate current of V1 which in turn increases the plate voltage resulting in a positive pulse which is coupled by C1 to the grid of V2. This increases the plate current and therefore hastens the retrace or discharge of C2.

Some multivibrator circuits are plate coupled instead of cathode coupled. In the plate coupled circuit the cathodes are grounded, and the reduction in voltage which appears at the plate of V2, as a result of C2 discharging, is capacitor coupled to the grid of V1. The negative variation at the grid of V1 has the same effect as a positive variation at the cathode resulting in the same type of multivibrator action previously described.

In the next issue the sine-wave sweep generator together with the synchronizing circuits will be discussed.

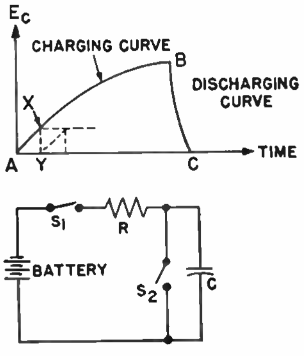


**Fig. 6. Circuit for charging and discharging a capacitor with the resulting curve.**

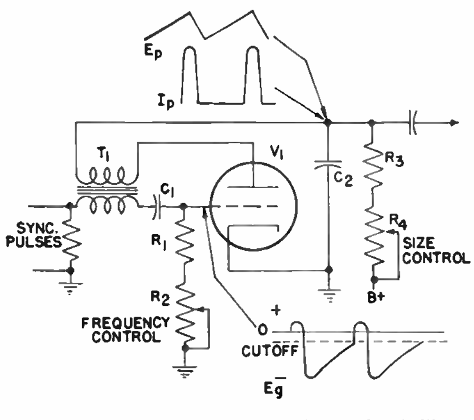


**Fig. 7. A typical blocking oscillator circuit illustrating the wave forms which appear in the grid and plate circuits.**

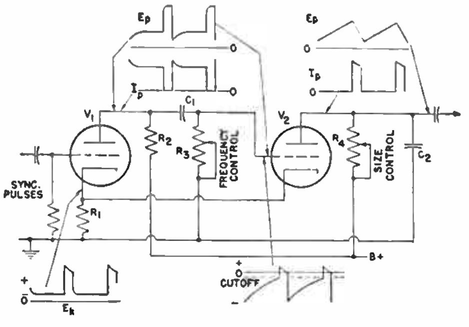
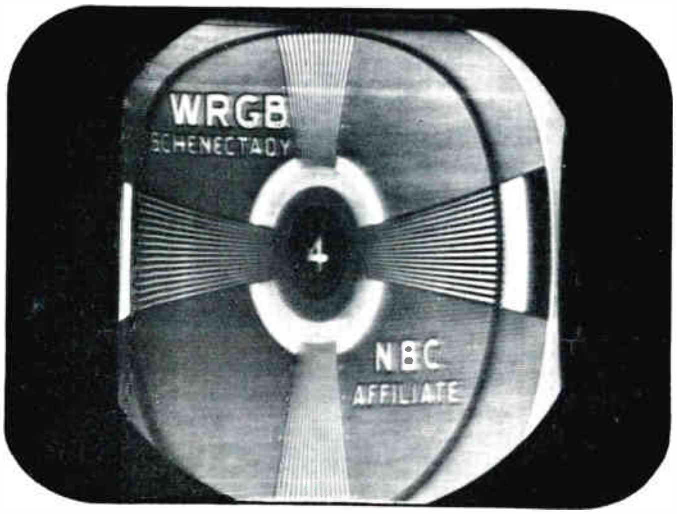
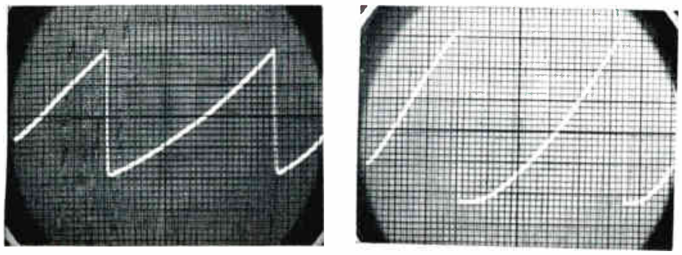


**Fig. 8. A typical multivibrator circuit illustrating the wave forms which appear in this type circuit.**

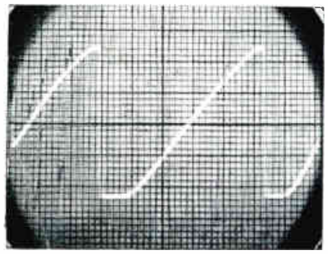
# Tele-Clues

The Tele-Clues in this issue indicate six different defects which may occur in a vertical multivibrator circuit. Also shown, to help you identify these troubles, are the wave forms which appeared on an oscilloscope connected between the grid of V10 and ground in Fig. 1. The fine frequency control had to be readjusted slightly but all other controls were untouched. The operation of this type of circuit is given in the article appearing on pages one and two. A typical example of Barkhausen oscillation and 4.5 mc interference is also included.

