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news



THE CONAR DIVISION OF NRI OFFERS, FOR THE FIRST TIME, A TUBE TESTER IN KIT FORM. READ THE DISCUSSION OF THE CONAR MODEL 220 TUBE TESTER KIT ON PAGE ONE.

ALSO IN THIS ISSUE

**PRINCIPLES OF VACUUM TUBE AMPLIFIERS
TRANSFORMERLESS POWER SUPPLIES**

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Editorial: THE WHEEL TAPPER

One of the largest steel mills in the country was visited by a news reporter to observe the production techniques employed by such a vast operation. His personal guide was a vice president of the company. The reporter seemed most impressed by the large number of employees performing so many duties. He was introduced to many executives, engineers, metallurgists, chemists and factory workers.

After lunch with some of the top brass, his host again guided him through even more interesting sections of the plant to see more of the multi-million dollar steel empire at work.

Finally - the tour was nearing its end and the two men came outside to a huge area where various steel products were temporarily stored. What appeared to be several areas of railroad wheel assemblies caught the attention of the reporter. After moving closer for a better look, the reporter noticed a little old man carrying a small hammer. He would move along a row of wheels, pausing long enough to tap each wheel at several places over its surface.

The reporter observed this peculiar behavior for several minutes. Finally - he could no longer restrain his curiosity. Walking over to the man he inquired, "Do you work here?" The little old man - startled by such a question, snapped "Whaddaya think I'm doin' - just having fun?" "Do they pay you to just bang on these wheels?" asked the reporter. "They sure do" came the reply. "I'm one of the highest paid employees at this plant, but they pay me for what I know - not for hitting these wheels." He then continued, "I can detect even the slightest flaw in the wheel by the sounds my hammer makes when I strike the surface. It's my professional know-how - not my labor - that pays off."

There is a lot of truth to this story. Service technicians can profit by avoiding the use of the word "labor" when submitting charges to a customer. It is far more effective to use "For Professional Services" or simply "Service Rendered." You are charging for "know-how" - not "labor."

J. M. Smith
President

Introducing The New CONAR Tube Tester Kit

By
Art Widmann
Technical Editor



Art Widmann

A completely new tube tester in kit form is now being offered by the Conar Division of National Radio Institute. This is another user-tested instrument that is designed to give the service technician a lot for his money.

Some technicians hesitate to build test equipment for fear the calibration procedure will be difficult and tedious. This is never the case because the calibration procedure in a well-designed kit is always kept simple. However, here is one instrument in kit form that requires absolutely no calibration! You simply perform the assembly and start testing tubes. The calibration has been taken care of in the tube chart data.

An attractive price is made possible in two ways. First, by building the kit yourself you save the assembly cost. And second, the instrument has been shaved of all frills. Only those essential features that make a tube tester useful to the busy service technician have been retained. Yet, the instrument is attractive and is one that you can be proud to take into a customer's home or display on your workbench. Besides, it is small and light enough so you won't mind carrying it on service calls. At the same time, it has all the new and old-type standard sockets including the 7, 9, and 10-pin miniature, nuvistor, and compactron. The lever switch system of selecting individual elements of the tube under test provides testing flexibility and prevents obsolescence due to different new tube basing terminations. But the feature that really makes this tube tester a pleasure to use is the ease of operation. It takes less time to master the use of the tester than it takes to read the operating instructions.

OPERATING INSTRUCTIONS

You can follow the steps for setting up and operating the Model 220 Tube Tester by observing the view of the front panel in Fig. 1. Notice the convenient grouping of the few

simple controls that make this tester so easy to operate. Here are the steps starting from scratch:

Connect the power cord to 100-125, 50-60 cycle source.

Move the roll chart to the listing of the tube you want to test.

Set controls A, B, and D to the positions indicated on the chart.

Throw the lever switch indicated under the "C" heading on the chart to the "C" row.

Insert the tube to be tested into the proper socket.

Turn the ADJUST LINE control until the meter pointer is over the ADJUST LINE marking on the meter.

Move the lever switch that you previously set to "C" to the TEST position. If the neon lamp (marked short, filament, continuity, and leakage) fails to light, you can reject the tube without further tests because it has an open filament. If the neon lamp lights, return the lever switch to row "C" and continue the tests.

Throw all lever switches listed under cathode shorts to the TEST row. The lamp should not glow. If a glow is obtained, reject the tube because it has a cathode short. Lightly tap the tube during short tests to expose any intermittent shorts. Return these switches to NORMAL.

Throw the lever switches indicated under the TEST heading to the TEST row. The neon lamp should not glow. If the neon lamp glows, reject the tube because an element is shorted.

When all indicated levers are in the TEST position, press the READ METER button and

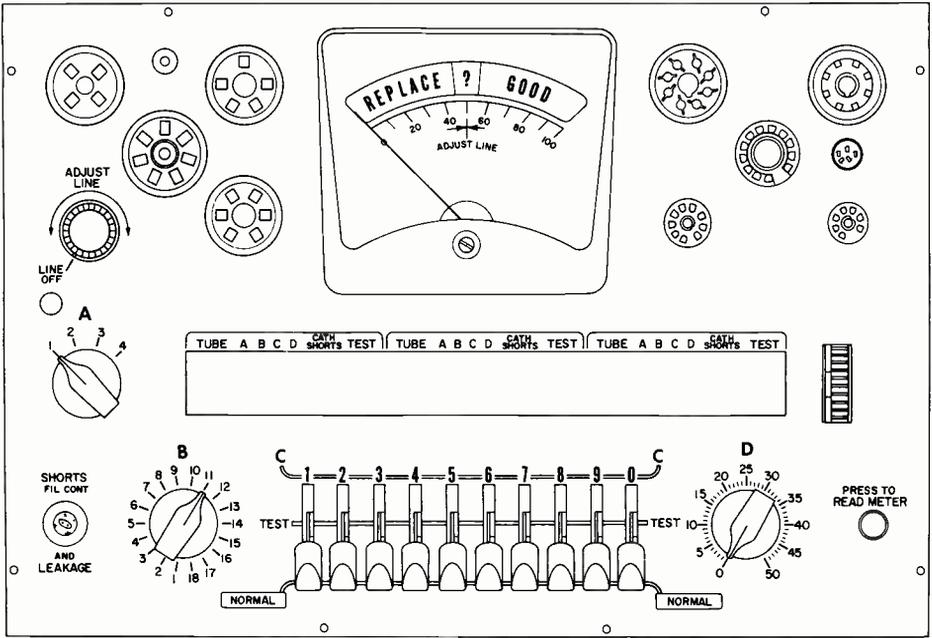


FIG. 1. Front panel view of the Conar Model 220 Tube Tester.

observe the test of the tube quality on the meter. Perform any special tests as indicated on the roll chart for such tubes as electron-

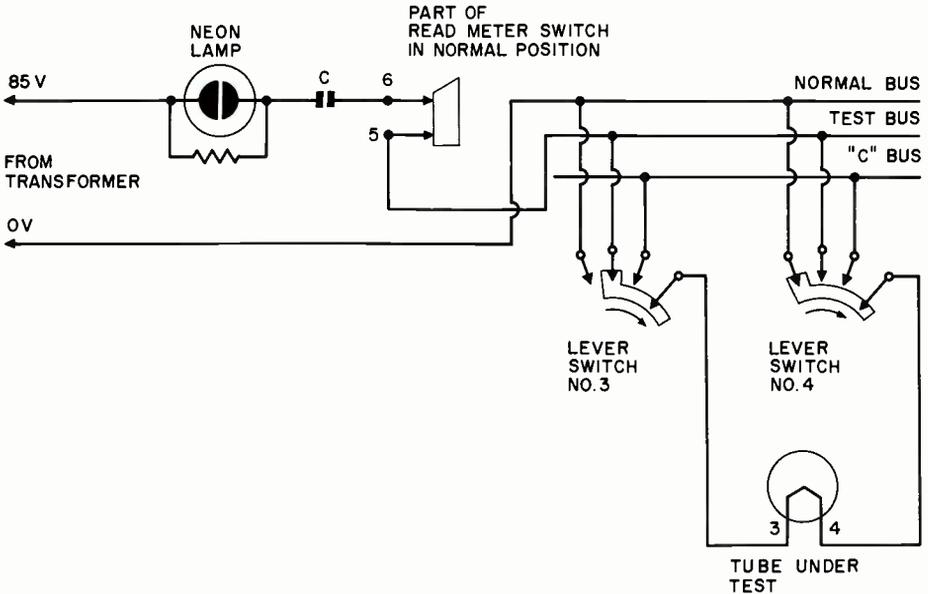


FIG. 2. Partial schematic showing the circuit for testing filament continuity.

ray type indicator tubes and gas-type rectifiers. A few special tubes require extra tests or modified test procedures. These tubes are seldom-used types that require special tests due to their internal construction or unusual characteristics.

The above test procedure sounds long and drawn out compared to actually doing the steps. Some of the steps need only be done when you first set up to use the tester. Other steps become second nature after you have checked a few tubes.

TYPES OF TESTS

The tests performed by the Model 220 Tube Tester are designed to determine rapidly whether a tube is good or bad. The test sequence is set up so you can quickly reject tubes that have such obvious defects as open filaments or shorts. If the tube passes these tests, you can proceed with more detailed tests that will uncover defects such as low emission or open elements. This results in a considerable saving of time. For example, there is not much point in standing around waiting for a tube to warm up if it has an open filament! The Model 220 tells you immediately if the filament has continuity.

The filament continuity test consists of putting the tube filament in series with the neon bulb and applying an ac voltage across the combination. If the neon bulb glows, the filament has continuity. Fig. 2 shows a partial schematic with the switches shown in the position for testing filament continuity. Let's trace out the circuit. From the 85-volt tap on the transformer we go through the neon lamp and capacitor C to terminal 6 on the READ METER switch. With this switch in the normal (not pressed) position, terminal 6 makes contact with terminal 5 which connects to the TEST bus of the lever switches. Notice that lever switch No. 3 is in the TEST position. Lever switch No. 3 is the switch that was in the "C" position for the test setup. You flick this switch from the "C" position to the TEST position, as shown, to test for filament continuity. This connects the TEST bus through lever switch No. 3 to one side of the filament, in this case pin 3 of the tube under test. From pin 3 we go through the filament of the tube to pin 4 of the tube under test. Pin 4 connects to the NORMAL bus through lever switch No. 4 which is in the NORMAL position. The NORMAL bus is connected to the zero terminal on the transformer. Thus, with a good filament we have a slight current flow through the entire circuit, and the bulb glows indicating continuity through the filament of the tube under test.

