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Season's Greetings

To all our students and graduates, from the Staff of the National Radio Institute:

Our Very Best Wishes For The Holiday Season!

May Happiness And Prosperity Be Yours Throughout the New Year!

J. E. Smith,
Founder

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The Multivibrator And How It Works

By J. KELLY,
NRI Consultant

In the past, technicians have sometimes bypassed learning the principles of the multivibrator circuit because its operation is different from the more common circuits. Also they did not frequently meet it in servicing work. However, the great rise in industrial and military electronics in the past few years makes the multivibrator circuit very important. The signals handled by industrial electronic equipment, computers, guided missiles, radar, and countless other modern electronic devices are usually in the form of pulses. These rectangular pulses are formed and handled by multivibrator circuits. The multivibrator is used as the source of the sawtooth sweep signals in many Television receivers, and it forms the composite video signal at the TV station. The use of square wave generators with multivibrators in servicing work is also increasing. The man entering the electronic field today cannot afford to overlook this. In the future there will be a great need for skilled men to work with this new type of electronic equipment. Obviously these men must master the multivibrator circuit. Actually, it is quite simple.

Keep in sight that the purpose of the circuit is to work as a switch. When it is turned on and off the voltage it passes will be in the form of pulses. These pulses have a square or rectangular shape when viewed on an oscilloscope. With the multivibrator, we can control both the number of pulses per second and the duration of each pulse. Triode tubes serve as switches. The grid circuits control the turning on and off of the tubes. Unlike the familiar class A amplifiers, the grid voltage here swings over a very wide range. To turn the tube off, the grid voltage goes so far in a negative direction that all plate current is stopped. To effectively close this electronic switch and allow current to flow, this high negative grid voltage is removed. With these basic thoughts in mind, let us consider the multivibrator circuit in detail.

In Fig. 1 is shown a basic multivibrator circuit. The action of the circuit is this: first one tube will be conducting while the other is cut off, then the situation will reverse itself; the first tube will then be cut off and the second tube will conduct. This action will repeat itself over and over again. The plate currents and voltages of each tube will be pulses.

Now let's look at the circuit more closely. One tube will be cut off by its grid circuit while the other conducts. Eventually its grid circuit will

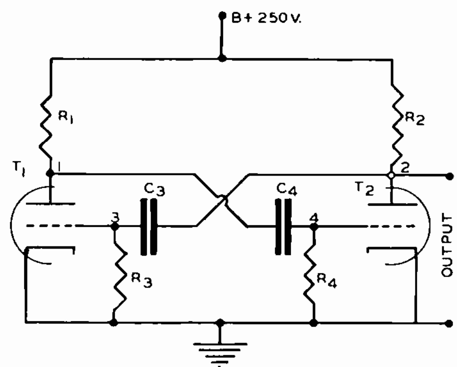

Fig. 1. The basic multivibrator circuit.

allow it to conduct. When this happens, the voltage in the plate circuit is coupled into the grid circuit of the second tube and cuts it off. The grid circuit of the second tube then takes over. It will keep the second tube cut off for a prearranged period of time. The first tube will continue to conduct because there is nothing to change its grid voltage during this time. Eventually this second tube will be allowed to conduct by its grid. Now, the voltage at the plate of the tube that has just started to conduct will be coupled to the grid of the other tube and cut it off. We are now back where we started. In analyzing the operation of this circuit, we will use the four waveforms shown in Fig. 2. These are the waveforms that would be seen if an oscilloscope were connected at various points in the multivibrator circuit. The first waveform, EP1, is the waveform of the plate voltage of tube 1. The grid voltage waveform is shown just beneath EP1 in the figure. It is the waveform of the signal at the grid of tube 1. Similarly, EP2 is the waveform of the voltage at the plate of tube 2, and EG2 is the waveform of the voltage across the grid of tube 2 and ground. These four waveforms are all placed one above the other so that at each instant of time you can see what action is taking place in each of the circuits. Moving from left to right corresponds to the passage of time. By means of Fig. 2, we can see exactly what is happening in each circuit as time progresses.

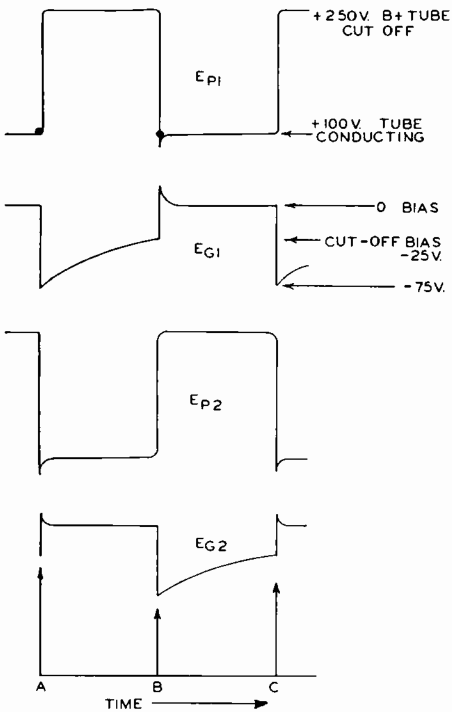

Fig. 2. Voltage waveforms in the multivibrator.

Let us assume that the multivibrator circuit is operating. We look into the circuit at the instant of time A, when tube 1 is cut off. In waveform EP1 of Fig. 2 as soon as the tube is cut off, the voltage in the plate circuit jumps up to the B+ voltage of 250 volts. This is because no current flows through R1 to cause a voltage drop. The voltage will remain at this level until instant of time B when the tube will again conduct. When we look at the waveform of the voltage at the plate of tube 2, at instant of time A, this tube begins to conduct. The voltage at its plate will drop from the B+ value of 250 volts down to 100 volts because of the voltage drop across R2. This voltage also will remain constant until some later time when the tube will be cut off. Looking at the waveform of the voltage at the grid of tube 2, we see that this grid voltage is zero. Tube 2 is allowed to conduct freely. This voltage also will remain essentially constant until some future time when the situation in the circuit changes.

The remaining waveform is the voltage at the control grid of tube 1 which is cut off. At the instant of time, A, this voltage swings far negative cutting off tube 1. However, this voltage does not remain constant like all three of the other voltages just discussed. This negative voltage gradually becomes less negative until it finally decreases to the point at instant of time B when it allows tube 1 to conduct. As soon as tube T1 is allowed to conduct the plate voltage will drop sharply because of the voltage drop across R1. We can see this in waveform EP1.

Here is the important action to observe. This change in the plate voltage of tube 1 will be felt at the grid of tube 2, and tube 2 will now be cut off. The action we have just observed will now repeat itself with the jobs done by the two tubes interchanged.

The key to the operation of the multivibrator lies in the action that takes place in the grid circuit. Since the exact same action takes place in both circuits, we need consider only one. Look at the grid circuit of tube 2 when tube 1 just begins to conduct, and its plate voltage drops down to 100 volts. Since the grid circuit made up of C4 and R4 in series is across the plate of tube 1 and ground, the new plate voltage will be felt across this series circuit.

Condenser C4 will try to have the charge across it changed so that it will be the same as the new voltage. The 250-volt charge that has been present across condenser C4 when EP1 was 250 volts, will now try to change to 100 volts. This means that the condenser must discharge; it must get rid of some of the electrons that are stored in it. This discharge path is through resistor R4. Since R4 has high resistance, it will take a reasonable amount of time for C4 to discharge through it. Moreover, these electrons will travel down through resistor R4 making the voltage at the top end of the resistor negative with respect to the bottom. This voltage drop will be felt across the grid and cathode of tube 2 as a negative bias which cuts off plate current.

At first, a relatively large amount of current will flow. This is because the condenser has a great deal of electrical pressure stored in it that it wants to get rid of. Since this is so, the discharge current will be heavy at first. The voltage drop across resistor R4 will be correspondingly large as we see in wave EG2 at instant of time B. In this way, the change in the plate voltage of tube 1 causes tube 2 to be cut off.

As the condenser gradually discharges, the voltage stored in it becomes smaller and smaller. Therefore there will be less pressure to push electrons down through resistor R4. The current will diminish gradually, and the negative voltage that is developed across resistor R4 will likewise diminish gradually. Eventually the negative grid voltage drops to the point where tube 2 conducts again. The entire action we have just observed will repeat itself again with action performed by the two tubes changed so that tube 2 now conducts.

When tube 2 is allowed to conduct, its plate voltage change cuts off tube 1. This means that the voltage across the series circuit of C4 and R4 jumps back up to 250 volts. The condenser will want to become charged to this new voltage.

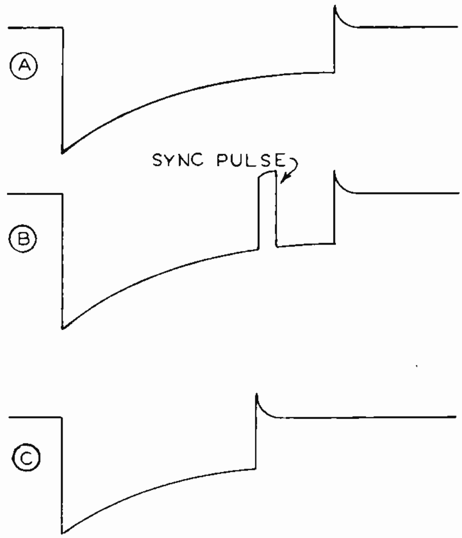

Fig. 3. The addition of the sync pulse to the grid voltage waveforms.

When the condenser discharged, an appreciable amount of time was required for it to discharge through R4. However when the condenser charges, the charging current does not have to flow through R4. The polarities of the voltages in the circuit are such that the grid of tube 2 is now positive. The current going into C4 now flows from the cathode to the grid of tube 2. Because the cathode to grid resistance is far lower than the resistance of R4, the condenser is rapidly charged to the new voltage of 250 volts. Once the condenser is fully charged, no current flows through R4, and the grid voltage remains at zero until the voltage at the plate of tube 1 changes.

Observe this action in the grid circuit and wave Eg2 well; it is the key to the operation of the multivibrator.

The amount of time that it takes the voltage at the grid of the tube to diminish from —75 volts to the cut-off bias is dependent upon the size of resistor R4 and the size of condenser C4. For example, if condenser C4 is made larger, it will take a longer time for the larger charge on this condenser to diminish to the point where the voltage at the grid is reduced to the cut-off value. This is the R-C time constant. In other words, the amount of time that the tube will be cut off is determined by the size of the resistor and condenser in the grid circuit. In this way, the size of the condenser and resistor controls the duration of the pulse, and the number of pulses per second (frequency). This time is also controlled to a lesser degree by the characteristics of the tube that is used in the circuit.

In the basic multivibrator circuit with which we have been working thus far, each of the grid circuits contains the same size resistance and capacity. Therefore, each of the tubes would be turned off for the same period of time and the voltage obtained at the output of the multivibrator would be a square wave as shown at EP1 and EP2. However, we can use different size resistors and condensers in each of the two grid circuits so that one tube may be turned off for a longer period of time than the other tube. This would result in a waveform that is rectangular instead of square.

Let us briefly review the high points of the operation of the multivibrator again.

The two tubes in the multivibrator circuit are alternately turned on and turned off. This means that if we use the plate voltage of either of the tubes we will get a series of square pulses as the tube is turned on and turned off.

When the tube is turned off the cut-off bias applied to its grid will gradually diminish to the point at which the tube is allowed to turn on.

As soon as one tube is turned on, energy is fed from its plate circuit to the grid circuit of the other tube, which is turned off.

The duration of time that each tube will be turned off is controlled by the resistance and capacity in the grid circuit.

The frequency of oscillation of the multivibrator we have been considering is controlled solely by the characteristics of the multivibrator circuit; principally the R and C values in the grid circuit. In many circuits we want to synchronize the multivibrator; take the sync pulses that we get from an outside source and trigger one of the tubes in the multivibrator. To do this, apply the positive going sync pulse to the grid circuit of the tube that we want to trigger. This pulse will then be added to the normal waveform of the grid voltage shown in Fig. 3A. Notice that it must take longer for the tube to be triggered by itself than it will for it to be triggered by the sync pulse. If this were not so, the tube may be turned on by its own grid circuit before the sync pulse arrives.

In Fig. 3B, we see the grid voltage waveform of tube T1 with the sync pulse added to it. When we inject the sync pulse voltage into the grid circuit, it will add to the voltage that is already there. At the instant of time when the sync pulse arrives, it drives the bias voltage beyond the cut-off point, and the tube is thereby turned on. Actually, with the addition of the sync pulse the grid circuit waveform would not look exactly like that shown in Fig. 3B. As soon as the sync pulse arrives, the grid voltage wave will have the form shown in Fig. 3C and the tube fires on the newly positioned leading edge of the wave. One of the advantages of the multibrator is that it can easily be synchronized.

The basic plate-coupled multivibrator circuit can be used in television studios creating the sync pulses and blanking pedestals of the composite video signal; it will also be found in square wave generators, gating circuits, industrial electronic equipment, cathode ray oscilloscope horizontal sweeps and countless other situations. Now let us consider some of the variations of the basic plate-coupled multivibrator circuits.

Many technicians will soon find themselves working on electronic computers, either as repairmen or in the factory where the computers are assembled. They will work with the single cycle multivibrator, also known as a flip-flop circuit. The outstanding feature of this circuit is it is not free running. In other words the tubes will not be automatically switched on and off. To switch from one tube to another an external signal is required. The circuit we discussed previously would oscillate continuously regardless of whether sync pulses were reaching it or not. The flip-flop circuit on the other hand will not oscillate continuously. It will have one tube conducting and the other tube cut off. These two tubes will continue to operate in this manner until a sync pulse arrives. When the sync pulse arrives, the circuit will go through one cycle of oscillation. The tube that was previously conducting will be cut off and the second tube will conduct. The period of time that this condition exists will be determined by the R-C time constant of the grid circuit just as in other multivibrators. After this period of time the second tube will be cut off and the first tube will begin to conduct again. The circuit will then be back in the state of operation which was present before the sync pulses arrived. The circuit will not go through another cycle of operation until another sync pulse arrives. Flip-flops find widespread use in high speed counter circuits.