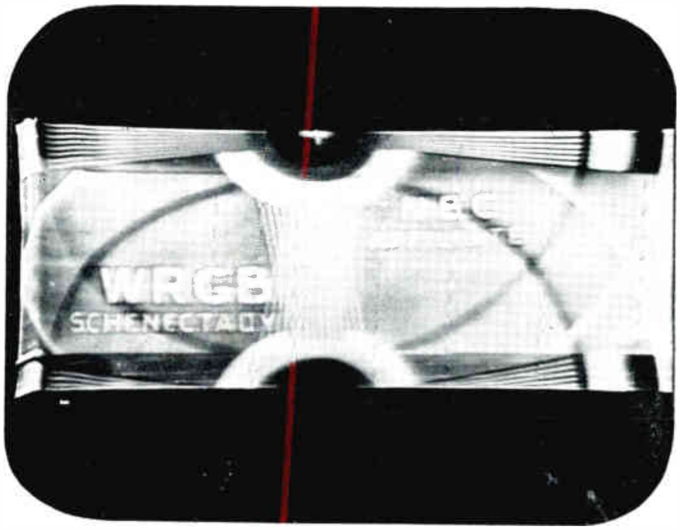


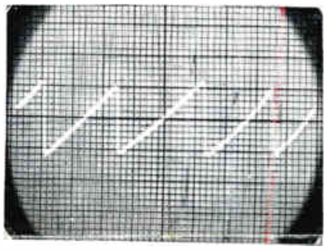


Tele-Clue No. 9. The increase in vertical size is due to changing the charging condenser C34 in Fig. 1 to .05 mfd. The height control was reduced because the top and bottom extended off the screen. The wave form on the left is a normal sawtooth and should be used for comparison. In the wave form on the right the .05 mfd capacitor has increased the height as well as rounded off the top peak. This peak caused the overlap or white streak across the bottom due to the increased charging rate reaching the non-linear portion of the charging curve (see Fig. 6 p. 2). By using a .08 mfd the height was more than adequate to cover a 12″ tube without the white streak.

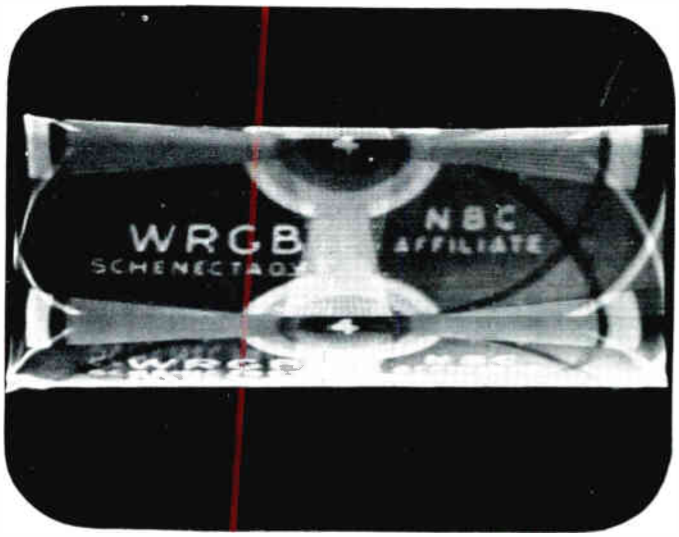


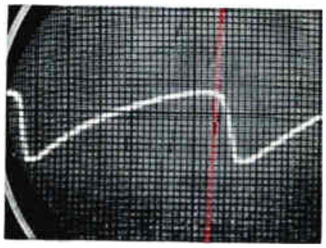
Tele-Clue No. 10. This shows the effect of leakage in charging capacitor C34 in Fig. 1. A 100,000 ohm resistor was placed across this capacitor which affects the linearity as shown in both the photographs. The increase in height is due to the resistance effectively reducing the capacitance.



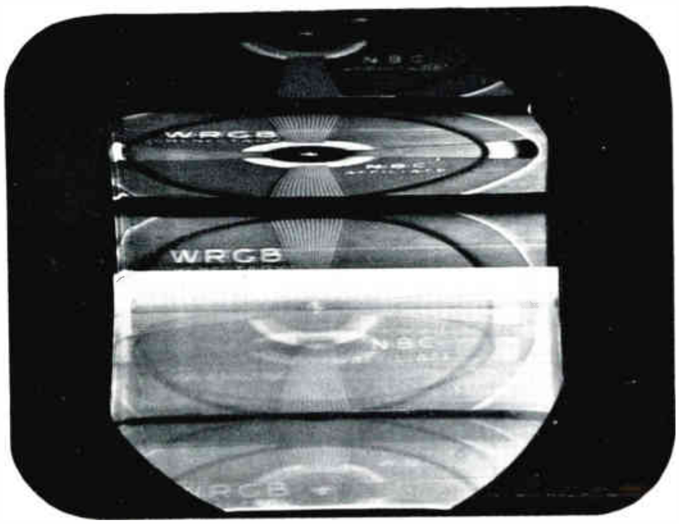


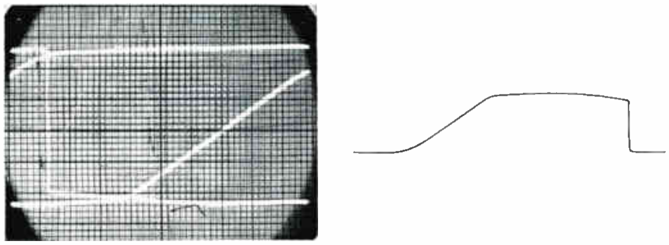
Tele-Clue No. 11. This photograph indicates leakage in capacitor C31 in the circuit shown in Fig. 1. A one megohm resistor was connected across this capacitor which reduced the height and increased the frequency as shown in the wave form. The hold control would not synchronize except with the top and bottom overlapped as shown. Leakage in this capacitor affects the time constant in the multivibrator grid circuit so that the synchronizing pulses are not effective in controlling the multivibrator at the correct speed.