Shorts or leakage tests are performed by a

circuit that is similar to the filament continuity test circuit. However, when the neon lamp glows during short tests it indicates a short and the tube should be rejected. Fig. 3 shows a sample test circuit for detecting shorts or leakage between the cathode and filament of a tube. The circuit is from the 85-volt tap on the transformer, through the neon lamp and capacitor C to terminal 6 on the READ METER switch. With the switch not pressed as shown, the circuit is completed to terminal 5 and the TEST bus of the lever switches. In the example shown, lever switch No. 7 is thrown to the TEST position connecting the TEST bus to the cathode, pin 7, of the tube under test. If the tube has a short or leakage between the cathode and the filament, the short connects the cathode to the filament. Since one side of the filament is connected to the NORMAL bus through lever switch No. 4, the short in the tube completes the circuit placing 85 volts (or a portion of it) across the neon lamp causing the lamp to glow. In this test, the filament is energized so that shorts or leakage that exist only when the tube is hot will show up.

The short test circuit can be switched so that any element in the tube can be checked for a short to any other element. However in the normal test procedure, after you test for cathode shorts, you throw the cathode switch back to NORMAL. Then the other elements are checked for shorts to the cathode or to each other. In this way any short in the tube will be exposed.

The quality of the tube is checked by a meter indication of the cathode emission of the tube. The tube under test is connected as a diode and an ac voltage is applied through a resistor network to the tube. The voltage may be 32, 50 or 250 volts ac depending upon the type of tube being tested. The ac voltage applied to the tube produces a tube current that is indicated on the meter when the READ METER switch is pressed.

Fig. 4 shows the circuit setup for measuring the quality of a 6C4 tube. Only those switches used for the emission test are shown. Also, the switch connections to the filament circuit have been left out for simplicity. The standard basing diagram of the 6C4 is shown so you can tell at a glance what tube elements are connected to the various switches. Notice that pins 1 and 5 are common to the plate of the 6C4. Pin 1 is connected through lever switch No. 1 to the TEST bus and pin 5 is connected through lever switch No. 5 to the TEST bus. The grid of the 6C4, pin 6, is also connected to the TEST bus, in this case through lever switch No. 6. The cathode, pin 7, is connected through lever switch No. 7 to the NORMAL bus. Thus the tube is connected as a diode

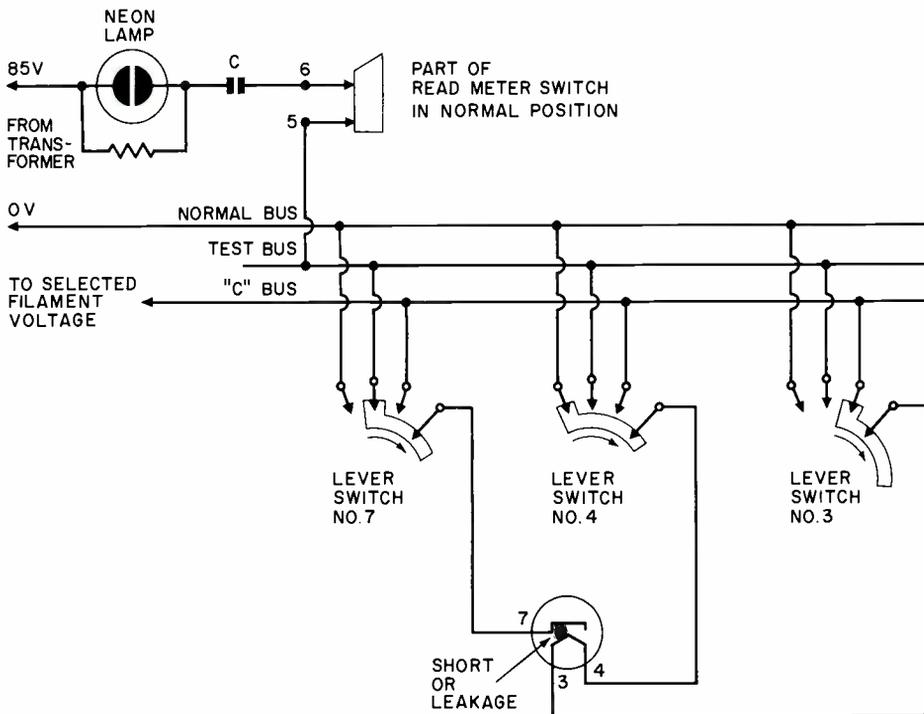


FIG. 3. Partial schematic showing test circuit for cathode-to-filament shorts.

between the TEST bus and the NORMAL bus.

In this test, the ac voltage is applied to the TEST bus through the READ METER switch (in the pressed position) and a resistor network. As shown in Fig. 4, the 32-volt tap on the transformer is connected through R1 and switch A to the resistor network made up of R2, R3, and R4. Resistor R4 is potentiometer control D on the tester. The setting of this control depends on the tube type being tested.

A simplified schematic of the circuit in Fig. 4 is shown in Fig. 5. Corresponding resistors are numbered the same so you can compare the two circuits. As you can see in Fig. 5, the tube current divides at the slider of potentiometer R4. Part of the tube current goes through R3, part through R2, and part through the meter. By moving the slider of R4 to the left, more of the current goes through R3 and less current goes through the meter. Moving the slider of R4 to the right results in more current through the meter. In this way the setting of R4 is selected to give the correct reading on the meter for a good tube of the particular tube type under test. For testing tube types that have very low current, resistor R2 is switched out of the circuit thereby providing more current for the meter.

You can read the tube qualities in two ways on the meter. The three section scale marked REPLACE-?-GOOD gives a quick indication of the tube quality. The 0-100 scale can be used for a more accurate comparison of tubes. A new tube should give an indication of approximately 70 on the 0-100 scale.

After a tube has been tested for emission, you can test for open elements. For example in Fig. 4, to test for an open grid you observe the meter while you flick lever switch No. 6 from the TEST position to the NORMAL position. The meter reading will decrease indicating that the grid is no longer contributing its current to the meter reading. If the meter reading does not change at all, it indicates that the grid is open internally and the tube should be rejected.

LINE ADJUST CIRCUIT

The line adjust function is combined with the line OFF function in one convenient control. The control is rotated clockwise from the "OFF" position to energize the instrument. Then you observe the meter while rotating the control until the meter pointer is over the adjust line in the center of the meter face. All the voltages in the instrument are now at

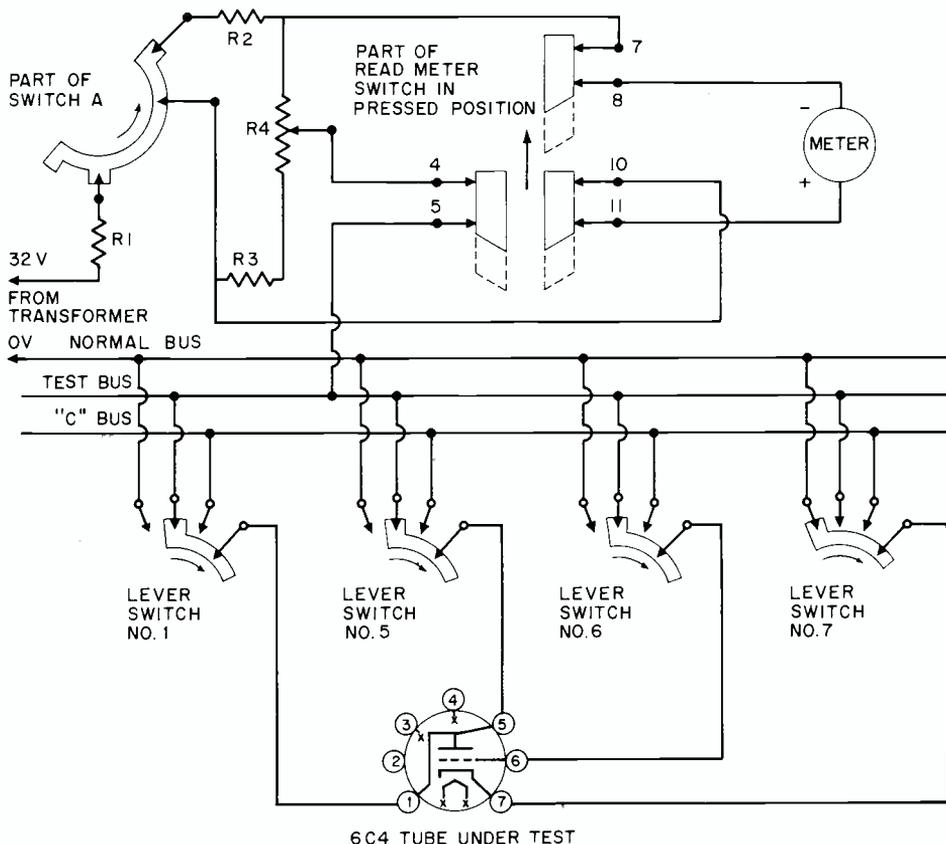


FIG. 4. Partial schematic showing circuit to measure the quality of a 6C4 tube.

the correct value for testing tubes. A nice feature of this line adjust is that the indication is always visible unless you have the

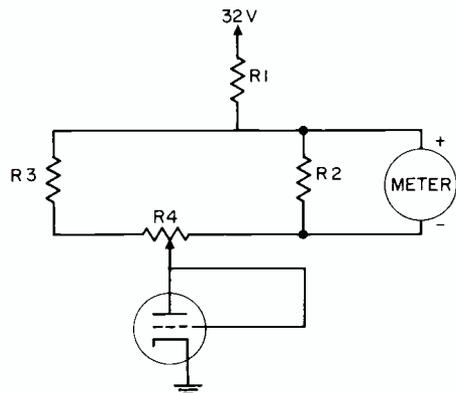


FIG. 5. Simplified schematic of the circuit in Fig. 4.

READ METER switch pressed. You don't have to make a separate switch setup to check to see if the ADJUST LINE is properly set. Also you won't overlook a change in line voltage if the line voltage changes while you are testing tubes.

The line adjust circuit is shown in the simplified schematic in Fig. 6. The 5-volt tap on the transformer secondary connects to a crystal diode. This diode rectifies the 5 volts ac, producing a direct current for the deflection of the meter. The path for the meter current is completed through the current-limiting resistor R, and the contacts on the READ METER switch when the switch is in the normal (not pressed) position.