The flip-flop circuit shown in Fig. 4 is a cathode-coupled multivibrator. The plate circuit of tube 2 is coupled to the grid circuit of tube 1, not by means of a condenser from plate to grid but instead by means of a common cathode resistor RK. However, the plate of tube 1 is coupled to the grid of tube 2 in the usual manner. In Fig. 4 the control grid of tube 2 does not go directly to ground (one end of resistor R3 connected to ground). On the contrary, the grid resistor of tube 2 goes to the top of the cathode resistor. This results in the voltage across the cathode resistor being applied only across the cathode and

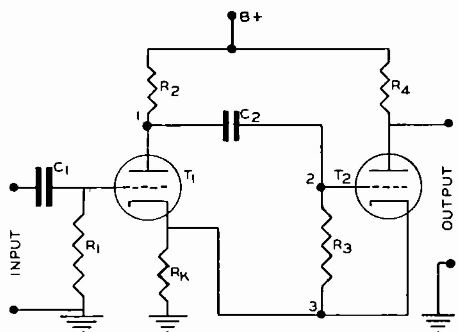

Fig. 4. The single cycle multivibrator.

grid of tube 1 and not across the cathode and grid of tube 2.

When no triggering pulse is applied to the circuit, tube 1 will be cut off continuously. The voltage developed across the cathode resistor as a result of the cathode-plate current of tube 2 will cause a cut-off bias. As soon as a triggering pulse reaches the grid of tube 1 it will begin to conduct because the positive triggering pulse overcomes the cathode bias. As soon as tube 1 conducts, a negative voltage is applied through C2, R3 in the usual manner, and tube 2 is cut off. The circuit will then remain in this condition for the period of time required for condenser C2 to discharge through resistor R3 just as in the basic multivibrator. When the blocking bias that is present across the grid and cathode of tube 2 finally reaches the conduction point, tube 2 will begin to conduct again, and tube 1 will be promptly cut off. Since this cut-off bias comes from the cathode resistor, and not from

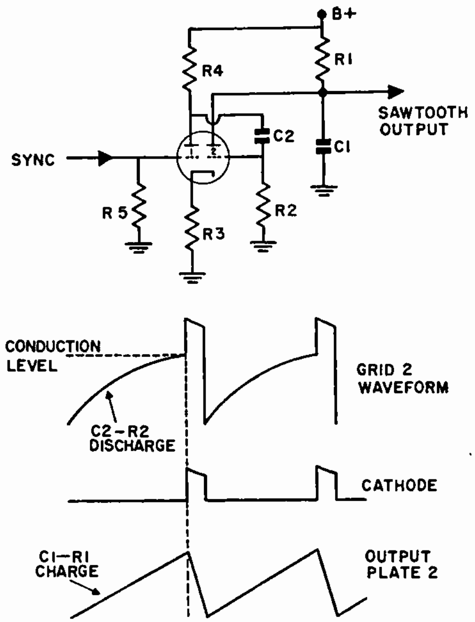

Fig. 5. Cathode-coupled multivibrator.

the discharge of a condenser, it will remain constant. A sync pulse must come from an outside source to overcome it. Therefore the circuit will remain in this state with one tube conducting and one tube cut off until another sync pulse arrives.

Now let us consider the cathode-coupled multivibrator in Fig. 5 that is used in many Television receivers as a source of vertical and horizontal sweep. The operation of this circuit is somewhat different from the operation of the single cycle multivibrator. As a result, this circuit, although cathode-coupled, is a free running circuit; it will oscillate continuously regardless of whether a sync pulse is applied or not.

The presence of condenser C1 between the plate of the second tube and ground brings about the formation of the sawtooth wave that we want in this circuit rather than the square wave that would normally be generated in a multivibrator.

In Fig. 5 we see the sawtooth wave which is present at the output of plate 2. Notice that this voltage is also the voltage across condenser C1. During the period of time when tube 2 is cut off, C1 gradually charges from the B supply. The voltage across C1 is also the voltage at plate 2. When the voltage applied to plate 2 becomes sufficiently high this section of the tube conducts through resistor R1. Because the plate resistance is relatively low when conducting, condenser C1 will quickly discharge through tube 2. This brings about the sharp drop in the sawtooth wave. Tube 2 conducts for a very brief period of time allowing C1 to discharge. After discharge of C1, tube 2 will be cut off until condenser C1 is again charged to the conduction level of tube 2. In this way the sawtooth wave needed for the sweep systems in many TV receivers is formed.

Look into the circuit at the period of time when the sawtooth is just starting to build up. At this instant of time, tube 2 has just been cut off. Tube 1 has just begun to conduct. This means that the voltage drop across resistor R4 has jumped up and the voltage available at the plate of tube 1 has dropped. Since the series circuit of C2 and R2 is across the plate of tube 1 and ground, condenser C2 will try to discharge to this new voltage. The action that will take place in this grid circuit is exactly the same as that in the basic multivibrator. Eventually the point will be reached where tube 2 is allowed to conduct.

A very important point that we must establish at this time is, unlike other multivibrators, tube 1 will not be completely cut off during the period of time when tube 2 conducts. The fact that the plate current of tube 1 greatly diminishes when tube 2 conducts allows the basic oscillating action of the multivibrator to take place. When tube 2 conducts, the current flowing through resistor R3 will increase. This means that the bias voltage across tube 1 will become more negative. As the current through tube 2 and R3 increases, the resulting bias on tube 1 makes it conduct less and less. It is true that the bias voltage across resistor R3 is also applied to the grid of tube 2. However, the charge across condenser C2 acts against the bias voltage coming from resistor R3 and prevents it from making the grid of tube 2 more negative.

As the grid of tube 1 is made more negative, less current will flow in its plate circuit and the voltage at the plate of tube 1 will increase. This increase in voltage will likewise be felt across the series circuit of C2 and R2, and the condenser will try to charge to this higher voltage. Since the condenser is charging and not discharging, current will now flow up throuh resistor R2, making the grid of tube 2 more positive.

Positive feedbtck is taking place during the period of time when tube 2 conducts. As the plate current passed by tube 2 increases, a more negative bias will be applied to the grid of tube 1 and its current will diminish. This in turn results in a higher positive voltage being applied to the grid of tube 2 and this tube will try to conduct even more. As the plate current of tube 2 increases, the positive feedback will make it increase even more. This positive feedback arrangement will allow tube 2 to conduct more and more until it finally reaches the point where it is saturated. This means that a further positive increase in the grid voltage will not result in a further increase in plate current in tube 2. The cathode cannot deliver any more current. When this saturation point is reached, the voltage drop across resistor R3 will stop increasing and the negative bias voltage on tube 1 will likewise stop increasing. As a result of this, the voltage at the plate of the tube will stop increasing in a positive direction, and finally the positive voltage at the grid of tube 2 will also stop increasing. Notice again that during this period of time tube 1 has not been completely cut off as it was in other multivibrator circuits. When this saturation point is reached and all of the voltages stop changing, current will no longer be flowing up through resistor R2 to cause the charge across condenser C2 to change. The positive voltage drop across resistor R2 as a result of this current flow will disappear. The positive voltage at the grid of tube 2 will suddenly slip back, becoming more and more negative. Tube 2 will be cut off and the circuit will be back in the condition that was present when we entered the circuit.

The interval of time during which tube 2 conducts is actually very brief. This interval of time is not controlled by an RC time constant as is the interval of time when tube 2 is cut off. Instead, it is controlled primarily by the characteristics of the tube itself, how long it takes the tube to reach the saturation point and the length of time C1 can supply the necessary plate voltage.

Look at the outstanding features of this circuit once again.

Condenser C1 allows us to get a sawtooth shaped voltage instead of a square shaped voltage at the plate of tube 2.

Coupling between the plate of tube 2 and the grid of tube 1 is accomplished by the cathode resistor.

Tube 1 does not completely cut off as it did in other multivibrators.

The circuit we have been considering is somewhat more elaborate when it is actually used in a TV receiver. However, these additional parts do not change the basic operation of the circuit. Some of the resistors are made variable so that the frequency of the oscillator and the wave shape of the signal can be changed. A resistor will be connected in series with condenser C1 in the circuit of Fig. 5 so that a very sharp pulse occurs during the retrace time, when tube 2 is conducting. This pulse is necessary because of the inductive reactance of the deflection coil. If this pulse were not present during the retrace time, the picture would not be shaped properly on the screen of the TV receiver. Also, a tank circuit made up of a condenser and coil may be added in the plate circuit of tube 1 to cause a high frequency sine wave to be generated in this circuit. The presence of this sine wave when added to the normal voltage at the grid of tube 1 will make the circuit less sensitive to noise which may trigger the circuit instead of the synchronizing pulse.

The multivibrator which is lightly passed over by many technicians because it seems hard to understand is actually quite simple. It is just two tubes connected so that the plate circuit of each tube will control the grid circuit of the other. This will result in the tubes being alternately turned on and turned off. When one tube is turned on the other will be turned off and vice versa.

You will occasionally hear the multivibrator described as two resistance-coupled amplifiers connected back to back. The signal passing through them goes through a 360-degree phase shift and comes back to the starting point. The 360-degree phase shift means that when the signal gets back to the starting point it is in phase. Positive feedback here, just as in any circuit, causes oscillation. Since the tubes are not operating in a linear class A fashion, the signal that appears in this oscillating circuit will not be a sine wave. It will be a greatly distorted wave; distorted to the point that it may be a square wave rather than a sine wave. This is just a highly theoretical way of explaining this simple circuit in which each tube is alternately turned on and turned off by the other tube.

It is well to keep in mind the basic multivibrator principles described here. More and more electronic equipment is being created each month in which the signal that is handled is in the form of a series of pulses; the multivibrator is one of the prime sources of such a signal. Therefore, the modern technician must know the multivibrator.

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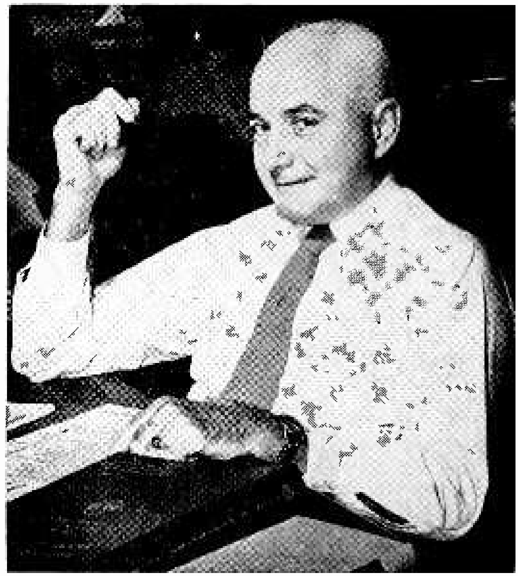
Servicing Hints

Printed circuit servicing can often be made easier by placing a light on either side of the board. When the light is on the "printed wire" side, the wiring is easily seen on the "parts" side simplifying tracing. Similarly, a light on the parts side will silhouette parts viewed from the wiring side.

A gradual drift off frequency of pulse-width type horizontal oscillators is often caused by a change of capacity of the condenser connected across parts of the horizontal oscillator transformer. Leakage in this condenser can be appreciable with no noticeable effect on circuit operation.

AUDIO OSCILLATORS IN SERVICING

By LEO M. CONNER,
NRI Consultant



Leo M. Conner

Servicemen are aware of the importance of an rf signal generator in routine service work. Most rf signal generators have a means of modulating the output with a tone of approximately 400 cycles. Some of the more flexible signal generators have a means of selecting either modulated output, unmodulated output or audio output alone.

However, in such cases, the audio output is a single frequency and cannot be used for many of the tests that are necessary in servicing high fidelity or other types of audio equipment. A variable frequency audio oscillator can also be used in radio servicing to find such things as cabinet resonance, acoustic feedback and speaker cone rattle on certain frequencies, and to determine the over-all frequency response of a receiver audio system.

Almost any oscillator can be made to generate audio frequencies by using the right electriccal values in the frequency determining circuits. Some circuits are more suited for audio purposes than others because they have better output wave shape. For most applications, a sine wave is preferred. If a square wave is desired, the sine wave output is fed into a clipper stage which changes the sine wave to a square wave.

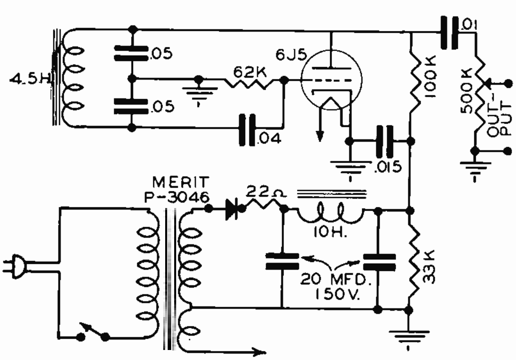


Fig. 1. Colpitts audio oscillator circuit. All resistors are ½ watt.

The construction of an audio oscillator is simple. However, the calibration is more difficult than that of an rf oscillator. In calibrating an rf oscillator for the broadcast band, one needs only a receiver capable of tuning over the band. Broadcast stations must operate within 20 cycles of their assigned frequency and they furnish an excellent source of signals for calibrating a signal generator.

The calibration of an audio oscillator is more difficult and requires an oscilloscope and a known source of audio frequency. Later on in this article we will show some calibration methods.