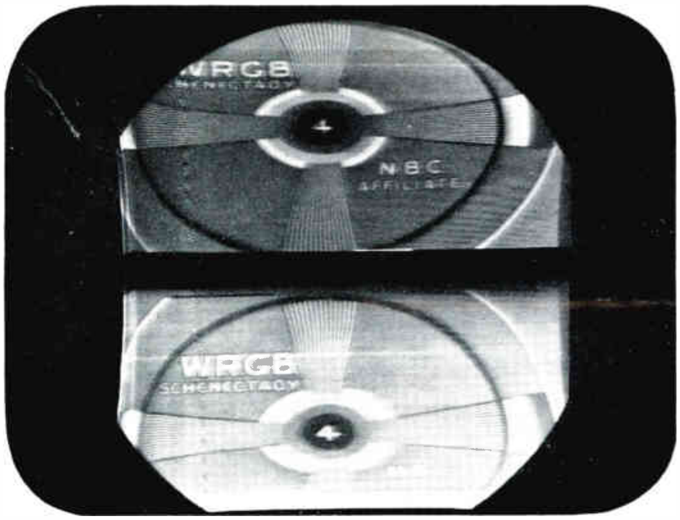


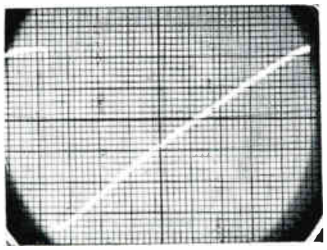
Tele-Clue No. 12. This illustrates a slightly different effect caused by leakage in capacitor C30. A 100,000 ohm resistor was connected across this capacitor resulting in a picture quite similar to Tele-Clue No. 11. The wave form however, is non-linear and the height is reduced with the greatest reduction being above the line.





Tele-Clue No. 13. The above photograph illustrates the effect of R27 in Fig. 1 being open. The frequency is reduced resulting in the wave form on the left which has been redrawn for clarification on the right. Otherwise the explanation given in Tele-Clue No. 11 would also apply here.





Tele-Clue No. 14. The resistance of R27 was changed to one megohm to obtain these photographs. The wave form is similar to the one shown on the right of Tele-Clue No. 9 except at one half the frequency. The hold control would not synchronize except as shown in the above photograph.

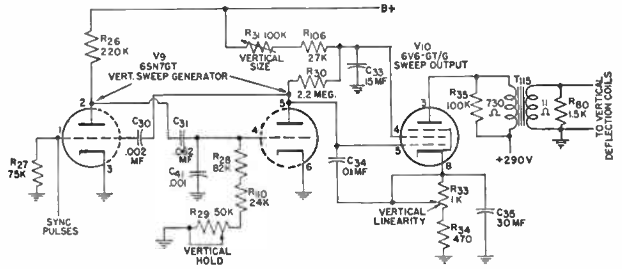
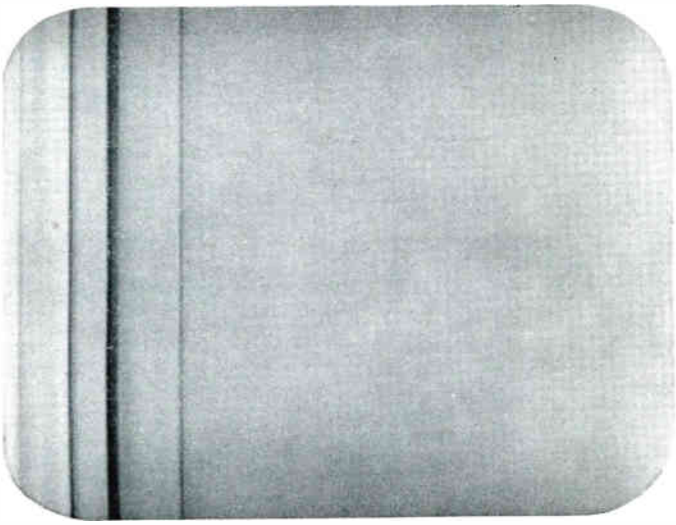


**Fig. 1. Vertical Multivibration circuit used in G. E. Model 810 Receiver**



Tele-Clue No. 15. The dark vertical lines are the result of Barkhausen oscillations in the horizontal output tube. This is a severe example which was obtained by placing a loop of the antenna lead-in around the 6BG6G tube. There are a number of ways in which this effect can be either reduced or eliminated, however, the most effective way in series filament type receivers is replacement with the new anti-Barkhausen type 19BG6G tube. These same lines may appear white and very similar to defective *damping* if the strength of the oscillation is reduced. A check to determine the source would be to place a loop of the antenna lead-in near the horizontal output tube. If the same white lines increase or change to black the cause is Barkhausen oscillations. Another method of checking would be to pull out the video amplifier tube as this type of interference is picked up in the head-end or i-f stages.