The meter pointer will deflect to the adjust line on the meter when the 5-volt tap is exactly 5 volts; at this time, all other secondary voltages are correct. The secondary voltages are adjusted by rotating the line adjust control that is in the primary circuit of the transformer.

KIT ASSEMBLY

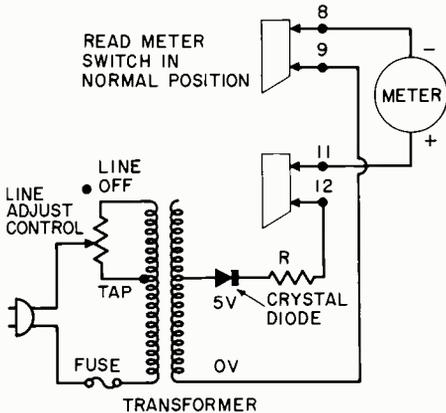


FIG. 6. Simplified schematic of line adjust circuit.

Rotating the line adjust control varies the effective voltage applied to the primary windings of the transformer. With the control all the way clockwise (down in Fig. 6) the ac line is connected to the tap on the primary winding. The turns ratio of the transformer is such that when 115 volts are applied to the tap all the secondary voltages are high. On the other hand, when the control is counter-clockwise so the slider connects the line to the top of the primary winding, the turns ratio is such that the secondary voltages are low. By adjusting the slider somewhere in between, the correct secondary voltages can be obtained. The secondary voltages are correct when the voltage at the 5-volt tap produces enough current to deflect the meter to the adjust line. In this way the ADJUST LINE control can be used to compensate for changes in line voltage or changes in the load placed on the secondary of the transformer.

An examination of Fig. 6 shows that the transformer provides complete isolation of the instrument from the power line. This assures safety for the operator and the instrument. Also, the fuse in the primary circuit of the transformer protects the instrument in case of a serious short circuit.

TEST TUBE DATA

The tube data for setting up the tester to test each tube type is provided on the roll chart. The roll chart has three columns visible through the internally lighted roll chart window. The three column arrangement enables you to find the desired tube type without undue movement of the roller.

The test data for new tubes that come on the market is compiled by Conar and made available periodically. Purchasers of the Model 220 Tester will be notified automatically as this data becomes available.

This kit is a real pleasure to construct. The assembly gets off to an easy start by mounting hardware on the panel. This includes the tube sockets, controls, switches, and the chart roller. Many detailed drawings are provided to make assembly foolproof. These include exploded pictorial views of the mechanical assembly details. In addition, there are large pull-out drawings that can be attached to the wall above your work space. I always use these large drawings as road maps to help orient detail steps to other parts of the instrument.

The next group of steps wire the switches and sockets. The steps are clear and concise. Each wiring step includes a note of "solder" or "don't solder" which makes it almost impossible to miss a solder connection.

Before mounting and wiring the transformer, most of the other parts are installed and wired. This makes access and handling of the partially completed panel easy. Meter and roll chart installation are left to the last to prevent accidental damage. The carrying case is assembled separately and then the completely assembled instrument is attached in the case. Like other Conar instrument manuals, a complete set of operating instructions is included. And of course the NRI Consultation Service is available, if needed, to assure you of obtaining complete satisfaction from your instrument.

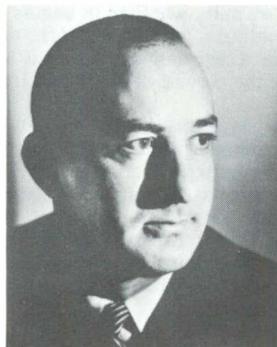
CONCLUSION

The Conar Model 220 Tube Tester is an excellent investment for the service technician. Its light weight and rugged construction make it suitable for carrying on service calls. There are other testers on the market, at a higher price, that will make more detailed tests than the Model 220. However, it is doubtful that they are more useful to the busy service technician even if he disregards the price. Here at Conar we have a six-hundred dollar tube tester in the quality control lab. It does a superb job of testing tubes but it takes time. We use it for spot checking tubes from manufacturers to see if they meet specifications. Often we use it in development work when we want to select a tube that has parameters exactly in the design center of that tube type. But when we want to quickly check a tube to see if it is good or bad, we use the NRI Professional Model 71 or the new Conar Model 220. It is simply a question of how much time you spend to get the information you want.

Then there is the problem of testing tubes that
(cont'd on page twenty-four)

Principles of Vacuum Tube Amplifiers

By
T. A. Ferraro
Technical Editor



T. A. Ferraro

The general term amplifier includes any device that receives a signal of one magnitude and delivers a more powerful signal at its output terminals. The input signal may be a current or a voltage of almost any type, such as a slowly varying direct voltage, a slowly or rapidly varying alternating voltage, or a combination of direct and alternating voltages.

Amplifiers may also be classified as: (1) voltage amplifiers, (2) current amplifiers, and (3) power amplifiers.

Finally, an amplifier can be classified according to the conditions under which its tubes operate. The principal classifications in this category are Class A, Class B, and Class C amplifiers.

Vacuum tubes are frequently operated as voltage amplifiers so that the output voltage is an enlarged reproduction of the input voltage. The tube is generally operated in Class A when serving as a voltage amplifier, and only this type of operation is covered in this discussion.

In Class A operation, where the tube operates only over the linear portion of its characteristic curve, the output waveform is, ideally, an amplified version of the input waveform. Thus, if we assume a sine-wave input having a peak-to-peak amplitude of 2 volts and the stage gain is 15, the output is a sine wave but now has an amplitude of 30 volts.

Distortion may be thought of as any change in the waveform other than amplitude, occurring between the input and output. Many factors contribute to distortion in the output waveform, but the only one with which we will be concerned here is distortion resulting from the selection of an improper Q (quiescent operation) point.

We begin with a discussion on the dc circuit

connections that are essential for a vacuum tube amplifier. The method of determining load lines and operating points is explained in detail. Next, the operation of a basic amplifier and the effect of load resistance on voltage amplification are discussed.

It will also be shown that voltage amplification can be defined as the swing in output voltage divided by the swing in input voltage.

DC CIRCUIT CONNECTIONS

A vacuum tube will not function properly unless there is a complete circuit for direct current running from the cathode to the plate, through the external load and supply, and back to the cathode. The negative terminal of the plate power supply provides the dc ground. This requirement is indicated schematically in Fig. 1.

It is necessary also to have a dc path between the grid of the tube and the source of constant grid voltage. This is also shown in Fig. 1. Other requirements exist. The impedance in

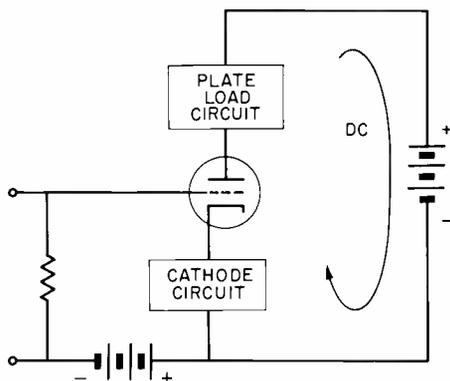


FIG. 1. Essential connections for a vacuum-tube amplifier.

the plate circuit, whether in series with the plate or cathode lead of the tube, cannot be zero at the frequency of the input signal. If it is zero, the circuit will not amplify.

Finally, some method must usually be provided for removing any dc component that may exist in the output of an amplifier. This is mainly important if the amplifier output is fed to the input of another amplifier. If the dc component is not removed from the output, the grid voltage on the succeeding amplifier stage will be changed and improper operation could result.

The general requirements that must be met by nearly all amplifier circuits have been listed. The necessity of removing the dc component from the output is the only one that can ever be violated.

LOAD LINES AND OPERATING POINTS

Load lines and operating points are used in the design of electronic circuits. For instance, for a Class A power amplifier to operate properly it is necessary to carefully proportion the load impedance and signal voltage with respect to the operating point. Load lines and operating points are also used in calculating the plate-voltage swing with grid-voltage swing; in determining the load resistance which may be inserted in series with the plate-cathode circuit of the tube and power supply; and in calculating the power output, plate efficiency, and harmonic distortion in a single tube, Class A audio power-output amplifier.

There are many other uses for load lines and operating points in circuit design. Before you can design electronic circuits, you must know how to construct load lines and find the operating points of vacuum tubes. In this section we will use the actual plate characteristics of a 12AU7 vacuum tube in solving for the operating point. First, let's acquaint ourselves with a typical basic amplifier circuit.

The circuit connections for one type of basic amplifier are shown in Fig. 2. The symbols used are standard, with terms specified as follows:

- E_{CC} = dc grid voltage = grid bias
- E_{bb} = plate supply voltage
- R_L = plate load resistor
- i_b = plate current
- e_g = grid signal voltage
- e_c = $e_g \pm E_{CC}$ = grid voltage
- e_b = plate voltage

This circuit meets all the requirements specified in the preceding section except that

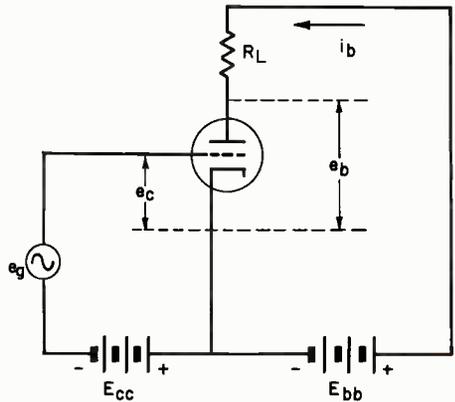


FIG. 2. Basic vacuum-tube amplifier.

no provision is made for removing the dc component from the output.

We are now ready to construct a load line which is simply a straight line connecting two points as shown in Fig. 3.

The first point is marked on the plate voltage axis and is equal to the value of the plate supply voltage, E_{bb} .

The second point is marked on the plate current axis and is equal to the value of E_{bb} divided by the value of the load resistance, R_L .

To illustrate, let's assume we are going to use a supply voltage of 300 volts, and a plate load resistance of 15K ohms. Since we stated above that the first point is marked on the plate voltage axis and is equal to the plate voltage E_{bb} , we place a point at 300 volts on the plate voltage axis. The second point is marked on the plate current axis and is equal to E_{bb}/R_L . Since $300/15000 = 0.02$ ampere or 20 ma, the second point is marked at 20 ma on the plate current axis. If we take a ruler and connect these two points, as shown in Fig. 3, we have constructed the load line for given values of R_L and E_{bb} .