Practical Circuits

One of the simplest circuits for producing audio signals is a Colpitts oscillator which uses an iron core choke coil and two paper condensers in the tuned circuit. Using the part values shown in Fig. 1, the output frequency is approximately 400 cycles. Note the word "approximately." Since all parts have a normal manufacturing tolerance the frequency may be somewhat higher or lower than 400 cycles. However, with the exact values shown, the frequency should be 400 cycles. Remember that choke inductance values are normally given for a definite direct current flow through the winding. With less than the rated value, therefore, the frequency would be lowered unless the capacity values were decreased to compensate for increased choke inductance.

Because of the iron core in the coil of the tuned circuit, the output signal will not be a perfect sine wave. However, it should be reasonably close. The frequency can be changed by substituting other values for the capacitors (.05 mfd) in the tuned circuit. Increasing the capacities will lower the frequency while decreasing the capacities will raise the frequency. The output control will have some slight effect on the frequency.

An oscillator of this type has very limited value to the serviceman. Due to the fact that it has only one output frequency it cannot be used for frequency response tests or for cabinet resonance tests. The output could be made variable over limits by using several pairs of capacitors and a two-pole multi-position switch. The number of pairs of capacitors and the number of positions on the switch will be determined by the number of frequencies desired. Fig. 2 shows how the tuned circuit would be modified to obtain six different output frequencies. The switch has two poles and six positions.

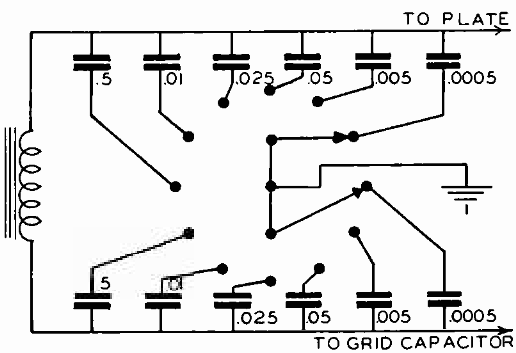


Fig. 2. How six pairs of capacitors can be connected to give six frequency.

While this arrangement gives greater flexibility than a single tone, it still has limitations in that only six frequencies are available. In addition, the amount of feedback varies with the different frequencies and the output at one frequency may be considerably more distorted than at other frequencies.

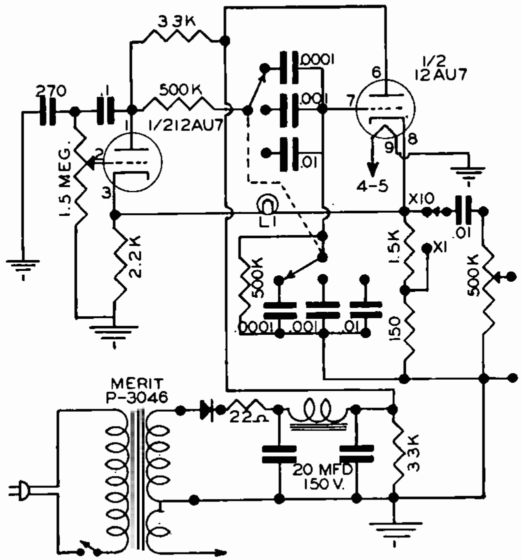


Fig. 3. A Wien Bridge oscillator circuit. All resistors ½ watt.

From this, it can be seen that something different is needed to get more frequencies and better output wave shape.

The output wave shape can be improved by going to another type of circuit. Then, if desired, the frequency can be made continuously variable.

The circuit shown in Fig. 3 is an R-C oscillator known as a Wien bridge. There are three frequencies with the circuit shown but later in this article we will show how to modify the circuit to get continuous coverage from about 30 cycles to 30,000 cycles.

A 12AU7 twin triode tube is used with one triode section of the tube serving as the oscillator and the second triode serving as a cathode follower. The 3 watt, 115-volt lamp connected between the two cathodes serves as a regulator since its resistance varies with the amount of current flowing through the lamp. Incidentally, this lamp does not light when the circuit is operating.

The two-pole, three-position switch serves to change frequency by switching in different pairs of capacitors. These capacitors in connection with the 500K resistors, connected to each switch, determine the frequency.

The output circuit is different than the one used in the first oscillator. An output attenuator of

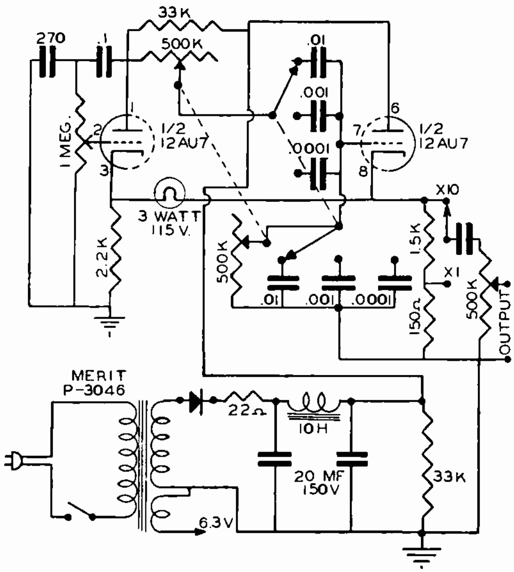


Fig. 4. A variable frequency Wien Bridge oscillator. All resistors 1/2 watt.

the step type has been added. When the switch is thrown to the x1 position the voltage at the variable control is 1/10 that available when the switch is in the x 10 position. With this output circuit, extremely fine control of the voltage may be obtained.

This circuit has excellent wave shape when the "oscillation control" is set properly. The correct setting is the point where oscillation just begins. If the control is advanced too far, the wave shape will be distorted. It may be necessary to readjust this control each time a new pair of capacitors is switched in. There remains one objection after cleaning up the wave shape and the output control circuit. This is the fact that the frequency is not continuously variable. This objection can be remedied quite easily. To do this, substitute a 2-gang potentiometer with .5-meg resistance in each section for the two 500K resistors in the frequency control section. The circuit is shown in Fig. 4. Note that the fixed capacitors and two-pole, three-position switch are still in the circuit. They serve as range controls.

The first range, using .01-mfd. capacitors in connection with the .5-meg potentiometer, is from approximately 30 cycles to 300 cycles. The second range, using .001-mfd capacitors, is from about 300 cycles to 3,000 cycles, and the third range is from about 3,000 cycles to about 30,000 cycles.

An interesting point is that if the capacitors in the range section are in an exact 10 times multiple, the frequencies in each range will be in 10 times multiples at the same potentiometer setting. That is, the setting for 60 cycles on range 1 will be the setting for 600 cycles on range 2 and for 6,000 cycles on range 3.

To achieve this condition it is necessary to carefully check on a capacity bridge, a number of capacities in each range in order to find two that match each other and, at the same time, be an exact 10 multiple of another pair. If 5 per cent mica capacitors are used, you should be able to find the right combinations by starting with 10 capacitors of each value. This precision is not necessary if you want to calibrate each range separately. However, since range 1 is the easiest to calibrate, the ease of calibration more than justifies the trouble in selecting the capacitors. A vernier type dial, such as the National Type 10039, is necessary for careful calibration and resetting. If you prefer a "slide rule" type dial, the National 10035 is a good one. However, it costs about twice as much as the type 10039 dial.

Any of these oscillators can be assembled on a wooden baseboard, a metal chassis or enclosed in a cabinet. There are no special precautions to be taken in building the oscillator. Of course, all connections must be properly soldered. Note that pins 4 and 5 of the 12AU7 tube socket are tied together and connected to the ungrounded side of the filament winding. Pin 9 of the 12AU7 tube socket is grounded.

Calibration

We have mentioned that an oscilloscope is needed to calibrate the oscillator. In addition, a 5 or 6 volt source of ac is needed. This voltage can be taken from the filament winding of another transformer or from the filament circuit of a receiver using a power transformer. Since the power line frequency is held fairly constant, the line frequency is used as a calibrating standard.

As shown in Fig. 5, the audio oscillator output is connected to the vertical terminals of the scope and the external voltage is connected to the horizontal terminals of the scope.

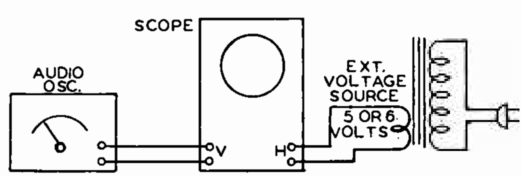


Fig. 5. How the oscillator, scope and external voltage are connected for calibration using the ac line frequency as standard.

With an external voltage applied to the horizontal terminals, turn the scope and audio oscillator ON and allow them to warm up for 10 minutes or so. Set the output control on the oscillator to about half of the full ON position and the attenuator switch to the 10 x position.

Set the range selector to position 1 and then adjust the oscillation control until a vertical line appears on the face of the scope. The length of this line will depend upon the setting of the vertical gain control on the scope and a good length is approximately 1½ inches. You should find that it is possible to make the line appear and disappear on the scope with the oscillation control. Set this control just slightly beyond the point where the vertical line appears. The feedback should then be right for sine wave output.

Next apply the 60-cycle input voltage to the horizontal scope terminals and adjust the horizontal gain control until the pattern is approximately as wide as it is high. Unless the two frequencies are the same or a multiple of the line frequency, the pattern will be a square similar to the raster on a TV set when no picture is being received.

As the dial of the oscillator is turned, you will see a rapidly changing series of patterns on the scope. When the audio oscillator frequency is 60 cycles, the pattern will be a circle indicating that the oscillator frequency and the line frequency are the same. The oscillator frequency may shift slightly, in which case the circle will rock slightly in one direction, then stop and turn back the other way. By using a vernier dial, it is possible to carefully set the dial so that the pattern drift is minimum. When this condition is reached, the dial can be marked for the 60-cycle position.

The line frequency is then used as a standard to obtain other calibration points. To do this, we will use Lissajous figures. These figures make it possible to use the oscilloscope to determine an unknown frequency provided a known standard is available. In our case, the known standard frequency (60 cycles) is furnished by the power line.

When two sine wave voltages are applied to the two sets of deflecting plates at the same time, the resulting pattern will show the ratio between the two frequencies. The exact pattern shape will depend upon the amplitudes of the two frequencies, the actual frequency and the phase relationship of the two voltages.

A number of Lissajous figures are shown in Fig. 6. The frequency ratio is found by counting the number of loops along two adjacent pattern edges. Fig. 6C shows 3 loops along the horizontal edge and 1 loop along the vertical edge. This pattern indicates that the ratio of vertical frequency to horizontal frequency is 3 to 1. Since 60 cycles is applied to the horizontal plates, this means the frequency that is applied to the vertical plates is 3 x 60 or 180 cycles. The pattern at B in Fig. 6 results when the unknown frequency is 120 cycles.

It is possible to count up to 10 loops without too much difficulty so that calibration points can be obtained for 60, 120, 180, 240, 300, 360, 420, 480, 540 and 600 cycles.

When you have these points, go back to the 60-cycle calibration mark. Then start turning the dial toward the low frequency end. At 45 cycles, the ratio will be 3 to 4 and there will be three horizontal loops and four vertical loops as shown in D of Fig. 6. At 30 cycles, the ratio is 1:2 and the pattern will be as shown in E.

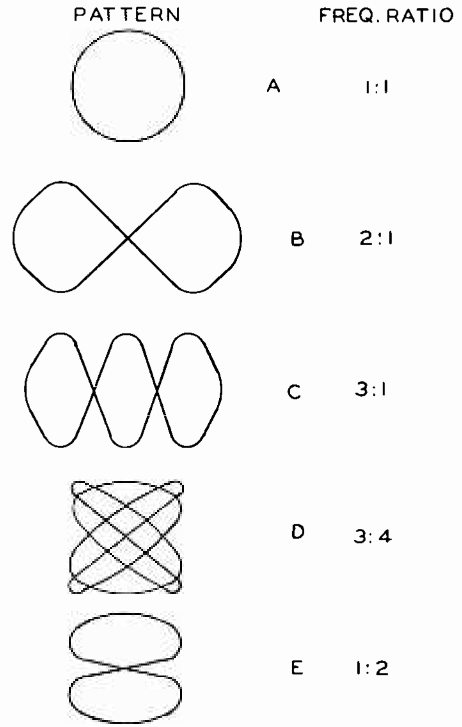


Fig. 6. Lissajous figures which give ratio between known and unknown frequencies for calibration purposes.

It might be possible to reach 20 cycles (1:3 ratio) in some cases but 30 cycles is normally the lowest usable frequency with this circuit.

After this much of the calibration has been completed, you can check the low frequency end of the second range. This is done by first getting a

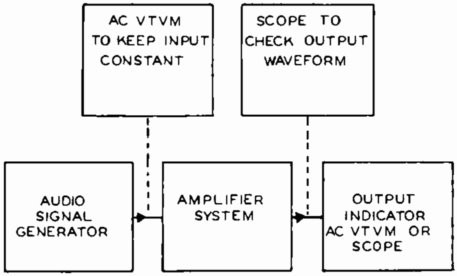


Fig. 7. Amplifier tests using Audio Signal Generator.

circle at 60 cycles with the line frequency used as a reference.

The range switch is then thrown to the second position and, if the capacities are 10 times those in the first range, there will be 10 loops indicating that the oscillator frequency is 10 times the reference frequency. Other frequencies can be checked with a similar procedure.

Since the counting of many loops becomes difficult, many designers would build two oscillators.

Then, when the basic range calibration was finished, the second oscillator would be used as a source of known frequency.

To do this, the second oscillator would be set to 10 times the line frequency (600 cycles). The variable oscillator is then set to range 2. With the second oscillator output connected to the horizontal scope terminals and the variable oscillator connected to the vertical scope terminals, you would get a circle when the variable oscillator frequency is 600 cycles. Lissajous figures can then be used to get calibration points up to 6000 cycles (10 loops).

To calibrate the third range, the calibrating oscillator frequency would be increased to 6000 cycles so that with the variable oscillator at 6000 cycles, a circle appears on the scope screen.