Tele-Clue No. 16. This is an enlargement of a photograph illustrating the effect of 4.5 mc frequency getting into the picture tube. This type of interference is the result of the video and audio carriers beating together and not being sufficiently attenuated either by trap circuits or the frequency limitation of the video amplifier circuits. It may also indicate incorrect adjustment of the fine tuning control.

# General Electric Model S1201D Loudspeaker

**Fig. 1. The General Electric Model S1201D Loudspeaker.**

The General Electric Model S1201D Loudspeaker pictured in Fig. 1 is a wide-range, heavy duty 12″ loudspeaker. The frequency response has been designed to fill the requirements of professionals and hobbiests who desire a loudspeaker which will reproduce the full range of high-fidelity audio equipment. The shape of the output curve is such that distortion in recorded or transmitted material is reduced to the minimum consistent with wide-range reproduction, and the extreme high-frequency output between 7000 and 13,000 cycles is equal in intensity to the 1000 cycle response.*

All parts of the Model S1201D loudspeaker are exceptionally durable, and the entire assembly has been designed to withstand continuous hard use.

The aluminum foil base voice coil offers two distinct advantages. First, the coil is not subject to dimensional change or strain release under high humidity conditions, with the result that the original shape and alignment are retained indefinitely. Second, the aluminum foil conducts heat away from the voice coil winding at a rate two times greater than is the case with conventional designs. This allows a higher power rating and minimizes the possibility of voice coil burnout under heavy power surges.

The heavy Alnico 5 magnet provides not only high power sensitivity, but high electrical damping, as well, thereby smoothing the frequency characteristic and minimizing output increase at the primary resonance of the moving system. This is one of the factors contributing to the smooth frequency response characteristic of the S1201D.

Technical specifications for the S1201D are listed below.

## SPECIFICATIONS FOR MODEL S1201D LOUDSPEAKER

| | |
|---|---|
| Type | 12″ PM with curvilinear cone |
| Magnet | 14.5 oz. Alnico 5 |
| Voice Coil Type | Aluminum foil base, 1¼″ dia. |
| Voice Coil Impedance (RMA Measurement) | 8 ohms |
| Frequency Response | 50–13,000* cycles, with several db of peaking from 1500–5000 cycles. |
| Power Rating | 25 watts |
| Air Gap Magnetic Density | 11,000 gauss |
| Air Gap Energy | $3.2 \times 10^6$ ergs $\text{cm}^2$. |
| Nominal Resonance Frequency (RMA Measurement) | 70 cycles |
| Recommended Baffle Opening | 10¾″–11″ dia. |

***Note 1. Response measured on axis. Output increasingly directional with increasing frequency. Loudspeaker baffle should be located in such a way that sound output is directed toward listening positions, not toward heavy draperies or softly upholstered furniture, in order to take advantage of normal diffusion of room walls and furnishings.**

***Note 2. The full frequency range of the S1201D loudspeaker can only be realized in an adequate baffle. Laboratory measurements are made in a baffle which is as nearly perfect as possible. In practical use, a wall mounting, totally enclosed baffle bass reflex or open back cabinets will all give excellent results if designed properly. Bass compensation must be incorporated in the amplifier, preferably in the volume control circuit, to provide satisfactory low-frequency response at normal listening levels.**

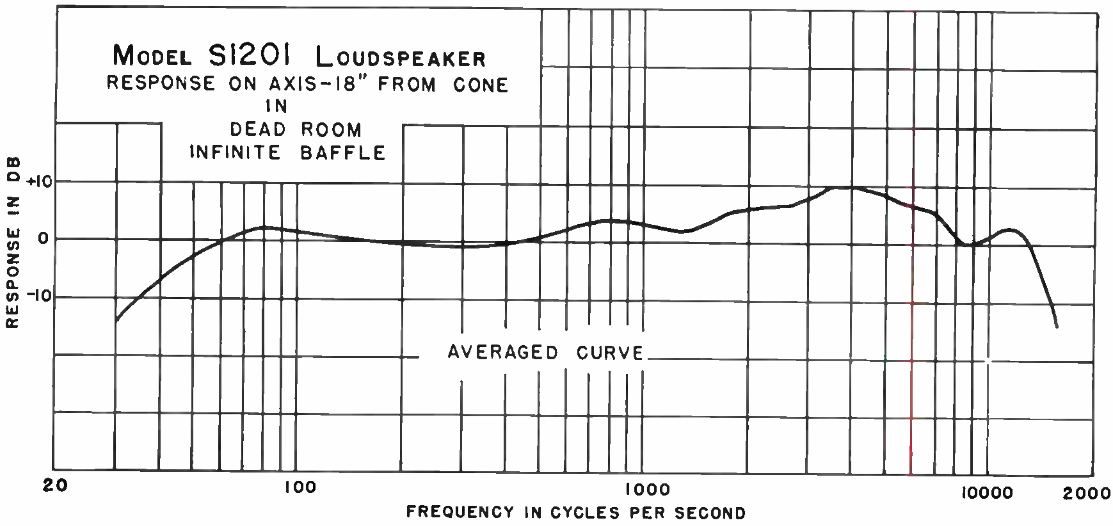


**Fig. 2. Frequency response curve for the Model S1201 Loudspeaker.**

# Variable Reluctance Stylus Wear Considerations

It is not possible to state the life of a pickup cartridge as a definite number of plays without taking a number of factors into account. The quality of the stylus material and conditions of use are important, but the definition of a worn stylus is just as important, and is also much less tangible. Because all these factors must be considered together it is necessary to discuss the entire subject to arrive at a complete answer.