Notice, that if we changed the value of R_L , the slope (slant) of the load line would change since E_{bb}/R_L would assume a new value.

If we increased R_L , the load line would become more nearly horizontal (the slope would decrease); and if we decreased the value of R_L , the load line would become more nearly vertical (the slope would increase). Because of this relationship, we say that the load line's slope is equal to the reciprocal of R_L . A reciprocal is simply a number divided into 1. Thus, the slope of the load line

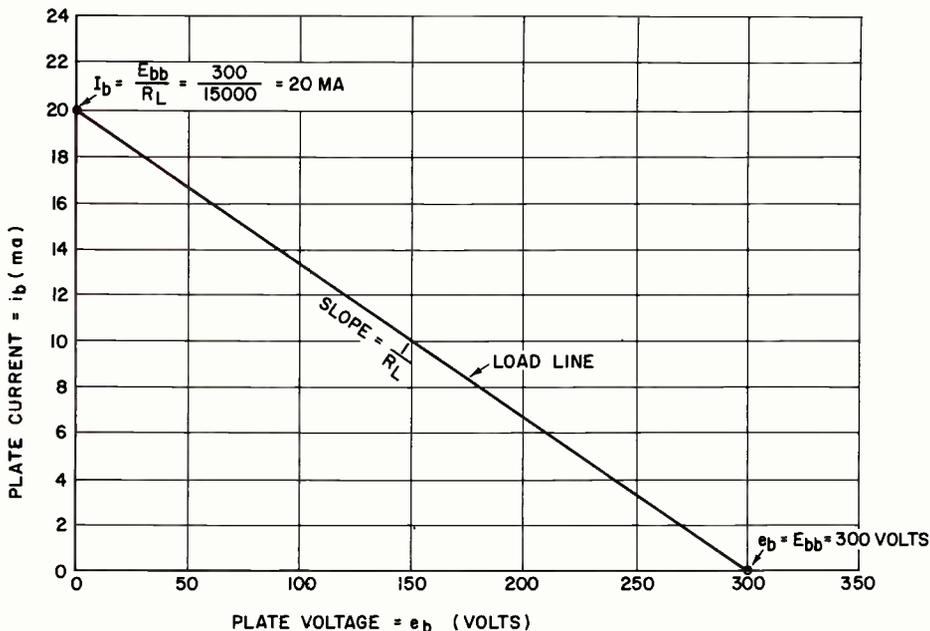


FIG. 3. Load line showing I_b and e_b intercepts. In this example, $R_L = 15K$ ohms and $E_{bb} = 300$ volts.

is equal to $1/R_L$. This is also indicated in Fig. 3.

It will be shown that as the slope of the load line decreases (that is, R_L increases), amplification increases. Seemingly, then, we could increase the value of R_L indefinitely to obtain any desired amplification, within the limits of the tube. Remember, however, that before a tube can amplify, a certain steady state voltage (no signal applied) must be present at the plate. The value of this voltage is equal to the supply voltage minus the voltage drop across R_L . Thus, as the voltage drop across R_L increases, E_{bb} must also be increased to maintain the required value of quiescent plate voltage. In the usual situation the value of E_{bb} is fixed by the capabilities of an available power supply and to change this supply is impractical. The value of R_L selected is, therefore, a compromise between the supply voltage and gain.

As stated previously, we will use the actual plate characteristics of a 12AU7 vacuum tube in solving for our operating point. In Fig. 4 we have shown a number of i_b - e_b curves for a 12AU7 triode as they appear in any tube manual.

Notice, that we have a plate voltage axis and a plate current axis, the same as we did in solving for our load line. Also, we have used the same voltage and current scales. Therefore, to find the proper operating point

of a 12AU7 triode using a plate supply voltage of 300 volts and a plate load resistance of 15K ohms, all that need be done is to superimpose the load line graph of Fig. 3 on Fig. 4. This is illustrated in Fig. 5.

In Fig. 5, a possible operating point appears wherever the load line crosses an e_c (grid voltage) curve. Now, let's find the quiescent or steady state point which is called the Q point.

Under quiescent conditions of operation (no signal applied to the input), the operating point is equal to the negative dc grid supply voltage, E_{cc} . Since we have selected a grid bias of -5 volts, our Q point then appears where the load line crosses the $e_c = -5$ volts curve.

In summarizing this section on load lines and operating points, we started out by assuming values for the plate supply voltage and the plate load resistance. From this we were able to construct a load line. Then we used the average plate characteristics of a 12AU7 triode to find all the possible operating points. Next, we chose a grid bias which enabled us to locate our Q point. Now, let's learn how load lines and operating points are used in finding a vacuum tube's amplification.

AMPLIFIER OPERATION

Vacuum tube amplification is easily under-

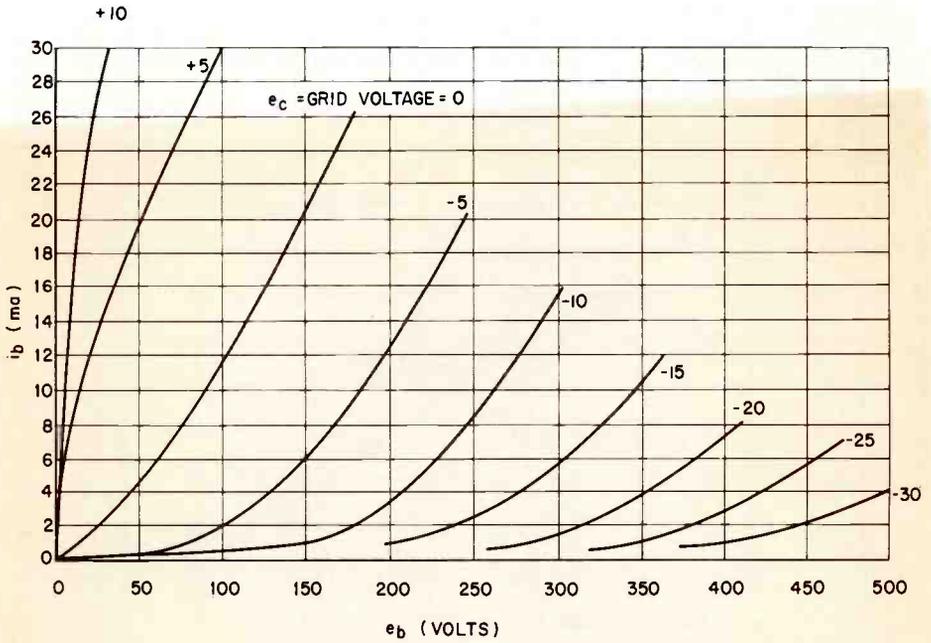


FIG. 4. Average plate characteristics of a 12AU7 vacuum tube.

stood from a graphical presentation. To show this, we have drawn another set of triode

characteristics in Fig. 6. We have done this so you may receive some practice in calcu-

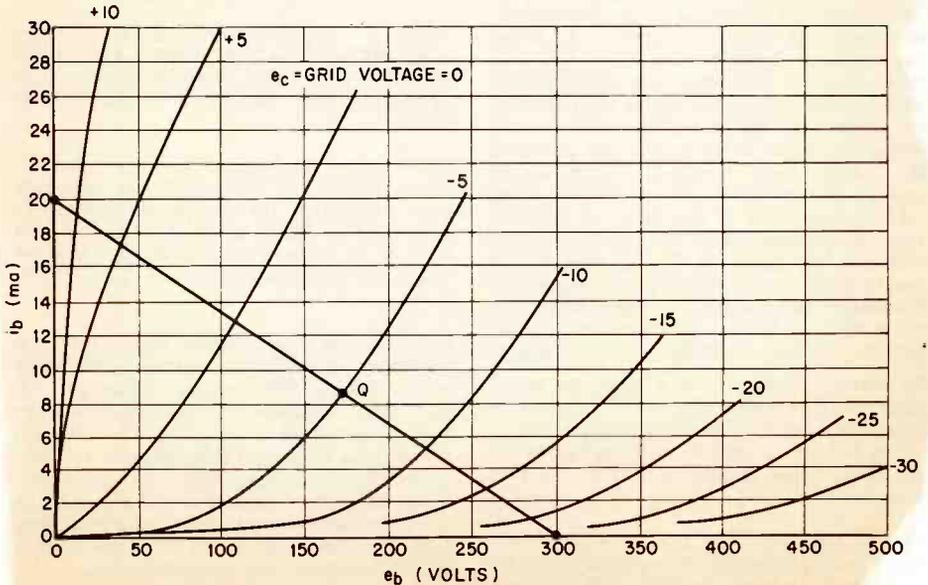


FIG. 5. Average plate characteristics of a 12AU7 vacuum tube with superimposed load line from Fig. 3.

In a-c circuits, such as you have in a refrigerator, washer and dryer, power is not always equal to "voltage times current." It is equal to voltage times current, or Joule's Law, only when the current is purely resistive. In other words, this holds true if we were using a circuit containing a pure resistance appliance, such as an electric iron.

However, this equation does not hold true when a reactance, in the form of inductance or capacitance, is present. An example of this would be the induction motors used in the washer and dryer. They are called induction motors because the currents flowing in the rotor are induced by currents flowing in the stator.

When reactance is present, it can influence the voltage or current, but absorbs no power. An adjustment must therefore be made to Joule's Law to correct for this influence. The correction is in the form of a "power factor."

This is a ratio of the actual amount of the resistance in the circuit to the total maximum resistance met by the alternating electric current on passing through the circuit, or the total circuit impedance. It is also equal to the true wattage divided by the quantity of the input volts times the input current.

Power factors are never higher than unity which equals 100% or 1.00. A unity power factor may be found, as an example, in an electric iron. Use the equation, Watts or Power equal Voltage times Amperage times Power Factor. If we have an iron that draws 5 amperes on a 115 volt line, and the power factor is 1.00, the power equals 575 watts.

But the power factor of a motor alone usually equals approximately 80% or 0.80. Therefore it is entirely conceivable that by multiplying the power factor by the determined wattage, the actual wattage will be greatly reduced. According to Underwriters' Laboratories, some appliance wattages may be reduced by this as much as 50 per cent.