The variable oscillator would then be switched to range 3 and tuned for a circle on the scope which would indicate 6000 cycles. Lissajous figures are then used to get calibration points up to 60,000 cycles.

From this it can be seen that the calibration of an audio oscillator is a laborious procedure which calls for a scope and a separate audio oscillator for best results.

Servicing With Audio Generators. The audio frequency generator can be connected to the amplifier under test in the manner shown in Fig. 7. The output indicator can either be an ac vacuum tube voltmeter or an oscilloscope. A rough check can be made using the audio signal generator and carefully listening to the strength of the loudspeaker output. If there is a sharp loss in low or high frequency response, it will be apparent on the indicating device (your ears are no good for this purpose) as the audio signal generator is varied through its frequency range, keeping the output of the audio generator at a reasonably constant level.

In making frequency checks, the audio signal generator is connected to the input of the amplifier and a 5 watt—5 or 10 ohm resistor connects across the output as a constant impedance load to replace the speaker voice coil. If the output of the audio generator is not constant over its range, it is advisable to connect an ac VTVM to its output so that a constant amplitude input is furnished to the amplifier at all frequencies.

With the gain control of the amplifier set at maximum, it is possible to measure the highest undistorted output of the audio amplifier. Maximum output is indicated when there is no further increase in audio output as the input level is increased. For a more precise measurement of undistorted power output, it is helpful to attach an oscilloscope to the audio amplifier output. With the oscilloscope connected, the audio output of the generator is increased to the point at which the wave form seen on the oscilloscope begins to distort. Then the audio output of the audio generator is decreased to just below this distortion point. This level of output wattage indicates the maximum undistorted output of the amplifier.

To check the frequency response of the amplifier, you may find it helpful to use ordinary graph paper in plotting the frequency response against the voltage level as indicated by the vtvm or calibrated oscilloscope. Use a test frequency range from 30 to 15,000 cps. The maximum usefulness of the graph will be realized when the check points are made as close as possible. You must be sure that a constant input voltage is applied to the amplifier by making certain (with the ac vtvm) that the output of the audio generator is set at the same level for each check frequency.

The output of an audio oscillator can be used to check cabinet and speaker resonances. Couple the audio generator to the speaker voice coil through a series connected resistor of approximately 100 ohms with a power rating of 10 watts. Connect an ac voltmeter set to a reasonably low range of 3 or 5 volts, across the voice coil. As the audio generator is varied through its range, it is possible to measure the resonant frequency of the speaker alone or with the speaker mounted in an enclosure. With this set-up, as the oscillator frequency is varied, the voltage across the speaker changes in direct proportion to its impedance. Therefore, at the frequency at which the voice coil impedance rises to maximum (this is at cone resonance) a voltage peak also occurs. A typical 10-inch speaker may show a voltage peak at 60 cycles that is 3 to 5 times as high as the voltage for frequencies below and above the resonant peak.

When the speaker is mounted in an enclosure, cabinet resonance can be indicated by the excessive vibration or buzzing of one or more panels of the enclosure. The usual method of tuning a base-reflex enclosure is to adjust the area of the opening until the mounted speaker has two impedance peaks of about the same amplitude and spaced equally above and below the free-space or unmounted resonance of the speaker. Fig. 8 illustrates the curve obtained when testing an unmounted speaker for resonant peaks in relation to the desired curve of the tuned base-reflex enclosure.

Cabinet resonance that will cause acoustical feedback can be kept to an absolute minimum

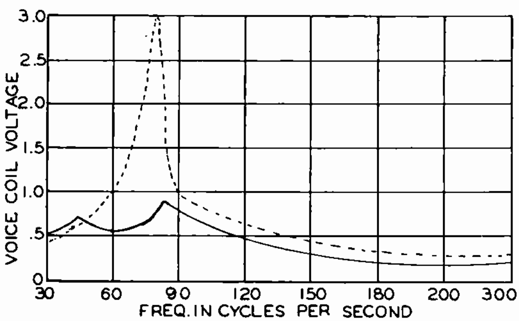


Fig. 8. Two curves to show the results of tuning the bass reflex enclosure.

by heavy glued construction of all joints. The interior of the enclosure must be well padded to prevent build-up of cabinet or speaker resonances.

Unusual and hard-to-find causes of distortion can sometimes be traced to speaker cone rattle resulting from cone resonance at one or more frequencies. Connect the audio generator directly to the speaker voice coil and with the output kept at a reasonable level, adjust the audio frequency output through its range and by carefully listening to the tone vibrations, any undue buzzing or rattling can be detected. To minimize this speaker distortion, in home radios, cement a small piece of foam rubber between the edge of the cone and a portion of the speaker frame, to dampen the resonant peak.

If an audio oscillator is used to check the frequency response of an amplifier, care should be taken to avoid overloading the high gain stages of the amplifier. Otherwise, distortion will appear and the tendency may be to blame the amplifier when the only cause of trouble is overloading. Keep the signal input to the lowest usable value in order to prevent overloading.

n r i

From A Toy, A World Of Sound

Christmas time is usually considered toy time, and certainly the children of the world make it so.

But did you know that from a toy came the world of sound brought to us by the telephone, the phonograph, the talking motion picture, radio, television?

Back in the 1870's while experimenting with the telephone, Thomas A. Edison learned of the power of a diaphragm to pick up sound vibrations. Archives of the McGraw-Edison Company at West Orange, N. J., show that to carry his experimentation further—and at the same time to amuse his children—Mr. Edison made a toy in which a ratchet and a pawl were connected to a diaphragm. When he spoke loudly into a funnel, a pulley on the ratchet would automatically cause a little toy man to saw wood.

Dreaming of the enormous possibilities of the telephone, Mr. Edison concentrated on conversion of Alexander Graham Bell's magnetic telephone into a practical commercial device. His famous carbon button transmitter, which made the modern telephone and microphone possible, was the result.

For many years Mr. Edison's name appeared on every Bell telephone set; and it was Mr. Edison who devised the "hello" which today begins virtually every telephone conversation.

Then in further experimentation the little man sawing wood gave way to a foil-wrapped cylinder; and the first recorded words became the popular "Mary had a little lamb," as Mr. Edison realized that if he could record the movements of the diaphragm properly, he could succeed in recording and reproducing the human voice.

Thus from a simple toy came the world of sound as we now know it.

n r i

The Leisure Time of Your Life

Prepared by the Medical Department The Equitable Life Assurance Society

Across the nation increasing attention is being focused on a part of our lives we have been little concerned about in the past—leisure time. With current talks about a shorter working day and

(*Page 24, please*)

INSTALLING A MULTIPLE TV ANTENNA SYSTEM

By TOM CARSWELL,
NRI Consultant

Tom Carswell

In most suburban residential areas, multiple TV antenna installations are unnecessary. That is, provided the area is located within a reasonable distance of a TV broadcasting station. In areas such as these, most TV set owners prefer their own individual antenna installations. However, even with such individual antennas, two or more TV sets are frequently employed on a single antenna array. Even though it may not be serious, a simple installation of this type will quite often cause interference and reaction between the TV sets unless proper isolation between the sets is employed.

In metropolitan residential areas, such as large apartment buildings, it is usually impossible for each TV set owner to install his own outside antenna system. As a result, a multiple outlet system must be used. Apartment building owners and managers have an acute dislike of having an unsightly array of numerous TV masts and antennas on the roofs of their buildings. A multiple system of this type will present the TV technician with many problems seldom encountered in a simple suburban installation. It is the purpose of this article to attempt to illustrate a few typical examples of obstacles and unusual conditions that may be met when making an installation such as this.

In choosing the type antenna to be used, it must be kept in mind that not all TV viewers have the same taste in channel preference. In other words, some of the viewers may prefer one or more channels in the low end of the band. Other viewers may prefer the channels in the high end of the band. The net result is that an antenna must be chosen that will provide equally satisfactory reception on all channels, regardless of their geographical location in the area. In fact, it is frequently necessary to use two or more separate antennas. If an antenna more complex than the simple hi-lo assembly is employed, a matching network must be provided in order to feed all antennas into a common multiple output line. This is to provide maximum isolation between antennas and also to present the highest signal level possible on the distribution line.

In a primary signal area, you will probably find that booster amplifiers between the antennas and the distribution line are unnecessary. Simple resistive pads may be employed to terminate the antenna transmission lines to the distribution line. However, for fringe area reception, it is usually essential that booster amplifiers be employed for each antenna, in turn feeding into a mixer stage. The distribution cable or cables are fed from the mixer stage. The gain of each individual booster amplifier should be adjusted so that the output from each amplifier is approximately equal on all channels.

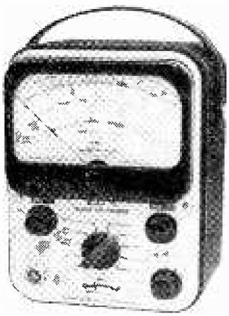
For a simple suburban installation on which only two TV receivers are employed at any one time, it is often satisfactory to simply connect the receiver transmission lines to a common tie point on the 300-ohm antenna line. In such cases, it is desirable to have at least 20-feet separation between the receivers in order to reduce any reaction between the sets when both are in operation simultaneously. In a primary signal area, such an installation would probably be satisfactory, although the paralleled receiver inputs present an effective impedance of only 150-ohms across the 300-ohm antenna line. Experimentation with the length of each individual receiver input line is often necessary in order to obtain the most satisfactory reception.

More satisfactory operation with these same two receivers may be obtained by further isolating the receiver antenna inputs by means of series

(Continued on page 19)

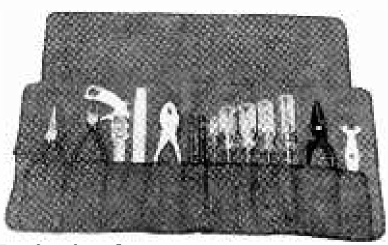
Christmas Suggestions

Here's a condensed catalog of items available through the NRI Supply Division. Any item would be just the Christmas gift you've been looking for. To place your order, just clip out the coupon on page 18, attach your check or money order, and mail it to the NRI Supply Division. Do it early and be sure of delivery in plenty of time for Christmas. All NRI instruments are covered by the standard 90-day RETMA warranty. Convenient monthly terms can be arranged on all instruments, the Replacement Parts Kit, and WEN Electric Drill. Write for full particulars.

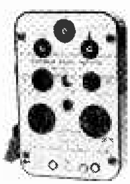


New Model 12 NRI Professional Vacuum Tube Voltmeter. Low price, top performance, easy to operate. Five ranges, 0-1200 volts AC-DC. Ohmmeter measurements to 1000 megohms in five ranges. Peak to peak AC volts. Metal, black ripple case with brushed aluminum panel. Overall size: 7¾" X 5⅞" X 3½". Actual weight 5¼ lbs. Shipping weight 7 lbs. Requires 50-60 cycle, 110-120 volts AC. Unsurpassed in quality at the low price of **$45.00**. Shipped Express, Collect with test leads and instructions.

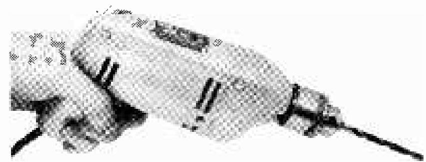
Optional Accessories—30,000 volt High Voltage TV probe, **$6.50**. Crystal Detector HF Probe, **$9.50.**



NRI Professional Tool Kit, only $10.95 postpaid. A real money-saving value. These 14 carefully selected tools would run close to $14.00 at dealer's net prices. Recommended for NRI experiments; Radio-TV service work. Packed in sturdy roll-up canvas case.

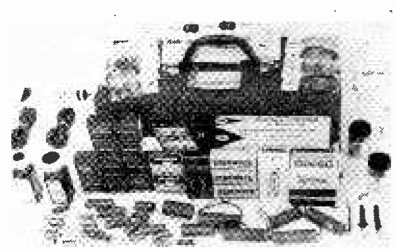


NRI Model O Series String Filament Tester. Completely self-contained. Quick checks receiver and TV picture tubes for filament continuity. Uses two long-life penlight cells. A real time saver on servicing jobs. Has built-in pin straighteners and also checks fuses, pilot lamps. Easily carried in jacket; size 1" X 3½" X 5⅜". Handsomely styled, custom made case, brushed aluminum panel with black lettering. Complete instructions on back. **Price only $5.50,** postpaid, complete with batteries.

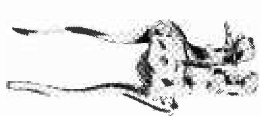


WEN ⅜" Drill, $18.50. (Regular retail price $26.95.) Has the power, low speed, and ideal size for Radio-TV work. Geared down to 1000 RPM with no load, 800 RPM under load. Takes bits 1/16" to ⅜". Shipped complete with rubber-covered handle that attaches to either side of drill for safe, two-hand operation. Highly recommended by NRI engineers. Weight: 3 lbs., length 9", height 6". Genuine geared Jacobs chuck with key. Low price includes postage.

Cabinet for your NRI Radio. Good-looking, improves tone. Well-seasoned, natural wood sanded to smooth finish. Comes to you knocked-down. Easy and fun to assemble. **Only $4.95,** postpaid.

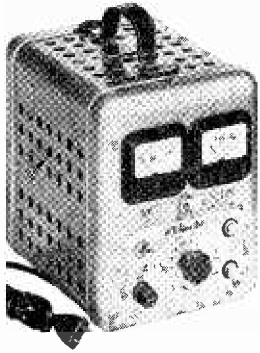


NRI Replacement Parts Kit, $24.75 including steel tool box. Most needed replacement parts for starting Radio-TV work. This assortment would run over $50 at dealer's net prices. Shipping weight 15 lbs. Sent Express Collect.