The styli used in standard General Electric variable reluctance cartridges are made of the highest quality natural sapphire material, carefully cut, precision ground, and highly polished. The abrasive action of the record surface upon the relatively small area of stylus-record contact, however, is such that even this high quality sapphire will be worn after a number of records have been played. The factors which determine how many satisfactory plays can be obtained from a given stylus are as follows:

*1. The type of record most commonly played and the condition of these records.*

Records vary in degree of abrasive action. In general, the higher quality classical records are the best in this respect, but unfortunately, the amount of distortion due to stylus wear which can be tolerated on a classical recording is generally less than that which can be tolerated on a popular recording.

The degree of groove modulation is also a factor in record wear, the heavier modulated recordings causing more rapid wear than those which are less highly modulated. Worn records or records which have been used with other types of pickups will cause considerably more stylus wear than new recordings which have been used only with the General Electric variable reluctance cartridge.

*2. Stylus pressure.*

Too much or too little stylus pressure both will cause more rapid wear of the stylus and the record. In any reasonably good tone arm one ounce should be considered the maximum pressure to be used with the General Electric variable reluctance cartridge. The stylus pressure should be adjusted to between one-half and one ounce, and 12 grams is sufficient for professional type arms specifically designed for the General Electric variable reluctance cartridge.

*3. The type of equipment with which the cartridge is used.*

Probably the largest number of users of the General Electric variable reluctance cartridge utilize what might be termed "average" equipment. This means that the amplifier and loudspeaker are of good quality, but are not "high fidelity" in the generally accepted sense of the term. Such equipment probably does not place emphasis on reproduction of frequencies above 7000 or 8000 cycles, and, although it provides excellent reproduction it tends to attenuate those frequencies in which the most disagreeable distortion components are found.

There are, however, a large number of users who utilize either the finest or reasonably priced wide-range audio equipment in the reproduction of their records. When the amplifier and speakers are capable of reproducing the entire range to 10,000 cycles or beyond, the requirements of the entire system with regard to distortion content become very strict, since the disagreeable distortion components will be reproduced fully.

*4. The degree to which the listener is critical.*

This factor ties in quite closely with Item 3, since, generally speaking, the person who has taken the trouble to provide himself with the finest of equipment will also be the most critical of the results. A critical listener will not tolerate as much distortion as the average listener, nor will he be willing, in most cases, to reduce the high frequency output by means of a tone control to lessen the effects of distortion when it is present.

The definition of a "critical listener" is not restricted to engineers or experienced musicians who listen expertly for definite manifestations of improper reproduction, but is extended to include those who enjoy and appreciate good music, and find excessive distortion very noticeable and disagreeable.

With all the factors above taken into consideration it is difficult to specify in exact terms the number of satisfactory plays which can be expected from a sapphire stylus. An "average" listener using the above mentioned "average" equipment will obtain approximately 1500 satisfactory plays before the stylus will need replacement. A play is defined as one side of a 12" record. A critical listener using wide range equipment may notice distortion due to stylus wear at as low as 200–300 plays, and, although this distortion does not seem to become a great deal worse between the 300 and 1000 play mark, it is sufficiently objectionable to some listeners to warrant stylus replacement at 300 plays.

The surest way to judge whether or not stylus replacement is necessary is to listen for distortion to develop, particularly on heavily modulated inner-grooves, i.e., grooves near the center of the record. It should be born in mind that many recordings have distortion which will be reproduced by either a new or old stylus, and only a record known to have low distortion should be used in tests of stylus wear.

With regard to diamond styli, it is a safe general rule that one diamond stylus will outwear approximately ten sapphires. Contrary to what might be expected, a highly-polished, precision-ground diamond stylus, as used in the General Electric variable reluctance cartridge, will not wear recordings any more rapidly than a sapphire. In fact, in extended period life tests, a diamond stylus will cause less wear than a sapphire, unless the sapphire stylus is changed when worn.

Precious metal styli are not used in the General Electric variable reluctance cartridge because of their extremely short useful life.

Replacement stylus assemblies are available for the RPX-040, RPX-041 and RPX-046 cartridges as listed below:

Note: The RPX-046 cartridge is the professional model, supplied less stylus assembly.

| CAT. NO. | TYPE | STYLUS RADIUS | LIST PRICE |
|---|---|---|---|
| RPJ-001 | Sapphire | .003 inch | $3.50 |
| RPJ-002 | Diamond | .0025 inch | 27.50 |
| RPJ-003 | Diamond | .003 inch | 27.50 |
| RPJ-004 | Diamond | .001 inch | 27.50 |
| RPJ-005 | Sapphire | .001 inch | 3.50 |
| RPJ-006 | Sapphire | .0025 inch | 3.50 |
| RPJ-010* | Sapphire | .001 & .003 inch | 5.95 |

* For RPX-050
Cartridge Only.