Your wattmeter automatically compensates for the power factor. But your computations cannot, since you are not using the complete equation for the situation. So remember, when computing appliance power on an a-c circuit, that the power factor is essential for correct calculations.

Here is an example which may help you in computing your power factor. If, on a motor rating plate, you see 115 volts, 1.50 amperes, 140 watts, you can obtain the following:

Total volt-ampere input equals 115 volts x 1.50 amps equals 172.5 watts.

Power factor equals

$$\frac{\text{True watts}}{\text{Volt-ampere input}} = \frac{140 \text{ watts}}{172.5 \text{ watts}} = 0.811 \text{ or } 81.1\%$$

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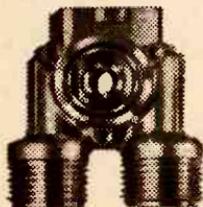
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lating a load line and operating point. Before reading any further, it would be good experience for you to try to find the values of the plate load resistance, R_L ; the plate supply voltage, E_{bb} ; and the grid bias, E_{cc} used in Fig. 6. After you have solved for these values, you may compare your results with ours which are shown on page 29.

In Fig. 6, with the value of load resistance used, a 2-volt swing in grid voltage above and below the bias E_{cc} (4 volts in all) will cause the plate voltage to swing over a range of 175 volts to 262 volts. This can be seen in Fig. 6 if we drop vertical lines to the plate voltage axis from the points where the load line crosses e_c at -2 volts and at -6 volts.

If we drop a vertical line to the plate voltage axis from the Q point, we see that the plate voltage is 223 volts at quiescent conditions. For a Class A amplifier to operate properly, a swing in grid voltage above and below the bias should cause the plate voltage to swing the same amount in either direction.

In our example for a 2-volt swing above the bias, we received a plate voltage of 175 volts. The plate voltage swing in this direction (223 - 175) is 48 volts. For a 2-volt

swing below the bias, we received a plate voltage of 262 volts. The plate voltage swing in this direction (262 - 223) is 39 volts. Since our swings in plate voltage are not equal, our output will be distorted and our amplifier will not operate properly. Therefore, we must use a different bias voltage and select a new Q point. By trial and error we can arrive at a bias so that when the grid swings a given amount above and below the bias we will receive the same plate voltage swing in each direction. Instead of using this trial and error method of finding the proper Q point, let's work our problem by a different method.

Since we must work our problem again, instead of using a plate supply of 350 volts let's be more practical and use 250 volts for the plate supply. We will again use the same i_b - e_b curves. Now, we must find a new load line.

To find a new load line we have learned that we must place marks on the plate voltage and plate current axes. Since we chose a 250-volt plate supply we can place a mark on the plate voltage axis at 250 volts. The mark on the plate current axis can be found by dividing the plate supply voltage by the load resistance

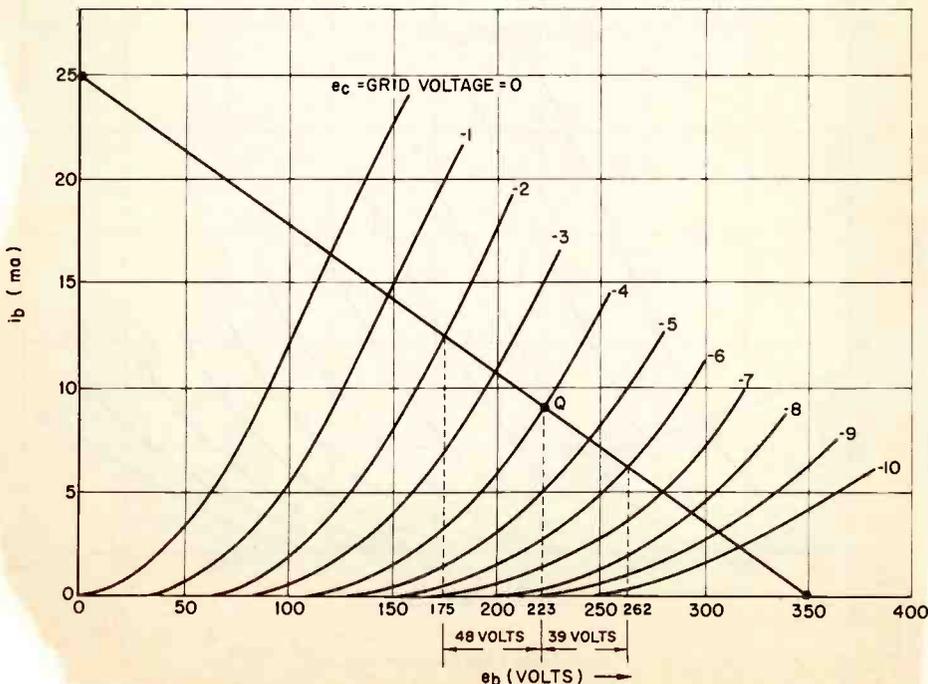


FIG. 6. Triode characteristics showing load line and incorrect operating point.

(E_{bb}/R_l) . This is the way we found it before. By using another method to find this mark on the plate current axis, we will save ourselves much work when we try to find the proper Q point.

Place the edge of a ruler on the 250-volt mark on the plate voltage axis. Now rotate about this 250-volt mark until you find the proper Q point (no grid signal). The proper Q point is when, for a given swing in grid voltage above and below the bias, the plate voltage swings the same amount in each direction. When you have located the proper Q point, all that must be done to draw the load line is to place your ruler on the 250-volt mark and on the Q point and connect these two points. Extend the line over to the plate current axis. This is shown in Fig. 7. Where this load line crosses the i_b axis is our new plate current (8.9 ma). From this we can now calculate our load resistance. Since we know the plate supply voltage (250 volts) and the plate current (8.9 ma) we can solve for the load resistance. Using the formula $i_b = E_{bb}/R_l$, transposing, and solving for R_l gives $R_l = E_{bb}/i_b = 250 + .0089 = 28K$ ohms. As can be seen in

Fig. 7, for a 2-volt swing in grid voltage above and below the bias ($E_{CC} = -4$ volts), the plate voltage swings an equal amount in each direction. Now we have an amplifier that will operate properly so we can safely determine our amplifier's voltage amplification.

If voltage amplification is defined as the swing in output voltage divided by the swing in input voltage, then

$$A = \text{voltage amplification} \\ = \frac{216 - 124}{4} = \frac{92}{4} = 23$$

Amplification is possible only because the load line has a slope. With no load, no output signal can be developed and A is obviously equal to zero. As the value of R_l is increased, a greater voltage drop is produced across it since, by Ohm's Law, $E = IR$. Seemingly, we could increase R_l indefinitely to obtain any desired amplification within the limits of the tube. This is not true in practice since the value of E_{bb} is limited and a certain minimum voltage must exist across

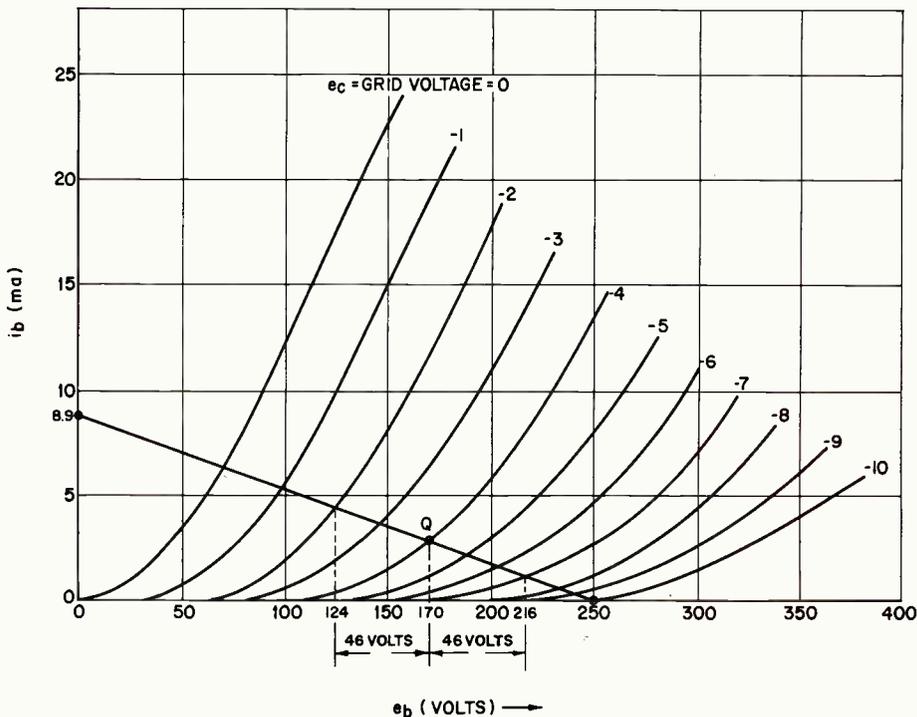


FIG. 7. Triode characteristics showing load line and correct operating point.

the tube. Thus, increasing R_L indefinitely is a purely theoretical case.

Fig. 7 shows how the load resistance affects the voltage amplification. The curve in Fig. 8 shows that the maximum possible voltage amplification obtainable from the single tube amplifier under discussion is equal to the amplification factor of the tube used. This value would be obtained at least theoretically, as the load resistance becomes infinite. Of course, the necessity of keeping the operating point fixed introduces practical difficulties when an attempt is made to increase the load resistance. Furthermore, the shunting effect of the capacities between tube electrodes and lead wires becomes more troublesome as the load resistance is increased. In practice, the load resistance, R_L , seldom exceeds a value ten times the

However, when the plate load is anything other than a simple resistance, the graphical determination becomes very complicated. When amplifiers contain inductance in the plate load, the load line is a reactive load line and takes the form of an ellipse. We did not discuss this type of load line in this article.

CONCLUSION

When constructing amplifiers it would obviously be advantageous to determine beforehand such factors as the actual gain the stage would provide, power dissipation, plate efficiency, and distortion. We can determine these problems with the use of load lines. In this article you learned what load lines are, how they are constructed, and how they provide a simple graphical solution to circuit design problems. Perhaps this discussion

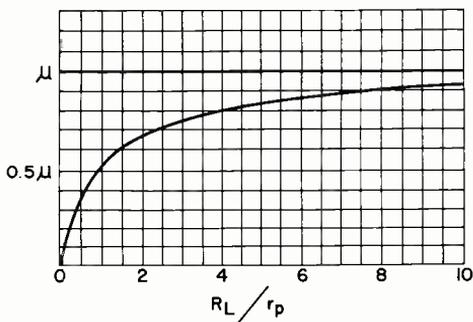


FIG. 8. Effect of load resistance on voltage amplification.