Speedex fully automatic Wirestripper. Won't crush stranded wires. A real time-saver. Sturdy construction. **$4.95.**

Weller Model 8100K Soldering Kit. $7.95 value. **NRI price $5.95 postpaid.** Contains 100-watt Weller "Junior" Soldering Gun, Soldering Aid, Brush, Roll of Resin-Core Solder. An ideal gift.



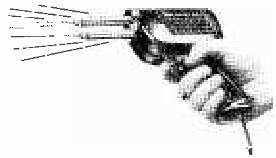
"A" Battery Eliminator for Auto Radio Service. Provides 6 volts at 10 amps continuous or 12 volts at 6 amps continuous. Operates the new 12-volt auto radios. Includes voltmeter and ammeter, variable output voltage control, on-off switch, fuse, and leather handle. Can also be used as a battery charger. Size 6½" X 9⅛" X 8½". Shipping weight 22 lbs. Shipped Express Collect. **NRI Price only $39.95.**

Drake Model 400 Soldering Iron, $3.75. Made by the well-known Drake Electric Works, Inc. Rated at 60 watts, 110-120 volts, ¼-inch tip. Perfect for NRI experiments and service work. Complete with 6-foot cord and stand. Postpaid.

Model 70 NRI Professional Tube Tester. Designed to test the latest Radio and Television tubes. Convenient, built-in roll chart. Approved RETMA emission circuit minimizes possibility of obsolescence. Ten separate four-position tube element switches. Eight tube test sockets. Fifteen filament voltages. Handsome, hardwood case. Size: 10¾" X 10¾" X 6¼". Actual weight, 11 lbs. Shipping weight, 13 lbs. Sent Express Collect. 50-60 cycle, 110-120 volts AC required. **Extremely popular and a real buy at $49.75.**

TV Picture Tube Adapter (not shown). For use with all NRI Tube Testers, Models 66 through 70. Provides cathode emission check, short and leakage test. **$4.98 postpaid.**

Please use order blank on Page 18.



Weller Dual-Heat Soldering Guns. Model D-440 rated at 100-150 watts. For Radio-TV work. List price $14.90. NRI price, **$10.73 Postpaid.** Model D-550 rated at 200-250 watts. Heavy duty. List price $16.25. **NRI price $11.71 postpaid.** (Note: prices include Gun only. Models D-440 and D-550 not available in Kit.)

NRI Deluxe Tube Caddy, $12.95 postpaid. Handsome, professional in appearance. One-fourth inch plywood construction. Protected by metal hardware. Covered with long-wearing luggage type fabric. Holds up to 200 tubes in assorted sizes. Lots of room for VTVM and small tools. Light weight, easy to carry. Size 16⅜" X 8" X 13½".

Cabinet for your NRI VTVM. Sturdy aluminum, gray baked-on wrinkle finish, brushed finish chrome handle. Protects VTVM and improves appearance. Exact fit. Installation requires but a few minutes. All necessary screws included. **Only $4.00 postpaid.**

Model 89 NRI Professional AM-FM-TV Signal Generator and Marker. One of NRI's most popular instruments. Wide ranges 170kc to 60mc on fundamentals. Guaranteed accuracy ± 1% on all six bands. Special calibration points for FM and TV alignment. Strong harmonics give accurate coverage up to 120mc. Uses stable Hartley Electron-Coupled r.f. oscillator circuit with cathode follower output. Single output jack with detachable coaxial output cable. Detailed instructions included.

Maroon crackle finish case with etched aluminum panel. Size: 12" X 8¼" X 10¼". Actual weight: 12 lbs. Shipping weight: 15 lbs. Shipped Express charges Collect. Requires 50-60 cycle, 110-120 volts AC. **Only $45.00.**

"Come when you can. We won't monkey with it."

Custom Installations

General Electric television engineers have voiced a word of caution for those planning to use a television set in a wall installation.

Prompted by the increasing popularity of "built-in" furniture and appliances, G. E. prefaced the cautionary note by urging those contemplating such an installation to seek professional advice before undertaking the task. In so doing, they said, the possibility of a heat or fire hazard due to lack of essential air circulation may be avoided.

All General Electric TV receivers, as well as those made by most manufacturers, are approved by the Underwriters Laboratory. But approval is given on the basis of the complete receiver with the chassis enclosed in its own cabinet.

The TV cabinet is designed by the manufacturer so as to permit adequate air circulation throughout the interior of the set when operating in an open area. This provides the necessary cooling action and is absolutely vital for safe operation and long life.

G. E. engineers point out that some people may assume the cabinet provided with the set can be built directly into a partition with no additional safety measures. This, they say, is not true. Even if the TV set were to be placed flush against a wall, sufficient air circulation might be cut off so as to impair operation of the set or create a heat menace.

Actually, a built-in television receiver, when properly installed, should be enclosed in a separate enclosure with a minimum of two inches of air space between the TV cabinet and the enclosure at bottom and rear and three inches between the enclosure and the top of the set. Adequate grill openings should be provided in front and at top and bottom of the receiver. This enclosure should be constructed of an approved galvanized material similar to the standard terminal or junction box or other approved fireproof material. The TV within the box should be supported by metal braces and the 110 volt power supply, installed by an electrician, should be within the enclosure.

It was also suggested that the electrician provide for an antenna lead to be brought into this housing. Provisions for removing the set for servicing or replacing with one of different size should, of course, be considered.

As a final recommendation, it is suggested that the electrician who makes the installation have it inspected by and furnish the owner with a certificate of compliance from the local electrical installation bureau.

(Continued from page 15)

resistive isolation pads. At the same time, this prevents any serious mismatch between the receivers and the antenna transmission line. By referring to Fig. 1-A, you will notice that 150-ohm resistors are placed in series with each leg of the receiver transmission line. With both receivers connected, this presents the approximate correct matching impedance to the antenna transmission line termination point. Of course, attenuation of the signal will result. This should be of little consequence if you are located in a metropolitan area where the TV signals are relatively strong.

Again, taking this same installation as a basic example, three or even four TV receivers may be operated simultaneously on the same antenna, employing only resistive isolation pads. In place of the 150-ohm series isolation resistors, 300-ohm resistors are necessary. In Fig. 1-B, such a hookup is illustrated. Of course, the signal attenuation will be greater due to the larger size of the isolation resistors.

In many primary signal areas, as many as four TV receivers may be satisfactorily used on a common antenna without the need of installing any special booster or mixer stages. The correct method of connecting four TV receivers in such a system is illustrated in Fig. 1C. Notice that the isolation resistors have increased in value to 450-ohms each. In each case where the sizes of these resistors were increased, it was necessary in order to maintain a proper 300-ohm match to the termination point of the antenna transmission line.

Although this type of resistive isolation in a multiple outlet TV antenna system is extremely simple, it is generally perfectly satisfactory in strong signal areas. Naturally, in a weak signal area, severe attenuation of the signal would take place, necessitating the installation of a booster amplifier between the antenna and the isolation networks. In most cases, the most satisfactory type of Booster to employ is one of the mast-mount types that mounts directly beneath the antenna array on the mast itself. With this type of booster amplifier, none of the noise picked up by the transmission line is amplified. Only the actual TV signal and the noise picked up by the antenna itself are boosted. If a booster amplifier were employed at the termination of the transmission line, all noise picked up on the transmission line would be amplified, resulting in a less satisfactory signal-to-noise ratio.

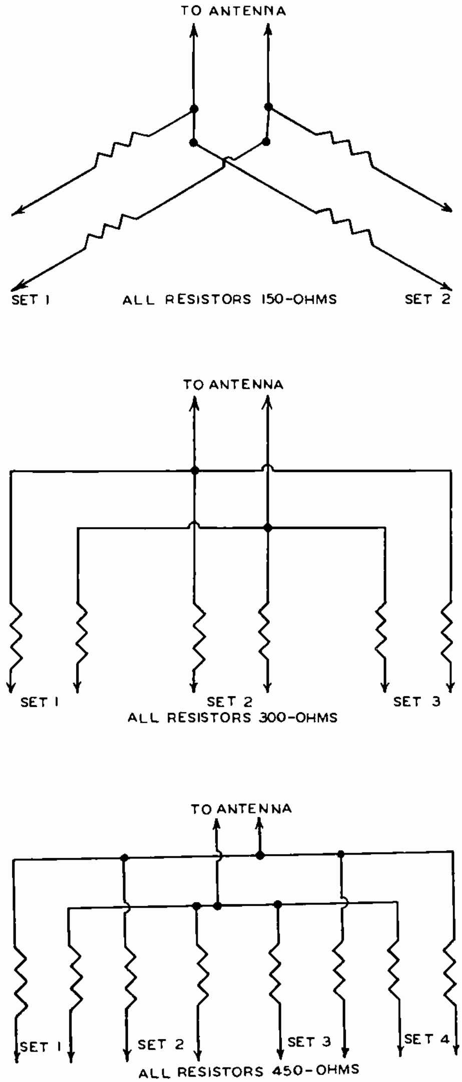


Fig. 1. Three types of simple resistive isolation networks that will provide satisfactory results in strong to average signal strength areas. Even with the resistive isolation provided, a distance of at least twenty feet is usually required between the TV receivers to reduce any inter-action.

A basic layout of a four receiver multiple outlet antenna system is shown in Fig. 2. Notice that a mast mount booster is employed in order to overcome the attenuation factor of the 450-ohm isolation resistors. In a suburban or fringe area, a booster is necessary in order to obtain satisfactory signal strength. Notice also that 450-ohm resistors are employed with a 4-output system. With four receivers connected to the system, the input impedance of the distribution line will be 300-ohms, providing a perfect match to the output of the mast-mount booster. However, with a resistive isolation system, a 300-ohm termination resistor must be connected in place of a receiver whenever the receiver is disconnected from the distribution line. If this is not done, the input impedance will be upset resulting in a mis-match between the booster output and the distribution line.

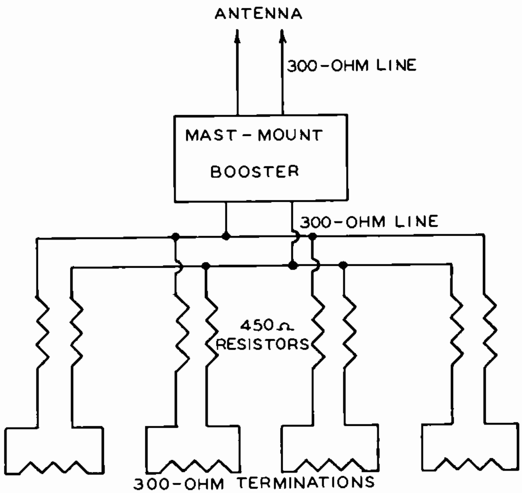


Fig. 2. A four receiver distribution system that uses a mast-mount booster amplifier. An installation of this type would be satisfactory in many suburban areas.

If a mast-mount booster is employed with three resistive isolation pads, 300-ohm resistors would be used. This would maintain the correct input impedance for the distribution system, providing the most efficient transfer of signal energy from the booster output to the distribution line. This same condition holds true if only two outlets are used. In other words, 150 ohm resistors would be employed.

In deep fringe areas, it is often necessary to employ a separate antenna for each channel, providing the most efficient transfer of energy from the antenna to the transmission line. Each antenna will be provided with its own booster amplifier, the output of which is fed into a master mixer. The output of the mixer is then transferred to the distribution line as in the previously described system. This method is by far the most efficient means of providing satisfactory reception in deep fringe areas.

Many times, a single wide-band booster amplifier can be satisfactorily used with a number of different antennas connected to its input. Due to the wide band-pass characteristics of the amplifier, satisfactory results may be obtained on all channels. Of course, since the booster amplifier must operate over a relatively wide range of frequencies, the efficiency will not be as high as that of a system employing separate boost amplifiers for each antenna or channel.

Up to this point, only general descriptions have been given of the various basic types of multiple outlet antenna systems for TV reception. Although these are good general rules to follow, there are many other factors that must be taken into consideration when making a specific installation. Let's create such an installation and see what problems must be overcome in order to provide satisfactory results. Use Fig. 3 as a reference.

The point designated as "R" is the location of the TV receiver. The cross marks indicate the TV transmitting antennas, and the numerals illustrate the channel numbers. Channels 2 and 11, on the inside of circle "A" will be considered as very strong stations. Between the inner circle "A" and the outer circle "B," let's consider this to be a moderate fringe area. As you see, channel 4 appears in this. The remaining channels, 3 and 12, will be considered as deep fringe area signals.

Channels 2 and 3, both in the low band, are almost adjacent to each other in relationship to the TV receiver location. However, channel 2 provides an extremely strong signal while channel 3 is in the deep fringe area. In addition, they are adjacent channels, making the problem of satisfactory reception even more difficult.

Channels 11 and 12 are in opposite directions in relationship to the receiver location, and they

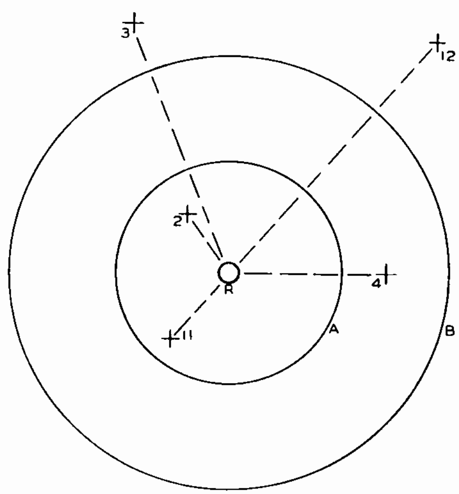


Fig. 3. Polar diagram of a TV receiver installation in which signals from five TV stations will be used. Notice the wide divergance in the station locations in relationship with the receiver location.

are adjacent channels in the TV broadcasting spectrum. Channel 11 provides a very strong signal, while channel 12 is in a deep fringe area.