### NEW RPX-050 "TRIPLE-PLAY" CARTRIDGE

The new General Electric "Triple-Play" Cartridge, the RPX-050, has filled a real need in the field of sound reproduction. The new cartridge plays 33⅓, 45, and 78 rpm records with uniform pressure, without changing its position in the arm. Equipped with 2 styli, one of which plays 33⅓ and 45, the other of which plays the 78 rpm, either styli may be placed in playing position with a simple twist of the positioning knob.

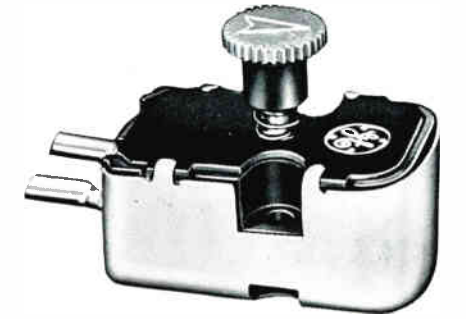


**Fig. 3.**
**Photograph of new General Electric "Triple Play" Cartridge.**

The styli assembly is replaceable as a unit. This single unit includes both 1 mil and 3 mil styli. In the present models the styli are sapphire but diamond styli will be available in the future.

The Triple Play Cartridge incorporates the newest feature of the Variable Reluctance Cartridges, the dual-twist, double-damped cantilever arm. This innovation, which has been hailed by experts as a notable achievement in the field of sound reproduction, cannot be overestimated. The improved cantilever design reduces needle talk substantially, eliminates resonance and improves the ability of the stylus to trace grooves. Electrically produced noise is reduced considerably for a given output level.

The uniform pressure, 6 to 8 grams for all three types of records, is particularly valuable in minimizing record wear. Many cartridges will track the microgroove records at such a low stylus pressure. However, in tracking the 78 rpm shellac records at this low pressure, the Triple Play Cartridge renders excellent service in prolonging the operating life of both stylus and record.

This one cartridge, which performs operations formerly requiring two cartridges, sells at less than 75% of the cost of the two cartridges. The Triple Play Cartridge retains the unexcelled frequency response characteristics of the previous G-E Variable Reluctance Cartridges.

# HOW TO GET THE MOST OUT OF YOUR TEST EQUIPMENT

## THE SIGNAL GENERATOR—PART 1

Next to a volt-ohm-milliammeter the signal generator is probably the most commonly used piece of test equipment in the service shop. While some alignment jobs can be accomplished without resorting to the signal generator, the ease, speed, and accuracy of doing the same job with one should make the instrument indispensable. On the other hand, alignment of FM and TV receivers is practically impossible without a good signal generator.

Signal generators fall into two general classes, radio frequency and audio frequency generators. Radio frequency signal generators may have outputs of (a) unmodulated RF, (b) amplitude modulated RF, (c) narrow sweep frequency modulated RF, and (d) wide sweep frequency modulated RF. The frequency modulated outputs are generally arranged in the instrument to give a variable frequency modulated output over the full range of the signal generator. Also included in many instruments are 100 kc and 1000 kc crystal controlled oscillators which may also be amplitude modulated. The purpose of these is to give an accurate signal source independent of the generators main variable signal.

Since there are many methods and circuits used to obtain RF and AF signals no attempt will be made here to explain the workings of them. However, a thorough understanding of the principles involved will certainly enable one to utilize the unit to its fullest extent and the instruction book which comes with the particular instrument should be read completely.

In general it may be said that trouble shooting in any receiver should start at the output end and so we can first consider the uses of an audio frequency signal generator. The speaker can be checked by connecting the output of the AF generator to the voice coil making sure of course that the speaker has a field supply in case it isn't a PM job. The performance of the entire audio section may be checked in a similar manner by connecting the output of the signal generator successively to the primary of the output transformer, the grid of the output stage and the grid of the 1st. AF amplifier stage. Unless the generator provides a high amplitude output, very little signal will be heard when it is connected to the primary of the output transformer. One word of caution, always use a blocking condenser between the generator and the receiver to prevent damaging your equipment if you are checking a circuit with B+ on it. A 0.5 mfd., 600 volt paper condenser should be satisfactory. If this procedure is carried step by step from the speaker to the output of the 2nd. detector, it should show immediately which stage is at fault and what component is causing the trouble. Interstage coupling capacitors may be checked for opens by connecting the generator first to the side that goes to the grid and then to the side that goes to the plate of the preceding stage. No change in output should be noticeable. Cathode bypass condensers in audio stages may be checked by connecting an output meter or scope across them and feeding the signal voltage into the grid of that stage. Very little or no reading should be seen if the condenser is OK. This is not a 100% check as obviously a shorted condenser would give no reading either. The gain of an audio stage may be checked by making use of the signal generator and your output meter, which incidentally may be any rectifier type AC voltmeter such as is found in most multimeters with a blocking condenser in series to protect against any DC voltage present. Connect the meter across either the primary or secondary of the output transformer and connect the signal generator to the grid of the AF output stage. Now note this reading on your meter and then connect the generator lead to the grid of the next preceding stage. The gain may be found by dividing the second voltage reading by the first. Triode stages usually give a gain of 10 to 15 for low mu types to 40 or so for high mu tubes while pentodes may be expected to give gains of from 50 to 200 or more, although these higher figures are not usually encountered in receivers but may be found in PA system amplifiers. The gain of the output stage requires the use of a meter which is sensitive enough to read the output of the signal generator and is accomplished as above except that the voltage of the signal fed into the grid of the output stage must be measured by means of the sensitive meter and may be but a fraction of a volt. Obviously any of the above tests may be made at any audio frequency but 400 cycles is considered a standard test frequency.