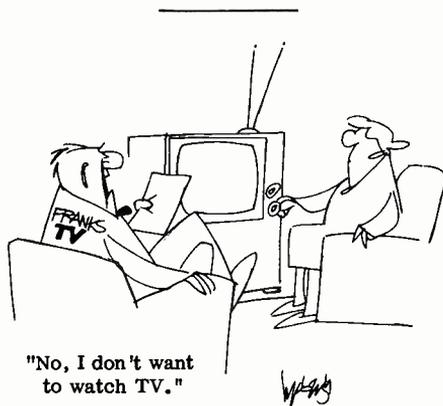
plate resistance, r_p , for triodes. The curve in Fig. 8 shows that the improvement in voltage amplification, obtainable by increasing the load resistance, is relatively small after the load resistance is four or five times the plate resistance.

Amplification is accomplished through the action of the grid in controlling the flow of current through the load resistance. Changes in grid voltage change the voltage drop across the tube, causing the constant voltage source, E_{bb} , to supply a changing plate current. This in turn produces a change in plate voltage. The vacuum tube acts simply as a converter of energy, changing the dc energy available from the plate supply into signal energy.

From Fig. 7 it is apparent that making the grid more negative than the bias voltage (-4 volts) causes: (1) plate current to decrease; (2) plate voltage to increase.

The voltage amplification of the simple amplifier of Fig. 2 can be determined from a graphical analysis of the type shown in Fig. 7.

has given you the incentive to learn much more about graphical constructions for vacuum tube circuits. If so, many texts have been written on this subject. They are available at most professional book stores and radio wholesale houses.



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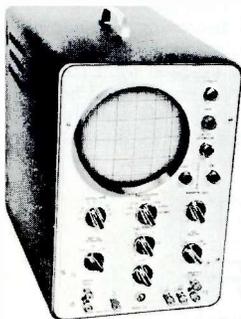
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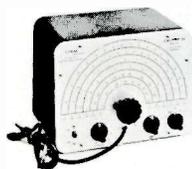
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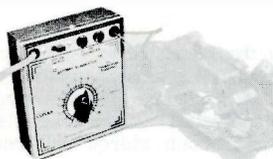
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USE ORDER BLANK ON PAGE 17

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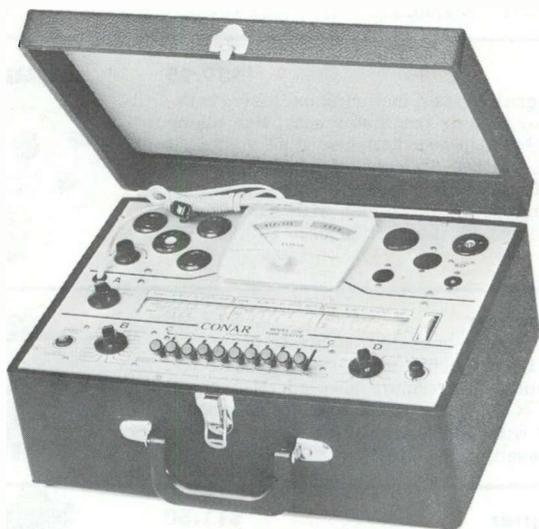
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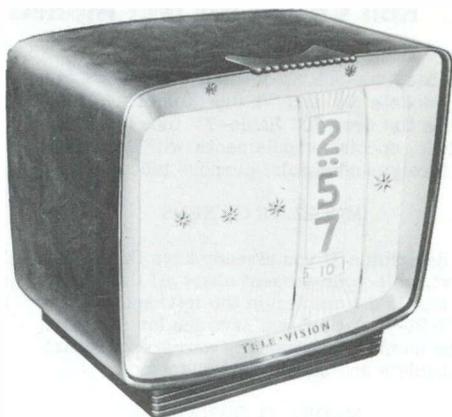
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Both Adapters \$9.75

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3	.26	.38	.41	.47	.55	.64	.74	.83
4	.28	.43	.47	.55	.65	.77	.90	1.02
5	.30	.48	.53	.63	.75	.90	1.06	1.21
6	.32	.53	.59	.70	.85	1.03	1.22	1.40
7	.34	.58	.65	.77	.95	1.16	1.38	1.59
8	.36	.63	.71	.84	1.05	1.29	1.54	1.78
9	.38	.68	.77	.91	1.15	1.42	1.70	1.97
10	.40	.73	.83	.98	1.25	1.55	1.86	2.16
11	.42	.77	.89	1.05	1.35	1.67	2.02	2.34
12	.44	.81	.95	1.12	1.45	1.79	2.18	2.52
13	.46	.85	1.01	1.19	1.55	1.91	2.34	2.70
14	.48	.89	1.07	1.26	1.65	2.03	2.50	2.88
15	.50	.93	1.13	1.33	1.75	2.15	2.66	3.06
16	.52	.97	1.18	1.40	1.85	2.27	2.81	3.24

NRI Is Again Accredited By National Home Study Council

NRI was first accredited by the National Home Study Council in 1956. Following are excerpts from the article that appeared about this in the December 1956 - January 1957 issue of the NRI News:

HISTORY OF NATIONAL HOME STUDY COUNCIL

"The National Home Study Council, organized in 1926, is an association composed of outstanding home study schools in the U.S. One of the chief purposes of the Council is to establish standards for advertising practices, quality of instruction materials, and business practices. Home study schools are required to meet these standards in order to qualify for and maintain their membership in the National Home Study Council. To this extent the Council has always been an accrediting agency.

COUNCIL STRENGTHENS ACCREDITING PROGRAM

"Recently the National Home Study Council rebuilt and strengthened its accrediting program, formalized stricter standards, and appointed a new and well qualified Commission to home study and outside educators to determine whether a home study school meets the new requirements for accreditation.

NRI AMONG FIRST SCHOOLS ACCREDITED

"On September 1, 1956, the Accrediting Commission of the National Home Study Council announced that it had included the National Radio Institute in its first list of accredited home study schools.

WHAT ACCREDITATION MEANS

"Accreditation means that NRI fulfills the strict educational, ethical and business standards adopted by the Accrediting Commission of the National Home Study Council. It means that the Accrediting Commission found that NRI meets the following requirements:

- It truthfully advertises its courses and services.
- It offers educationally sound and up-to-date courses.
- It has a competent faculty.
- It accepts only qualified students.
- Its tuition charges are fair and reasonable.
- It has demonstrated ample student success and satisfaction.
- It is financially responsible.

"To NRI students accreditation means that they can pursue their courses with the con-

fidence that they are getting their training from a school that has been thoroughly examined and found reliable by a competent and responsible agency. NRI graduates can take reassurance from the fact that they secured their training from an accredited school."

APPLIED FOR RE-ACCREDITATION

Accreditation by the National Home Study Council is valid for only five years. Since the school was originally accredited in 1956, NRI applied for re-accreditation in 1961 and was re-examined by the Accrediting Commission last November.

STANDARDS HIGH

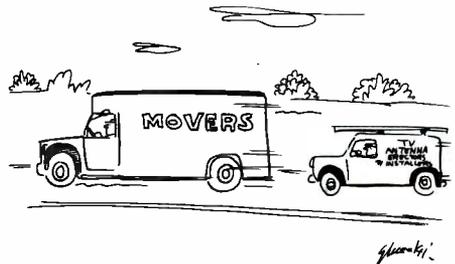
The Executive Secretary of the National Home Study Council, in a letter dated January 23, 1962, stated in part:

"I am happy to advise that the Accrediting Commission of the NHSC has continued the accreditation of the National Radio Institute for the next five years without qualification...

"The Commission conveys to you and your faculty and staff, its compliments and congratulations -- for maintaining high educational and ethical standards, and for your splendid cooperation with, and support of, the professional home study movement and the accrediting program of this Commission."

CONSTANT ENDEAVOR

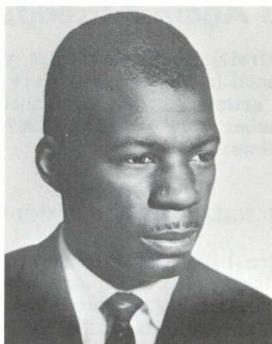
While accreditation by the National Home Study Council covers five years, constant endeavor has to be maintained to keep and even improve on the service and training afforded NRI students. Thus, students can be assured that they are getting their training from a school that fulfills the strict educational, ethical and business standards of a reliable agency.



Transformerless Power Supplies

By
Harry Taylor

Technical Editor



Harry Taylor

Most electronic circuits must have some source of dc voltage to operate. Yet, when we think of oscillators, amplifiers, etc., we are only concerned with the specific circuits. The plates and screens of the tubes are merely shown as being returned to B+ in many schematic diagrams. We simply assume that a dc voltage exists at a given point as we analyze the circuits.

Voltage doublers and multipliers, which are generally classified as transformerless power supplies, are among the many types of circuits used to supply dc. Where space, weight, or cost is limited and a dc voltage higher than the peak ac line voltage is required, these circuits are often used. These are the primary reasons for their wide application in TV receivers. As you will see later, there are a variety of voltage doubler and multiplier circuit configurations which you may find supplying the low voltage in TV sets. We will discuss some of the voltage doubler and multiplier circuits currently in use.

Diode switching action and the charging of capacitors to the peak of the applied voltage are the underlying principles in these power supplies. By passing current in only one direction, the diodes permit the capacitors in the circuit to charge. Once charged, the capacitors act like batteries or dc sources. The diodes then place the capacitors in series so that their stored voltages are added. Thus, a voltage higher than the peak value of the ac input voltage is made available for the external circuits.

The simplified diagram of a half-wave rectifier in Fig. 1 illustrates the operation of the voltage multiplier circuits. This is the type of power supply found in most ac/dc receivers. The filter network has been omitted.