The remaining station, channel 4 will be considered as a medium strength signal with no other stations in the general vicinity. Since it is located in a completely different direction than channels 2 or 3 in relationship to the reception point, a separate-low-band antenna will be necessary.

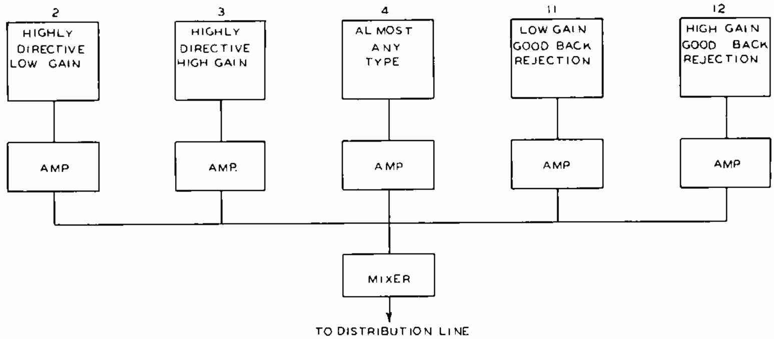


Fig. 4. Block diagram of a typical distribution system designed for a wide variety of TV signals.

The first problem that confronts us is—what type of antennas should be used? As can readily be seen, it is going to be necessary to use more than one type of array in order to provide channel separation and sufficient signal strength in order to receive all signals satisfactorily.

Continuing further, it is obvious that the signal strength of channels 2 and 3 will be quite different. The same condition is true of channels 11 and 12. However, channel 4 should present no great problem.

Since channels 2 and 3 present two major problems, let's take this part first. These two channels are separated geographically by only a few degrees in relationship to the receiving point. Therefore, under normal conditions, the same antenna could be used for both channels. However, in this case, channel 2 is in a primary signal area while channel 3 is in a deep fringe area. In order to maintain complete separation of the two channels while at the same time providing equal signal strength to the receiver, two antennas and one booster amplifier should be employed for the best results.

Channel 2, being the strongest signal, should not require too much gain, although great selectivity is required. Channel 3, on the other hand, will require a much greater amount of gain, in addition to the narrow-band characteristics necessary to separate this channel from channel 2.

A high-gain, highly directive array, fed into a high-gain booster amplifier should be used on channel 3. On the other hand, it is possible that channel 2 would not require a booster if the signal is of sufficient strength.

If interaction between channels 2 and 3 is experienced, even with narrow-beam antennas, it will be necessary to insert either tunable wave traps or shorted stubs in the lines in order to eliminate this interference.

The problems presented by channels 11 and 12 are of a completely different nature. In this case, although they are adjacent frequencies in the TV broadcast spectrum, they are located in opposite directions in relation to the receiving point. Obviously, two antenna arrays will again be required.

The antenna arrays chosen for these channels must have a good front-to-back signal rejection ratio. That is, the signal pickup from the back of the array should be practically zero in order to eliminate the possibility of back pickup from either of the channels. Also, channel 12 will require a high-gain array although it does not necessarily have to be of the narrow beam type. No great problem should be presented providing this procedure is followed in selecting these arrays. Of course, channel 12 will require its own booster amplifier although channel 11 signal may be of sufficient strength to eliminate the necessity of the booster.

Channel 4 represents the average type of installation encountered in suburban areas fairly adjacent to metropolitan areas. A medium-strength signal is available from this channel eliminating the necessity of a particularly high-gain array. Also, since no other channels are received at the reception point from this general direction, wave traps or stubs would normally not be necessary. With the resistive multiple outlets already described, a booster amplifier would probably be necessary.

Let's take this particular problem and draw up a simple block diagram of the entire receiving antenna installation, indicating the general types of antennas, together with their respective boosters. The solution to this problem is illustrated in Fig. 4.

You will notice that channels 2 and 11 in the block diagram have the channel amplifiers installed in the circuit. If a relatively small number of TV receivers is to be used on this installation, for example—less than 6—these amplifiers probably would not be necessary. If more than this amount is contemplated, in all probability the amplifiers would be necessary in order to overcome the insertion loss of the individual isolation resistive pads.

Referring back to Fig. 3, channels 2 and 11 are approximately 90° apart in relationship to the receiving point. Obviously, if these were the only two channels under consideration, narrow beam width antennas would not be necessary. But since channel 2 appears to be in almost the same direction as channel 3, a highly directive array is necessary. Since channel 11 is relatively clear of any other channel, a highly directive array is not necessary. Notice, however, that channel 12 is almost opposite in direction to channel 11. As a result, channel 11 should have an antenna with an excellent back signal rejection ratio in order to eliminate any possibility of back-side interference from channel 12. Similar to channel 2, channel 11 is in a strong signal area, making a high-gain antenna unnecessary. If a larger number of receivers is employed in this installation, a channel amplifier will be used.

Channel 3 is definitely in a fringe signal area, necessitating a high-gain array. Since channel 2 is almost in the same direction in relationship to the receiving point, a narrow-band array is essential. In addition, a channel amplifier is definitely necessary in order to boost the signal strength up to a satisfactory level.

Channel 4 should present no problems whatever. It is located just outside the primary signal area, relatively free of any interference from adjacent channels. In this particular case, almost any type of medium-gain, low-band antenna would be satisfactory. A channel amplifier should be used to prevent any possibility of loss of signal strength, even though only a few TV receivers are being used.

Channel 12, similar to channel 3, is definitely in a deep fringe area, providing a low-level signal at the reception point. The array for this channel must have high-gain combined with good back rejection in order to eliminate possible interference from channel 11. In fact, since channel 11 is in the primary signal area, an antenna with exceptionally good back signal rejection would be essential. As with any fringe-area signal, a channel amplifier must be used.

The combined outputs of all channel amplifiers are then coupled into the mixer which normally provides little or no gain. It is merely employed as a means of correctly matching the impedance of the combined channel amplifier outputs to the impedance of the distribution line.

Each of the channel amplifiers has its own individual gain control. This makes it possible to adjust each channel in order to provide the same signal level into the mixer, making readjustment of the TV receiver unnecessary. If individual gain controls were not provided, a stronger signal would quite possibly saturate or overload the receiver, while the weaker signals would necessitate increasing both the volume and contrast controls on the receiver.

You will notice that no reference has been made regarding interfering objects such as water tanks, large buildings, hills, etc. Instead, idealized line-of-sight reception has been used. Of course, in a practical installation of this type, these conditions are seldom realized. In fact, you will frequently find it necessary to employ a reflected signal rather than a direct line-of-sight signal in order to provide the most satisfactory signal strength. Rather than depend upon a field or signal strength meter as an indicating device in orienting the individual antennas, it is always best to actually have a TV receiver in operation when making the final orientation adjustments on the antenna. This will leave no doubt as to the best position in which the antenna should be placed. Even though a strong signal may be indicated on a field strength meter when the antenna is set in a certain direction, serious ghosts may be encountered in the picture that can only be eliminated by using a weaker reflected signal.

Various types of multiple outlets TV antenna installations have now been covered. However, no consideration as yet has been given to an installation in an area where high electrical interference prevails. This would be particularly true in large apartment buildings, hotels, etc. Since relatively long antenna leads and distribution lines are required, the majority of this interference is absorbed in these lines themselves. Therefore, some provision must be made in order to eliminate this source of interference.

When planning a TV antenna installation in a high-interference area, you must first determine the amount of signal strength available. In other words, you may find it unnecessary to employ a mast-mount booster amplifier if a high-gain antenna assembly is used. However, you must also remember that the attenuation or loss with shielded twin leads or coaxial cables is higher than that of standard open wire or weatherproofed twin lead. If a relatively long length of shielded transmission line is used, you will probably find it necessary to employ booster amplifiers along the transmission line in order to maintain a satisfactory signal level. This can quickly be determined by consulting the manufacturer's specifications for the type cable to be used. This will be given usually in attenuation in DB's per 100 feet. Normally, an attenuation of 3 DB's means that one-half of the signal strength has been lost.

In order to provide the highest possible gain in a system of this type, it is desirable to employ an efficient means of matching each TV receiver to the distribution line, in addition to providing adequate isolation. Normally, at least 20-feet separation is necessary between each individual outlet to avoid reaction between 2 or more receivers. Also, this is necessary to avoid excessive loading of the distribution line, resulting in a serious mismatch of termination impedances between the line and the receiver input.

If the installation requires a maximum of 4 outlets, highly efficient set couplers are available from your TV parts distributor. Units of this type provide adequate isolation with little insertion loss. Of course, as previously stated, if you are

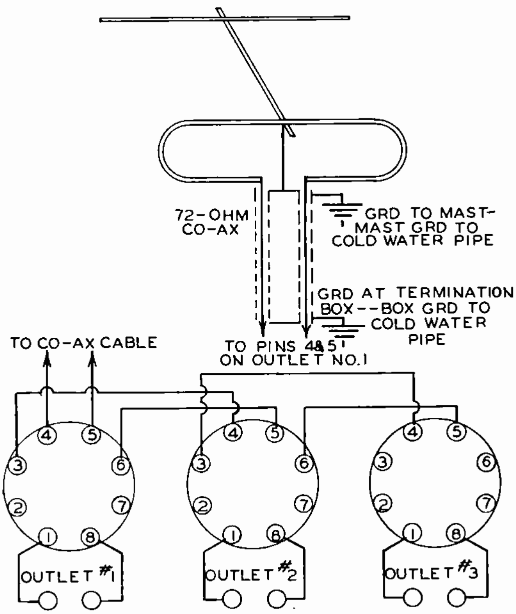
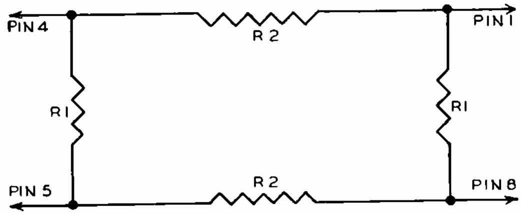


Fig. 5. This is an antenna system that would be satisfactory for many service establishments in strong to average signal strength areas. Co-axial cable must be used when connecting each outlet, grounding both ends of the outer conductors for the cable. This prevents additional noise pickup in the line.

in a primary signal area, resistive isolation paths would probably be satisfactory.

In Fig. 5, you will find illustrated a typical multiple outlet system for the average TV service establishment. By employing a pair of 72-ohm coaxial leads, a termination impedance of approximately 150-ohms is obtained. Since the nominal input impedance of a TV receiver is 300 ohms, two receivers when connected in parallel will give you a satisfactory match between the



ATTENUATOR PADS				
att.	for 150-ohm line		for 300-ohm line	
(db)	R1	R2	R1	R2
3	750-ohms	27-ohms	1.5K-ohms	47-ohms
6	450-ohms	55-ohms	890-ohms	110-ohms
9	350-ohms	80-ohms	600-ohms	220-ohms
12	250-ohms	120-ohms	380-ohms	275-ohms

Fig. 6. Balanced attenuation networks that may be constructed in discarded octal tube bases. The resistance values are approximate as standard, easily available components are used. Each 3db attenuation reduces the singal strength by about one-half.

antenna lead and the receiver. If only one receiver is being used, a 300-ohm, non-inductive resistor must be placed in parallel with the line in order to provide the same impedance match.

Although the nominal center impedance of a folded dipole is 300-ohms, excellent results have been obtained with this system at NRI. Very satisfactory signal strength was obtained on out-of-town channels, even though only a single reflector element is being used. The electrical interference from outside sources is extremely low, due to the complete shielding of the co-axial feed lines.

Notice that octal sockets are employed to provide multiple-outlet connections. These are desirable since the leakage loss is extremely low. In addition, many different types of attenuators can be constructed in discarded octal tube bases without the necessity of disturbing any electrical connections inside the termination box.

With this installation, pins 4 and 5 on outlet number 1 connect directly to the center conductors of the co-axial line. If only one receiver is to be used, a jumper wire should be connected between pins 1 and 4, and pins 8 and 5 in the octal tube base. In addition, a 300-ohm resistor must be connected between the center conductors of the transmission line. You would probably find it easier to connect this resistor between pins 4 and 8 inside the tube base.

If two outlets are to be used, additional jumpers would be required between pins 3 and 4, and 5 and 6 on the plug-in octal assembly in socket 1. Pins 4 and 1, and 5 and 8 on plug-in unit 2 would then have jumper wires inside the tube base.

In many cases, it is desirable to provide some degree of isolation between these outlets. A pair of 75-ohm resistors replacing the jumper wires in the tube bases is usually sufficient. Also, resistive termination attenuators may be employed in order to reduce the signal input in order to duplicate fringe-area reception. A number of these plug-in attenuators should be constructed in order to duplicate different types of signal reception. By referring to figure 6 you will be able to construct these plug-in attenuators.

If two or more outlets are installed, you must of course use the same type coaxial line between the outlets. The outer conductors must be connected together at each end and securely grounded to the termination boxes. If this is not done, it is quite possible that electrical interference will be picked up by the distribution line.

Although it is impossible to accurately illustrate all problems that are encountered when making multiple TV outlet installations, the ones described will normally cover the most common difficulties. Let's sum up the factors that will influence the choice of antennas and outlet systems.

The operating frequency of the station or stations that will be received will have a definite effect on the physical size of the antenna to be used. That is, if all signals are in either the high-band or the low-band, it is possible that a single wide band antenna could be used. Of course, unless an antenna rotator is employed, the signals must all come from the same general direction. To prevent interaction between the receivers, it will probably be necessary to install resistive isolation pads. Although the pads described attenuate the signal somewhat, they do provide adequate isolation.

If the installation is located in a fringe or weak signal area, booster amplifiers will usually be necessary. A mast-mount assembly will provide signal amplification before the signal is fed into the transmission line. As a result, any interference that is picked up by the line will be overridden by the amplified TV signal.