If you get a receiver in the shop that does not have a tonal quality which is to the satisfaction of the customer, the first step in correcting this should be to find out just what the frequency response of the audio section is. This may be accomplished by using your variable audio frequency generator and plotting a curve of output vs. frequency. The output level is usually given in decibels and most audio output meters are so calibrated, however, a curve plotted in voltage will serve as well as we are mainly interested in obtaining relative outputs at various frequencies. The readings are obtained by connecting your output meter across the voice coil of the speaker and the signal generator to the grid of the first AF amplifier stage. Adjust the output of the generator to give a convenient reading on the meter at 400 cycles, the standard test frequency. Next vary the frequency of the signal generator from 40 or 50 cycles to 10,000 cycles or higher taking readings every hundred cycles or so to be sure to have points close enough to make a nice curve. While doing this it is very important to hold the output level of the signal generator constant, making use of a scope or a sensitive AF voltmeter connected across the generator output. A typical curve might look like Fig. 1 below. After you have plotted the response of the receiver it will be apparent if the high or low frequencies are not coming through. Of course this will not account for poor fidelity caused by a poor speaker or improper baffling. If the response falls off on the low frequencies, look for interstage coupling capacitors which are low in value and also grid resistors which are low. Since many methods of tone compensation are employed it is not possible to cover all troubles which might be encountered but in general it is wise to suspect trouble in any inverse feedback arrangements used and also in the tuning capacitor or RC combination across the output transformer primary.

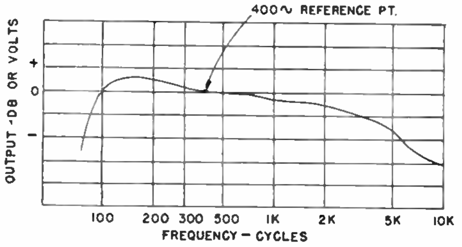


**Fig. 1. A typical audio frequency response curve.**

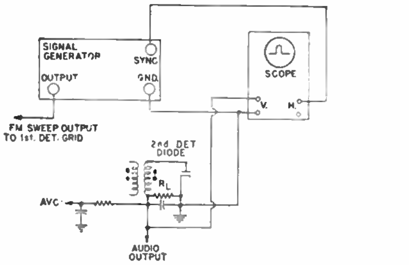


**Fig. 2. Illustration of visual alignment of an AM receiver using signal generator and oscilloscope.**

Now that the audio amplifier has been checked, the next section of the receiver to be adjusted is the IF amplifier. Since AM, FM, and TV receivers all differ in the alignment procedure we will cover first the methods used to correctly align a typical superhet broadcast receiver.

There are several methods of accomplishing the IF alignment and wherever possible the manufacturers recommendations as given in the service manual should be followed closely. Probably the simplest method is to connect the signal generator to the grid of the 1st. detector stage and tune each IF transformer for maximum output as heard in the speaker. The signal generator should be tuned to the recommended IF frequency and be amplitude modulated at 400 cycles. This method is, however, not to be recommended as an approved way of alignment. Several precautionary measures should be taken and a more sensitive means than the ear should be used to indicate maximum output.

First it is wise to use a blocking condenser of approximately .01 mfd. between the signal generator and the receiver to prevent shorting any DC voltages present. Secondly it should be realized that the receiver's AVC action may give rise to false readings if the signal level is too high so use the lowest possible signal level from the generator which will give a satisfactory reading of output.

Three methods may be used to indicate output. The first would be to use an output meter connected to the audio output of the receiver and setting the signal generator to provide a 400 cycle modulated RF output as explained above. The second method uses an unmodulated RF output from the generator and reading the receiver output by means of a VTVM connected across the 2nd. detector load resistor. The third and perhaps the most accurate method makes use of an oscilloscope connected across the 2nd. detector load resistor and setting the signal generator to the FM output position with a sweep of 30 kc. The horizontal input to the scope should be connected to the synchronizing voltage terminals of the signal generator. These connections are shown below in Fig. 2.

The manner in which the first two methods are used is merely to tune each IF transformer for maximum output, starting with the last stage. However, if the receiver is badly out of line or when a transformer has been replaced it may be necessary to connect the signal generator to the grid of each stage successively, starting again with the last stage and ending with the generator connected to the grid of the first detector. After each stage has been aligned individually, it is wise to go back over each transformer and recheck the settings as there is sometimes a slight amount of interaction between them.