Let us discuss the action of this circuit be-

fore going on to the voltage doublers. The ac line voltage is applied to the plate of the diode (rectifier) and through capacitor C to its cathode. A pulsating dc voltage is developed across capacitor C. When the plate of the diode is more positive than the cathode, the diode conducts. Current is drawn from

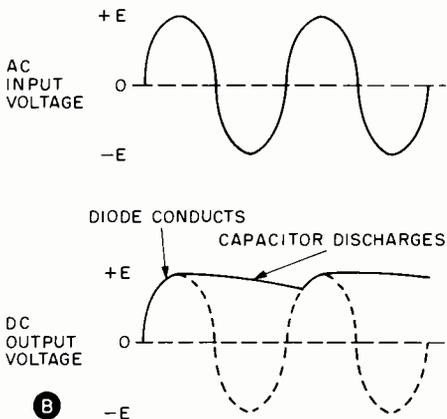
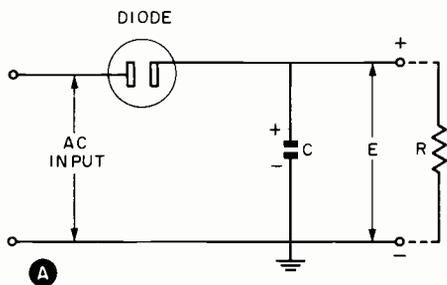


FIG. 1. Basic half-wave rectifier circuit at (A) and voltage waveforms at (B).

the grounded side of the ac line through the load resistor R to the cathode of the diode. At the same time, electrons are drawn from the top plate of the capacitor and flow into its bottom plate. Electrons thus collected at the cathode flow through the diode to the anode or plate. From the anode the electrons are returned to the ac line.

During the next half cycle when the voltage at the plate of the diode swings negative, the diode will not conduct. If the capacitor is sufficiently large and the load current is not extreme, the capacitor will hold most of its charge when the ac at the plate of the diode swings negative. Thus, a dc supply voltage will exist across the capacitor. This process is repeated on each cycle of the input voltage, as shown in Fig. 1B. In this manner the diode and capacitor convert the ac line voltage to a usable dc voltage. The capacitor will charge to the peak of the ac input, which we will refer to as +E. This means that if 110 volts is applied to the circuit and the diode has negligible resistance when it is conducting, the capacitor will charge to approximately 155 volts. Unless the voltage across the capacitor drops below this value, the diode will not conduct. It conducts only enough to replenish the voltage across the capacitor.

The voltage doubler also depends upon the switching action of diodes and the ability of capacitors to charge to the peak of the voltage applied to them and hold the charge. Look at the half-wave voltage doubler circuit shown in Fig. 2A. Notice that to double the output voltage, it is only necessary to add one more capacitor and one more diode to the circuit shown in Fig. 1. Usually, semiconductors rather than vacuum diodes are used in these circuits.

Let us see how the half-wave voltage doubler operates. When the ac line at terminal T1 is negative with respect to the grounded side of the line (T2), diode D1 conducts. This conduction pulls electrons from the positive plate of C1. Current flows down through D1 to the grounded ac line. Since positive means a deficiency of electrons, the junction of C1, D1 and D2 is now positive. Fig. 2B shows that the voltage at this point is approximately equal to the peak value of the ac line voltage. Capacitor C1 can hold this charge until the ac at T1 swings positive. When this happens, C1 discharges in series with D2, C2 and the ac voltage applied to it. This occurs on the

THIS IS MATURITY: To be able to stick with a job until it's finished; to be able to bear an injustice without wanting to get even; to be able to carry money without spending it; and to do one's duty without being supervised.

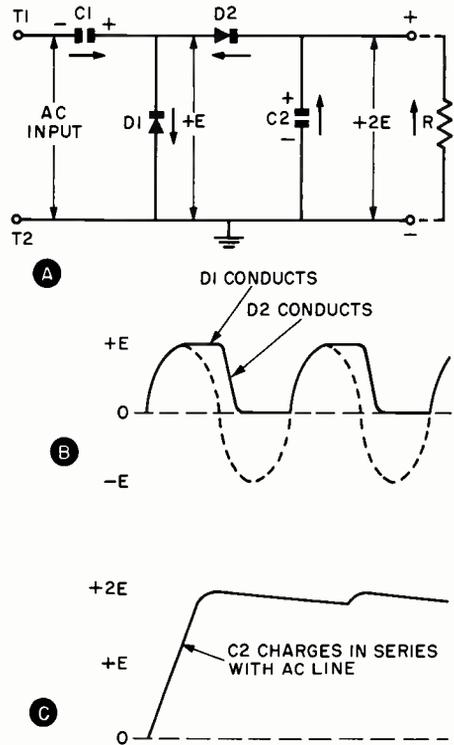


FIG. 2. Half-wave voltage doubler circuit at (A), voltage across C1 at (B), and voltage across C2 at (C).

next half cycle. Because this junction is at the peak of the ac voltage (+E), the voltage applied to the anode of D2 will be the ac voltage superimposed on this dc level to which C1 was charged.

When T1 goes positive, +2E is applied to the anode of D2. D2 conducts and draws electrons from the positive plate of the output capacitor as the diode did in the half-wave circuit in Fig. 1. Capacitor C2 charges. The voltage developed across C2 is now +2E, or twice the peak value of the ac input voltage as shown in Fig. 2C.

If the current through the load resistor R is sufficient to discharge C2, this process will be repeated during the next cycle. C1 will charge on the negative half cycle and discharge in series with the ac line voltage as D2 conducts on the positive half cycle. C2 will then charge to +2E. If C2 is only partially discharged, C1 will discharge and D2 will conduct only enough to restore the potential of +2E across C2. You can see again that the load controls the action of the circuit.

The capacitors used in TV voltage doublers are usually quite large and the diodes have high current ratings. Because of the tremendous current required for the various stages, the capacitors must be able to hold enough charge to supply these stages while the diodes are cut off. During most of each cycle, the output capacitor is the source of dc. Current drawn by the load discharges the capacitor. Also, the diodes must pass enough current to charge the capacitors quickly. Incidentally, when the ac is first applied to the power supply, the current may exceed the diode peak current rating. A low ohmic value resistor is often placed in series with the line to prevent damage to the components.

A full-wave voltage doubler circuit is shown in Fig. 3A. Notice that the circuit resembles a bridge rectifier with capacitors substituted for two of the diodes. Also notice that the capacitors are in series across the dc output terminals. The basic difference between the half-wave and full-wave circuits is that the output capacitor in the half-wave circuit is charged to $+2E$ once during each complete cycle and one of the output capacitors in the full-wave circuit is charged to $+E$ during each half cycle. Assuming that the frequency of the ac line voltage is 60 cycles, the output of the half-wave doubler would have a 60-cycle ripple frequency, while the full-wave circuit would have a 120-cycle ripple.

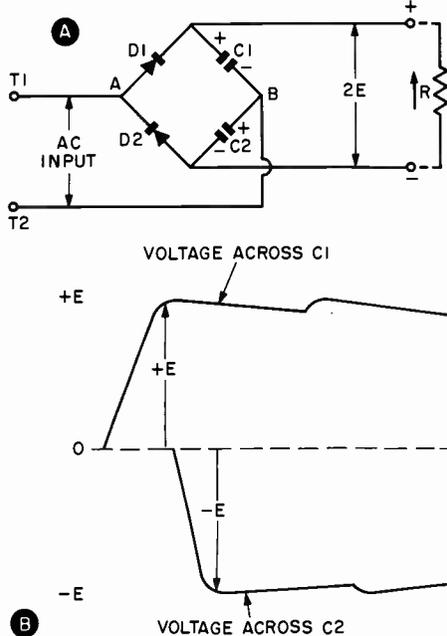


FIG. 3. Full-wave doubler circuit at (A) and voltage across capacitors at (B).

One diode conducts during each half cycle.

The ac is applied between point A in Fig. 3A, the junction of the diodes, and point B, the junction of the capacitors. Let us assume that input terminal T1 is positive with respect to T2. Current will flow from T2 to the junction of the capacitors. At the same time, diode D1 conducts because of the positive voltage applied to its anode. Electrons flow from the upper plate of C1 through D1 to the ac line at T1. This electron flow charged C1 to $+E$, the peak value of the line voltage with respect to point B. Refer to Fig. 3B.

On the next half cycle when the ac at T2 is positive with respect to T1, diode D2 will conduct. Current will flow from T1 through D2 to capacitor C2. Current will also flow from the positive plate of C2 back to the ac line at T2. Now $+E$ exists across C1 and $-E$ exists across C2 as shown in Fig. 3B. Since the dc is taken between the top of C1 and the bottom of C2, a voltage of approximately twice the peak value of the ac line voltage is available across the load R.

In the full-wave doubler circuit, each diode conducts only enough to recharge the capacitor associated with it. D1 will conduct to recharge C1, and D2 will conduct to recharge C2. Because the capacitors are in series, the current drawn by the load will discharge each of them equally. As in the half-wave doubler, the load which the doubler must handle determines not only the size of the capacitors but also the current rating of the diodes.

Now that you understand how the voltage doubler works, we can go on to the voltage tripler. A half-wave tripler is shown in Fig. 4. Notice the similarity between this and the circuit in Fig. 2. The half-wave is a conventional doubler with a negative half-wave section added. Therefore, the operation is already familiar to you. However, we will review the operation of the doubler. Diode D1 conducts when T2 is positive with respect to T1 and charges C1 to $+E$. D1 cuts off during the next half cycle, thus preventing capacitor C1 from discharging through it. As T1 becomes positive with respect to T2, diode D2 conducts. C1 which held a charge of $+E$ while D2 was cut off, now discharges in series with the ac line. This conduction through D2 charges C2 to $+2E$. With $+2E$ across C2, we can add the tripler action. Assume that no load is connected between the $+2E$ terminal and ground so that C2 can maintain the charge of $+2E$. Thus, neither C1 nor C2 will need recharging during the next cycle. When T1 goes negative again, D3 will conduct. Electrons will be fed into the negative plate of C3. The path for the current at T1 is from D3 through C3 to the line at T2. The voltage across capaci-

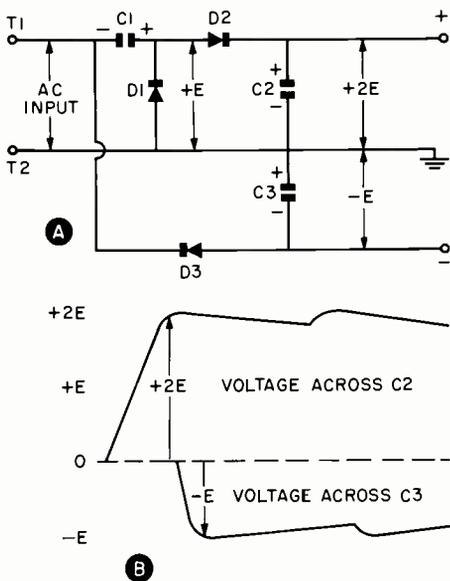


FIG. 4. Half-wave voltage tripler circuit shown at (A) and voltage waveforms at (B).

tors C2 and C3 in series is approximately three times the peak ac. Fig. 4B shows the comparison of voltage across these capacitors. Depending upon the circuits to be supplied, the loads may be connected so that +E, +2E, or +3E is applied to them.