When the stations are not in the same general direction, separate antennas are desirable. A mixer stage is installed in order to provide the proper impedance match between the antenna system and the distribution lines.

In areas where the signals are received from various directions with wide differences in amplitudes, variable gain booster amplifiers should be employed between the antenna and the mixer stage. In addition, different types of antennas would be necessary in order to obtain the best possible results. An example of this type of system was described and illustrated in Figs. 3 and 4.

For more complete details on the equipment required for multiple TV antenna installations, consult your local TV parts distributor. The majority of wholesale TV parts dealers will have this equipment available locally. Boosters, amplifiers, matching networks, etc., are all available, and no difficulty should be encountered in obtaining equipment exactly suited to your installation needs.

n r i

(From page 14)

even some hint about a four-day work week, consideration of leisure time *will* become more important, simply because there will be more of it for us all.

Recent advances in automation and increasing productivity make the dream of more leisure very apt to come true before long. Actually, it won't be dramatic, unheard-of change it may seem now, in a country where the work week has already shrunk almost in half in just one century: in 1850 the average working man put in 70 hours a week, but today the 35-hour week is no longer rare. The 12-hour day of 100 years ago is now almost unknown, replaced by the more usual 8-hour day.

Obviously, these developments mean there already has been an enormous increase in the amount of leisure, or free time, available to Americans—more than to any other people in the history of the world. Even without a 4-day week, our leisure time has increased by leaps and bounds, thanks to labor-saving machinery which has added many hours to our days, and extraordinary advances in medicine and public health which have added many years to our lives.

With all these extra hours in our lifetimes, "What shall we do?" is becoming an increasingly urgent and perplexing problem to millions of Americans. Free time is a great blessing and a rich opportunity for fuller living if we have good health and lots of friends and interests.

What should be a reason for happiness can be, instead, a reason for boredom, wasting of time, or even serious social problems, if people don't know what to do with their leisure. The increase in vandalism and crime among bored, thrill-seeking teenagers in some of our major cities in recent weeks illustrates this danger: if people cannot think of something interesting and worth-

(Page 31, please)

N.R.I. ALUMNI NEWS

Elmer E. Shue .... President
F. Earl Oliver .... Vice Pres.
John Babcock .... Vice Pres.
William Fox .... Vice Pres.
Joseph Stocker .... Vice Pres.
Theodore E. Rose .... Executive Secretary

HOWARD SMITH IS PRESIDENT-ELECT OF NRIAA

William Fox, F. Earl Oliver, and Joseph Stocker Returned to Office As Vice-Presidents; One New Vice-President Elected

Howard Smith

On January 1 Howard Smith of Springfield, Mass., will take office as President of the NRIAA for the ensuing year.

His election was truly a landslide. His opponent, Wilbur Carnes of Columbus, Ohio, being comparatively unknown to NRIAA members, was not in a position to pose any real threat to Smith. Nevertheless Carnes is entitled to take pride in having been chosen to run for the office.

The race for Vice-Presidencies was a different story, the voting being quite close at times. Final results were that three current Vice Presidents, F. Earl Oliver, William Fox, and Joseph Stocker, were returned to office, and one new Vice President, Jules Cohen, was elected.

President-Elect Howard Smith is a widower, was born in Coaticook, Quebec, in 1899, became a citizen of the U. S. and attended grade school and high schools in Worcester, Mass. He completed the NRI course in Radio Servicing in

1933, then the NRI course in Radio Communications in 1939, and attended the Sylvania Factory School in 1953. He was in charge of electric and air brake production (trolley and railroad cars) and plant maintenance at the Wason Manufacturing Company from 1925 to 1931 and was a ham prior to World War I. Beginning full-time Radio Servicing in 1931 and later branching into TV Servicing he now does all kinds of electronic service under the name of Valley Electronics, Springfield, Mass. While getting his start in Radio Servicing he also served as a spare-time motion picture projectionist and still does to a limited extent.

He is a member of the DeSoto Lodge IOOF, having progressed through various offices and is now a Past Grand (Past Presiding Officer): is a member of Massachusetts Grand Lodge IOOF; has been a member of the Society of Motion Picture and Television Engineers (active grade) since 1934. His hobbies are aviation, camping, fishing, and photography. In October, 1953, Mr. Smith, in his own words "got a violent inspiration to form a local chapter" in Springfield. He got busy on the project and the Chapter was chartered on April 4, 1954. The charter members elected him its first Chairman, re-elected him Chairman in 1955, then Vice Chairman in 1956. He is Chairman again this year. Further recognition was accorded him in his being elected a Vice-President of the NRIAA for 1956.

In electing him President of the NRIAA for 1958, the members of the Association have now bestowed upon Mr. Smith the highest honor within their power to grant. Because of his proven qualities of leadership, and his enthusiasm and industry in supporting the aims and welfare of the NRIAA, his election is a well-deserved reward.

Currently President Elmer Shue of Baltimore will terminate his office on December 31. He has served the Association well and will continue his participation in the activities of the Baltimore Chapter.

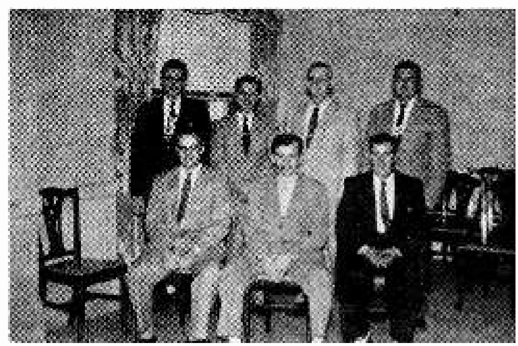
Vice-President F. Earl Oliver of Detroit is setting some kind of a record. He has served more terms as Vice-President than any other member. William Fox of New York City will begin his third term as Vice-President. Is he on the way to a record, too? This is the second Vice-Presidential term for Joseph Stocker of Los Angeles and the first one for Jules Cohen of Philadelphia. Welcome to the ranks of the Veeps, Jules!

Our warmest congratulations to these successful candidates for office in the NRIAA for 1958.

Chapter Chatter

NRIAA Welcomes Two New Local Chapters

Last Spring NRIAA Member Walter Adamiec, Middleboro, Mass., wrote National Headquarters proposing the establishment of a new local Chapter in the Taunton-Fall River-New Bedford area of Massachusetts. National Headquarters appointed Mr. Adamiec Temporary Chairman of the proposed chapter to be known as the **Southeastern Massachusetts Chapter.** With the help of other interested members, Mr. Adamiec secured the necessary number of signatures to an application for Charter and forwarded the application to National Headquarters.



Officers elected at organizational meeting of Southeastern Massachusetts Chapter. Left to right, seated: Bill Pritchard, Treasurer; Walter Adamiec, Chairman; John Walsh, Secretary. Standing: Ernest McKay and Stanley Tobal, Financial Committeemen; Ted Rose, Executive Secretary of NRIAA; Michael Lesiak, Vice-Chairman.

The organizational meeting, which was attended by NRIAA Executive Secretary Ted Rose, was held at the New Bedford Hotel, New Bedford, Mass. The evening began auspiciously with a buffet supper. Following the buffet supper, the first item of business was the election of officers, as follows: Walter Adamiec, Chairman; Michael Lesiak, Vice-Chairman; John Walsh, Secretary; Bill Pritchard, Treasurer; Stanley Tobal and Ernest McKay, Financial Committeemen.

Ted Rose administered the oath of office and installed the permanent officers. He then delivered a short address in which he expressed the appreciation of the members and of the NRIAA to Chairman Adamiec for his successful efforts in forming the new Chapter, explained what other chapters are doing and made suggestions for the activities the chapter might undertake to promote the interest and welfare of its members.

Discussion of dues and scheduling meetings was then taken up. It was decided that members would pay dues of fifty cents per-meeting until a fund is accumulated in the Chapter's treasury. The members voted in favor of holding meetings at 7:30 P.M. on the first Monday of each month at the New Bedford Hotel and on the third Monday of each month alternately at Taunton or Fall River.

Here is an opportunity for NRI men in the Southeastern area of Massachusetts to avail themselves of the many benefits of membership in a local chapter. Graduates are eligible for regular membership; students may join as associate members. All those interested in joining the Chapter or in attending a meeting as a guest should contact Chairman Walter Adamiec, 109 Taunton Street, Middleboro, Mass., or Secretary John Walsh, 26 White Street, Taunton, Mass.

n r i

One of the features of NRI's Open House celebration on June 28 was the presence of the four National Vice-Presidents of the NRIAA, including Joseph Stocker of Los Angeles. While here Mr. Stocker met and talked with his fellow Vice-Presidents and other members of the NRIAA who attended the celebration. He became interested in the possibility of forming a Chapter in Los Angeles and wrote National Headquarters about it when he got back home. National Headquarters thereupon appointed Mr. Stocker to act as Temporary Chairman for the formation of the proposed chapter.

Mr. Stocker had his work cut out for him, for Los Angeles covers a very large area and NRIAA Members in the area live at considerable distances from each other. But due to Mr. Stocker's persistence and the enthusiasm of those who helped him, he secured the required number of Charter Members to establish the new Chapter.

Executive Secretary Ted Rose flew to Los Angeles to attend the organizational meeting, which was held at St. Joseph's Catholic School Hall, 1220 S. Los Angeles Street, Los Angeles. As with all organizational meetings, the first item of business was the election of permanent officers. In appreciation of his efforts, the members elected Mr. Stocker as Chairman. The other officers elected were: Jim Rothberg, Vice-Chairman; Thomas McMullen, Secretary; Clarence Adams, Treasurer; and Maurice Larner and Earl Stewart, Financial Committeemen.

Following the election, Ted Rose administered the oath of office to the officers, presented the new Chapter's Charter, and made suggestions for programs to be followed at the meetings and for promoting the growth of the Chapter. The members then devoted considerable discussion to dues and the scheduling of meetings. It was finally decided that for the present each member would pay an initiation fee of $2 and dues of fifty cents per meeting; that regular meetings would be held on the second Friday of each month at St. Joseph's Catholic School Hall. An additional meeting may be held during the month at a time and place to be decided upon.

NRI students and graduates in the Los Angeles area should welcome this opportunity to join and participate in the activities of a local NRIAA Chapter. Those interested should contact Chairman Joseph Stocker, 208 E. Pico Blvd., Los Angeles.

n r i

Baltimore Chapter's Chairman Joe Dolivka reports that a recent meeting fell into the should-have-stayed-home category because of the following series of events:

First, Elmer Shue had trouble with his car on his way to the meeting. He finally did make the meeting but only at the sacrifice of missing his dinner. Naturally, he wasn't too happy.

Enter Charles Schneider, a new member, with a radio receiver in his hand. Half-way across the room he stumbled and fell. The receiver hit the floor with a loud thud. Charlie picked himself up and brought the receiver over to Elmer. Thinking he could determine the defect before meeting time, Elmer plugged the set in and turned it on. Result: blown fuse, darkness.

Members were posted at the entrance of the building to receive late comers, who ordinarily seeing the third floor dark would have assumed the meeting had been cancelled. In due time, the lights came on again. Frank Bradley, who brought his camera along to take pictures, had his flash bulbs on the desk. Without warning, one of the bulbs rolled off the desk and hit the floor with the effect of a pistol shot. Treasurer John Harp, who was in the act of filling his fountain pen and was holding an ink bottle in his left hand, was startled. Result: ink all over the Due's Book and cards. The Baltimore Chapter can now offer its members something unique in 1958: speckled membership cards.

The windows were open, for it was a warm night. Chairman Dolivka had his notes and correspondence on a chair near a window. Somebody turned on the big fan. Result: papers sailed through the window and down into the street.

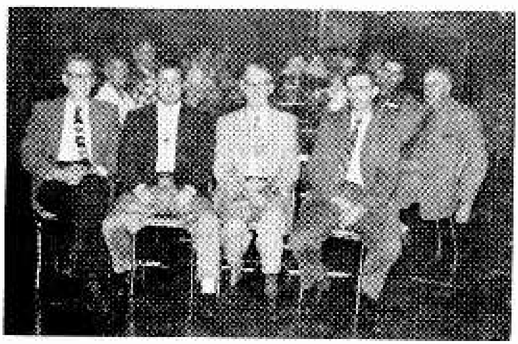
By this time tempers were wearing a bit thin.

Somebody suggested "let's start all over to change our luck." So all members went down the stairs, out of the building, and walked around the block. During the walk Chairman Dolivka was able to retrieve his papers. To the wide-eyed amazement of the custodian of the building, members re-entered the building, went back up the stairs and into the meeting room. The meeting then proceeded smoothly and all breathed a sigh of relief!

NRI men in the Baltimore area interested in joining the Chapter or attending a meeting, please take notice: the above is not the account of a *typical* meeting of the Baltimore Chapter. While members do have fun at and enjoy the meetings, they also acquire valuable practical knowledge of radio and TV without such complications as indicated above.

Meetings are held at 8 P.M. on the second Tuesday of each month at 100 N. Paca St., Baltimore. For further information, write or telephone Chairman Joseph Dolivka, 717 N. Montford Ave., or Secretary John Woolschleger, 1106 S. Lakewood Ave., Baltimore.

Hagerstown (Cumberland Valley) Chapter held its customary fall banquet at the Veterans of Foreign Wars Home in Hagerstown on Septem-



After the dishes were cleared away at the Hagerstown (Cumberland Valley) Chapter's fall banquet. Front row, left to right: Ted Rose, guest from National Headquarters; John Pearl, Chairman; Ed Kemp, Secretary; Jack Thompson, assistant to Ted Rose.

ber 12. NRI Executive Secretary Ted Rose was guest at the banquet. Everyone present thoroughly enjoyed the dinner and the talks and discussions that followed.

At the next meeting the entire evening was devoted to devising a new program to be followed at subsequent meetings this season. This resulted in a new starting time of 7 P.M. Will all members of the Chapter please be sure to note this change?