The third method, using the scope and FM source, involves tuning each transformer for maximum output as shown on the scope and so as to produce a single symmetrical curve similar to the illustration in Fig. 2. If the stages are misaligned the curve will be displaced either to the left or right of the exact center depending on whether the transformers are tuned too low or too high in frequency. If all the transformers are not tuned to exactly the same frequency, two or more peaks may be obtained or the top may be broad if the transformers are tuned fairly closely to the same frequency.

This third method should be used to align the IF amplifiers of high fidelity receivers. Here it is important to have a broad flat tapped IF curve with a 10 kc bandwidth and by using the visual alignment method the stages may be stagger tuned if necessary by watching the effect on the curve as each stage is adjusted. The

*(Continued on page 8)*

# BENCH NOTES

**Contributions to this column are solicited. For each question, shortcut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. Send contributions to The Editor, Techni-Talk, Tube Division, General Electric Company, Schenectady 5, New York.**

### H-V BUT NO P-I-C

I have had quite a few of G. E. TV Model 805, 806, 807, 809, and 821 come in for service with the complaint "Sound and no picture." A routine check showed voltage on the picture tube anode cap, but upon checking the cathode I found the voltage had gone up to 345 v. instead of the specified 110 v. An ohmmeter check showed shorts in C302 (.02 mfd); this condenser is mounted on a bakelite strip on top of the chassis.

*C. Beaufort, Equitable Radio Service*
*Jersey City, New Jersey*

### TV STACK INSURANCE

In fringe areas, where tall installations are required, it has often been told how one mast came down after another, reason: windstorm, weather, ice. Those masts with four stack combinations simply broke off and hanged there. This is not exaggerated and it can be proven with this remedy:

In order to accomplish satisfactory and foolproof installations it is necessary to make them "vibration proof" simply by attaching another guyring with another set of guy wires only 1" below the topmost element of the mast, similar improvements can be made by steadfasting the lead-in with more standoffs than necessary and tension proof connections to the elements.

This is a good precaution for any size of TV installation.

*J. J. Schalit, Providence. R. I.*

### CRYSTAL HOLDERS

I recently bought some surplus crystals in holders, but couldn't buy sockets of the right size to receive the pins. I then tried putting them in tube sockets, and found the 8-pin octal type socket just the thing to hold two of these crystal holders. Using four wafer type octal sockets from an old radio chassis and mounted side by side in a rectangular slot on the chassis, I built up a fine crystal signal generator with eight surplus crystals mounted side by side. Makes a neat looking job. Crystal holders are FT type used in the FM service receivers, with pins one-half inch apart.

*Bernard J. Beck, Brockroad, Virginia*

### WIDTH INCREASE

On General Electric Television Receivers Model 805–806–807–821 when the raster has decreased in horizontal size so the picture will not fill the screen, place a .0001 Mica Condenser from the Red Lead to the White Lead on the Flyback transformer.

This will increase the horizontal sweep to the extent it will be necessary to adjust the Horizontal Control to bring the picture down in size to fit the screen.

This may be carried further and by increasing the size of the condenser the sweep can be increased enough to fully sweep the face of a 20 inch tube should this be desired.

*A. S. Cooke, Brooklyn, New York.*

EDITOR'S NOTE: *The capacitor should be at least 1.5 kv rating. In some cases a fold-over may be noticed due to a reduction in the retrace time. If fold-over is noticed a slightly lower capacity condenser should be used.*

### DIAL STRINGING AID

The handiest tool I have found for putting on dial cords is a crochet needle. The end is small and is long enough to get into small places to install springs and to put cord around pulleys.

I would like to pass this tip on to your readers as I think it will help them in service work.

*Troy L. Williams, Newport News, Va.*

## HOW TO GET THE MOST OUT OF YOUR TEST EQUIPMENT (Cont.)

manufacturers instructions should be followed closely when doing this.

To align the RF and oscillator sections of an AM receiver the above methods apply equally well except that the signal generator should be connected to the antenna terminals of the receiver and two alignment frequencies are used, one at approximately 550 kc and one at 1500 kc. As receivers vary widely in the method in which alignment of the RF section is made only general instructions can be given here. Provision is usually made for tracking the oscillator tuning at both ends of the broadcast band. At the low end this may be done by means of a slug tuned coil or padder condenser and at the high end by means of a trimmer condenser. If both of these means are provided the procedure of tuning them should be gone through several times until no change is apparent to either adjustment when the other is peaked up. The RF stages are tuned in a similar manner although most receivers have provisions for tracking only on the high frequency end of the tuning range. The 100 kc and 1000 kc crystal oscillators and their harmonics may conveniently be used here to check for exact dial calibration so that the owner will know just where to set his dial to find his favorite station and not have to remember that WPDQ comes in at 968 instead of 950 as the radio program says it should.

---

Electronics Department
GENERAL ELECTRIC
Company
Schenectady 5, N. Y.

Sec. 34.66, P. L. & R.
U. S. POSTAGE
PAID
Schenectady, N. Y.
Permit No. 148

Boyd's Radio Service
411 Fredericksburg Rd.
San Antonio 1, Texas
E-223/J-75

6-13-49