All NRI students and graduates in the Cumberland Valley are cordially invited to attend the meetings of the chapter as guests. Those interested should contact Secretary Edwin Kemp, 618 Sunset Avenue, Hagerstown.

Philadelphia-Camden Chapter has welcomed another new member to its ranks. He is Robert H. Hansteen, NRI student from Philadelphia. Congratulations, Mr. Hansteen. You are going to get a lot out of your membership in the Chapter.

Mr. Evan Wells and Mr. Vincent Folley of the International Resistance Company attended an October meeting and gave a very interesting talk on controls, resistors, and other affiliated products made by IRC.

Secretary Jules Cohen says that everything is set for the Chapter's banquet in December for members and their wives. There will be live music and entertainment by a very talented group of people. The Chapter is anticipating a large turn-out and a very enjoyable evening. For more information about the banquet contact Secretary Jules Cohen.

The Chapter regularly meets on the second and fourth Monday of each month at the Knights of Columbus Hall, Tulip and Tyson, Sts., Philadelphia. The Chapter extends a cordial invitation to all NRI students and graduates to come to one of its meetings as a guest. Those interested should write or telephone Secretary Jules Cohen, 7124 Souder St., Phidalelphia.

Pittsburgh Chapter was pleased to welcome as a guest speaker Mr. Clement McKelvey, Instructor at Allegheny Tech TV and Honorary Member of the Chapter. With the assistance of film slides, Mr. McKelvey gave a complete explanation of the theory and operation of the horizontal sync circuits in various TV receivers.

At this same meeting, Chapter Member Tom Schnader gave a talk on general service problems.

The Chapter is planning a party for its December meeting.

Regular meetings are held at 8 P.M. on the first Thursday of each month at 134 Market St., Pittsburgh. NRI students and graduates in the area are cordially welcome to attend as guests or potential members. Get in touch with Chairman Frank Skolnik, 932 Spring Garden Ave., or Secretary William Roberts, 2521 Wenzell Ave., Pittsburgh.

Detroit Chapter held its annual Stag Party on October 11. As in past years the party was given at the Chry-Moto Club in Windsor, Ontario.

The party this year was very well attended.

There were eight visitors. Seven had been expected but the eighth was very much of a surprise to all except two or three members. The surprise visitor was Ted Rose, Executive Secretary of the NRI Alumni Association, who visited the Chapter on this occasion.

There was the usual fish and shrimp dinner plus cold cuts of meat, baked beans, celery, olives, cheeses of various kinds, a variety of accessories, and coffee, beer and soft drinks. Clarence McMaster of Windsor again this year did his customary excellent job of providing the refreshments. Almost every one at the party remarked about how good the refreshments were and how much fun the occasion was.

Secretary Jim Kelley reports that he believes most of the seven visitors expect to join the Chapter in the near future directly as a result of the party and what they find they can learn at the meetings.

Other NRI students and graduates in the Detroit area interested in taking advantage of the same opportunity or in attending a meeting as a guest should write or telephone Chairman John Nagy, 1406 Euclid, Lincoln Park, or Secretary James Kelley, 1140 Livernois Ave.. Detroit. Meetings are held on the second and fourth Friday of each month, 8 P.M., at St. Andrews Hall, 431 E. Congress St., Detroit.

New York City Chapter held a social instead of its regular meeting on October 17, at 12 St. Mark's Place. A cold supper was served including a variety of cold cuts, cheeses, celery, olives, beer and soft drinks. The real feature was a delicious potato salad prepared by Chairman McAdams' wife. The only problem was that there was far too much food, but nevertheless everyone fell to with a will and made quite a dent in available supplies.

Talks before, during, and after the supper—some informative, some instructive, and some humorous—were delivered by Chairman McAdams, Tom Hull, Phil Stampinato, Dave Spitzer, Frank Catalano, Jim Eaddy, Mark Antony, Willie Fox, guest John Maxwell, and Ted Rose, who chose this happy occasion for his annual visit to the Chapter. Particularly amusing was Willie Fox's hilarious account of an incident that took place in his hotel room when he was in Washington to attend NRI's Open House last summer.

At the meeting preceding this social, Jim Eaddy delivered a run-down on transistor radios and what makes them tick. Jim is also planning to construct and bring in for demonstration, practical transistor circuity test equipment. Tom Hull, continuing his TV series, started his discussion of the vertical output section of a television receiver, comparing it to the output stage of a simple radio.

Those attending the meetings are assured not only of learning a great deal about practical radio and television but also of having a good time and enjoying the fellowship of other members. Any NRI student or graduate in the New York City area is welcome to attend a meeting as a guest. The Chapter meets on the first and third Thursday of each month at St. Mark's Community Center, 12 St. Mark's Place. The Chairman is Edward McAdams, 135 West 90th St., New York 24. The Secretary is Emil Paul, 6 Gateway, Bethpage, L. I., N. Y.

Springfield Chapter members, at a dinner held on October 18 at Blake's Restaurant, Springfield, were hosts to Guests Col. John J. Sullivan, Commandant of the U. S. Army Reserve Training Center, Springfield; Robert K. Lyman, Manager, Soundco Electronic Supply Company, Springfield; and Ted Rose, Executive Secretary of the NRIAA, Washington, D. C. At the conclusion of the excellent dinner the regular meeting was held in an adjacent room instead of at the Chapter's usual meeting place.

Head table at Springfield Chapter's October 18th banquet. Facing camera, left to right: Robert Lyman, guest; Howard Smith, Chairman; Col. Sullivan, guest; Ted Rose, Executive Secretary of NRIAA.

Chairman Howard Smith introduced Col. Sullivan to the membership and, in doing so, expressed the Chapter's appreciation for the Colonel's having made it possible for the Chapter to hold its meetings at the U. S. Army Reserve Headquarters. Ted Rose then addressed the members and on behalf of the Chapter presented a Certificate of Honorary Membership to Mr. Lyman in recognition of his contributions to the activities and welfare of the Springfield Chapter.

Lyman Brown, the Chapter Technical Advisor, took the floor to explain the function and hoped-for demonstrations available with the chapter's nearly-completed TV Test Panel, after which he conducted his customary question-and-answer session. This was followed by a collation of ice cream, cake and coffee. Upon adjournment of the meeting, Chairman Howard Smith, Lyman Brown and his son Donald, and Ted Rose, repaired to Chairman Smith's home to view films taken at NRI's Open House celebration and at other points in Washington, D. C. and vicinity.

The meetings of the Springfield Chapter are regularly held at the U. S. Army Headquarters Building, 50 East St., Springfield, on the first and third Friday of each month, at 7 P.M. All NRI students and graduates are cordially invited to attend the meetings as guests. Contact Chairman Howard Smith, 53 Bangor St., Springfield, or Secretary Marcellus Reed, 41 Westland St., Hartford, Conn.

Milwaukee Chapter is continuing its chalk talks of prearranged subjects on TV analysis. Under the plan, the member chosen to deliver a talk at a meeting prepares his circuit analysis by stages before the meeting begins.

Mr. Werner delivered a talk on the video IF and video detector output. After the lecture Chairman Kapheim invited the members present to discuss their various TV and radio problems.

At a subsequent meeting James Lasky devoted a talk to color TV, the color tube and how to adjust it. Members were particularly impressed by and appreciative of this address by Mr. Lasky.

The blackboard TV circuit analysis talks are now dominating the meetings—and well they might, for they are important and members can learn a great deal from them. More members are beginning to take part in the talks, too. There are now three regular speakers: James Lasky, Hank Werner, and Slavko Petrich.

NRI students and graduates can also pick up valuable information and knowledge from these talks by attending a meeting of the chapter as a guest. Those interested should get in touch with Chairman Erwin Kapheim, 3525 N. 4th St., or Secretary Robert Krauss, 2467 N. 29th St., Milwaukee. The chapter meets on the third Monday of each month at the Radio-TV Store and Shop of S. J. Petrich, 5901 W. Vliet St., Milwaukee.

Minneapolis-St. Paul (Twin City) Chapters Paul Donatell has had to give up his post as Secretary. He no longer has the time for it due to having started school this fall. His duties have been taken over by a new Secretary, Elmer Buck. Congratulations, Elmer, and the best of luck to you in your post as Secretary.

At one meeting this fall the members were addressed by Mr. Warren Schulze, factory representative, on new equipment. At a subsequent meeting, Chairman John Babcock delivered a talk and held a discussion on transistor theory, during which the NRI manual on how transistors work was used. At this meeting it was also decided to set up some actual test circuits of transistors so as to actually check their action and characteristics.

The Chapter extends a cordial invitation to NRI students and graduates in the area to attend its meetings as guests or potential members. The meetings are held at 8 P.M. on the second Thursday of each month. For more information about the meetings, write or telephone Chairman John Babcock, 3157 32d Avenue, S. Minneapolis, or Secretary Elmer Buck, 1539 Maywood St., St. Paul.

Flint (Saginaw Valley) Chapter after having suspended meetings during the summer months, has now resumed its regular meetings on the second Saturday of each month at 2538 Wolcott St., Flint.

The Chapter plans to promote a real constructive and educational program for its members, in order to maintain a substantial numerical attendance at its meetings and to educate those really interested in the rapid advancements of radio and television.

The Chapter welcomes all NRI men in the area to attend its meetings. For more information write or telephone Chairman Warren Williamson, 1201 Allen St., Flint, or Secretary David J. Nagel, 3135 E. Mt. Morris Rd., Mt. Morris, Mich.

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TV Servicemen Wanted

Mr. R. L. Simpson, owner of Franklin TV, 2713 12th Street, N.E., Washington, D. C., is in need of several TV servicemen for outside and inside work. Interested students or graduates may contact Mr. Simpson at the above address. Attractive salary.

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EFFECTIVE WAY TO SELL COLOR-TV sets being employed by dealers in numbers of the smaller towns and cities consists of inviting prospects to the merchant's home for demonstrations. In a relaxed atmosphere, the prospective customer can view the shows in color and partake of refreshments provided by the retailer. The same technique is being employed by some dealers in selling Hi-Fi, too.

INDEX

(*From page 24*)

while to do in their spare time, they are all too apt to find something dangerous and destructive to do. This is why more and more public health officials, doctors, educators, psychologists, recreation leaders, government officials and other people concerned with our country's welfare are taking the subject of leisure time so seriously these days.

The Equitable Life Assurance Society is offering a new publication on this increasingly important topic, a booklet called "Leisure Time." The booklet takes up many of the problems that people have about leisure, and offers useful suggestions on how to spend it. For additional information write: Bureau of Public Health, Medical Department, Equitable Life Assurance Society, 393 7th Avenue, New York 1, N. Y.

The approach of the booklet is practical and personal, rather than general and theoretical, and it contains helpful and interesting check-lists and specific recreation ideas. Designed to appeal to people of all age groups and economic levels, it will perhaps be of the greatest help to two groups: people who are so busy with families and jobs that they find it hard to believe anyone can actually have enough or more than enough leisure, and older people who are approaching retirement years and who are eager for ideas on how to spend those years fruitfully and interestingly.

The booklet's detailed information on hobbies and community volunteer work will be particularly useful to older people with time on their hands, and the material on how to budget your time efficiently, to make room for the things you really want to do, will be particularly helpful to busy young people.

Here and There Among Alumni Members

Graduate Richard Radovich writes he is now employed as a Communications Technician with the Seattle, Washington, City Light Co. Also reports a very profitable part-time Radio-TV business. He is giving some thought toward opening his own full-time shop.

Now with a research and development laboratory in North Hollywood, California, Jack R. Kelly tells us his NRI experimental kits gave him the practical experience he needed to apply for, and obtain this position.

The IBM Public Relations Department writes Graduate Ray M. McCauley has recently completed a six month Air Defense Training Course with their Military Products Division. The course prepares him for installation work, testing, and maintenance of IBM computers for twenty-four hour a day operation. Graduate McCauley has been assigned to the Air Defense Installation at Fort Custer, Michigan where he will reside with his wife and child. We wish Ray every success in his career with IBM.

Graduate Chester B. Janutolo, Bethel, Connecticut, owns and operates a custom disc recording studio known as Jan-Trics Recordings. Chester and a neighbor hit on the idea of cutting a disc with the "beep" signals from Sputnik I. They report sales of this new record doing even better than anticipated thanks to ads and short articles that have appeared in local newspapers. We add our congratulations too, for coming up with a quick and clever idea. Hope the "beeps" keep moving, Chet.

Our thanks to Graduate Jasper L. Spain, Atlanta, Georgia, for taking the time to write and bring us up-to-date on his activities. Actually, we wonder where he found the time! In addition to his full-time work as a high school science teacher, he is also working toward his Master's degree at the University of Georgia, is an active "ham," and holds the rank of Major in Air Force Reserve as Electronics Officer. When he completes his studies, he plans to re-enroll with NRI for the advanced TV course. A fellow with such ambition must go a long way. You may be sure we look forward to having you back as an active student, Jasper.

Another Grad furthering his studies in Radio Engineering, Dallas C. Meurer of Cincinnati, Ohio, holds a full-time job as technician in engineering with the Avco Manufacturing Co.

Arden Ramsey now has his first class license and is transmitting engineer at KBMB, Bismarck, North Dakota. Has just enrolled for his second NRI course.

Graduate W. R. Elliott, Baton Rouge, La., writes he is in his thirty-fifth year with Esso Standard Oil Co. He handles the electronic repair and maintenance in their Research Lab., and finds his spare time service shop gives him lots of pleasure as well as profit.

A Graduate of two NRI courses and Alumni member for nine years, George Egoroff, Prince Albert, Canada, fills us in on his work as an Electrical Instructor at a correctional institution. His instruction covers a wide variety of electrical subjects including Radio theory and transmitting.

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Mr Francis H Fingado 25236-G 4A
1653 California St
Denver 2 Colo