Fig. 5 shows a half-wave quadrupler circuit. This is merely two doublers arranged so that the voltage developed by the second doubler is added to the output of the first. Once C2 is charged to +2E, as you saw in the discussion of the half-wave doubler, C3 charges to +E, D4 conducts thereby charging C4 to +4E. Assume that D2 has charged C2 to +2E. On the next half cycle when T1 is negative, D3 conducts and charges C3 to +3E (+E added to the +2E across C2). When the ac at T2 be-

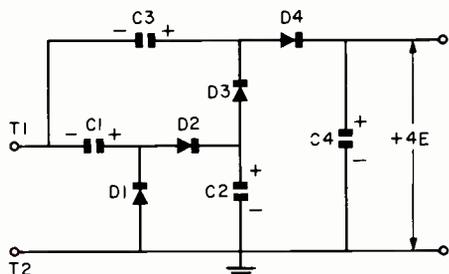


FIG. 5. Half-wave quadrupler circuit.

comes positive again, D4 will conduct because of the 3E plus the ac line voltage applied to its anode. Electrons are pulled from the negative side of C4 and returned to the ac line through D4. Thus the dc voltage across C4 is +4E.

By adding more doubler sections the output voltage may be increased even more. Theoretically, the number of doublers which can be cascaded for higher output voltages is limitless. In practical application, however, the resistance of the diodes, leakage through the capacitors and other problems must be considered.

To prove the "limitless multiplier," the circuit shown in Fig. 6 was assembled using crystal diodes and .25-mfd capacitors. This circuit may be called an octupler. Its theoretical output voltage is eight times the peak value of the input voltage. With an input of 6.3 volts ac, 64 volts dc was read at the output. The principles discussed in the doubler and quadrupler circuits apply also to the octupler in Fig. 6. Thus, you can easily understand how the octupler can develop such a high dc voltage. Once the capacitors have become charged, the odd-numbered diodes (such as D1, D3, D5, etc.) will conduct on negative half cycles and the even-numbered diodes will conduct on the positive half cycles. If C8 is not discharged by the load connected at the dc terminals or through leakage within the circuit, the remaining capacitors will stay charged. Thus, the diodes will not conduct. However, when C8 is partially discharged by a load, each of the diodes will have to re-charge its associated capacitor in turn to replace the voltage across C8.

In addition to poor regulation, voltage multipliers have other drawbacks which render them impractical if a dc voltage higher than 4E is required. Due to the high capacitance needed to supply the voltage during most of each cycle and the high dc working voltage ratings on the capacitors, cost is high. In the case of the octupler in Fig. 6, eight diodes and eight capacitors are needed. You can see that the cost of such a configuration can easily defeat its weight and space saving advantage.

During the period between the ac voltage peaks, the only source of dc is the charge on the output capacitor. If even a small amount of current is drawn from the circuit in Fig. 6, the output voltage will drop appreciably. The voltage regulation of this circuit is so poor that it is practical for use only where the current drain is negligible.

Many television receivers employ voltage doubler power supplies. Both half-wave and full-wave circuits are frequently used. The

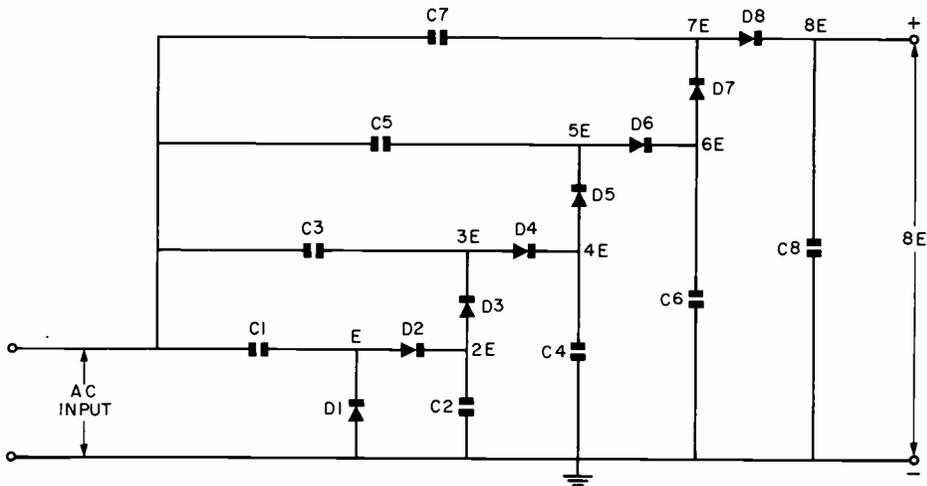


FIG. 6. Half-wave octupler circuit.

half-wave circuit has the advantage that one side of the ac line is common to the dc output. Thus, both the ac input and the dc B- may be grounded to the chassis. The full-wave doubler has the advantage of a lower dc voltage across each of the two output capacitors. Since the two are in series, each must have a rating of only 1E. Either the ac input or the dc output must be isolated from the chassis, however.

As we mentioned earlier, the surge of current through the rectifiers may be enough to damage them when power is first applied to the circuit. Usually, a 5-ohm fusible resistor

is inserted in series with the ac line to prevent this. In fact, when you are called upon to troubleshoot a TV which is completely dead and has a selenium rectifier power supply, first check this resistor.

Except for the octupler circuit in Fig. 6, you can expect to find these circuits in use. For troubleshooting, as well as experimenting, you will find a basic understanding of voltage doublers, triplers and quadruplers helpful. Finally, unless you are careful, you could receive a serious shock from the output of a voltage multiplier. At high voltages, even a little current can be extremely dangerous.

(cont'd from page six)

Tube Tester Kit

are used in critical circuits. Any tube tester will often fail to reject a tube that does not work properly in a critical circuit. The tube may be good but manufacturing tolerances are such that that particular tube won't work in that particular circuit. In a case like this, the only valid test is tube substitution. In fact, any time you are working in critical circuits such as TV front ends or sync circuits, the quickest valid test of a tube is substitution.

While it is tough to do service work without a tube tester, you can limit your investment. An inexpensive tester such as the Conar Model 220 will more than pay its way. Knowing the tester's limitations allows you to take advantage of its speed and simplicity. We believe the necessary compromise among price, completeness of tests, ease of operation, and rugged durability, has been well met in the Conar Model 220 Tube Tester.

DOES YOUR JOB SCARE YOU?

If you ever land in a position where the size of your assignment appalls you and you wonder privately, whether the job is too big for you, you might like to recall the experience of a Washington executive who was called to take on a wartime responsibility far greater than he had ever tackled before. But take it on he did, and he discharged it in a way that earned him the praise of a grateful nation.

An old friend, who was somewhat astonished at the capacity the man had shown, asked him how he was able to do a big job like that. The executive told him that the reason he didn't get panicky was because he refused to think of his assignment as a big job and thought of it as a lot of little jobs -- any one of which he could do, or get someone to do for him.

Frank Sullivan: "To produce an income tax return that has any depth to it, any feeling, one must have lived -- and suffered."

NRI ALUMNI NEWS



Frank Skolnik	President
Walter Berbee	Vice President
James Kelley	Vice President
J. Arthur Ragsdale	Vice President
David Spitzer	Vice President
Theodore E. Rose	Executive Sect.

Chapter Chatter

DETROIT CHAPTER elected its officers for the current year as follows: James Kelley, Chairman; John Nagy, Vice-Chairman, George Povlich, Secretary; Earl Oliver, Treasurer; Prince Bray, Librarian; Asa Belton and Leo Blevins, Finance Committee; and Asa Belton, Sergeant-At-Arms. Our congratulations to these gentlemen!

Secretary Povlich led a discussion on electron tubes. Asa Belton gave a demonstration on the i-f section of a TV receiver. This demonstration was refreshing to many of the members and was much appreciated by all of them.

Asa Belton and George Povlich plan more TV demonstrations. Each one will be a different section of a TV set. It is planned to have the entire chapter membership participate in building a TV panel board to promote the further study and understanding of Television principles and functions.

FLINT (SAGINAW VALLEY) CHAPTER reports its officers for 1962 as follows: Andrew

Jobbagy, Chairman; Cyde Morrissette, Vice-Chairman; Edward Miller, Treasurer; Henry Hubbard and William Jones, Executive Committee; Ernest Hubbard, Personnel Director; Wayne Todd and Gilbert Harris, Educational Committee; Art Clapp, Sergeant-At-Arms; Leroy Cockrell, Photographer; Robert Poll, George Martin, Leroy Cockrell and James Windom, Jr., World's Fair Committee.

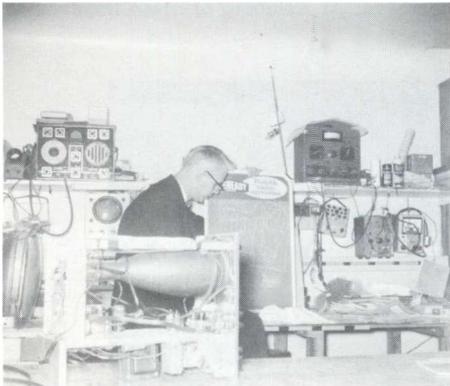
This year the Chapter offers its members the following: A free college education, a free trip to the World's Fair, and a free correspondence course. Those interested should get in touch with Chairman Jobbagy or Vice-Chairman Morrissette.

The Chapter has been following an excellent program of lectures. First Mr. George Chapman from the General Motors Institute, gave a basic lecture on the oscilloscope, to be followed at two later meetings on the advanced use of the oscilloscope. Mr. Chapman was then to take the members through the General Motors Electronic Experimental Laboratory.

Mr. Chapman is to be followed by Professor De Jenko of the University of Flint on TV servicing. Last of this series is to be a lecture on the Lasarlight by Mr. Richard Miller, Electronic Engineer. This is an ambitious program of lectures and demonstrations and every NRI graduate and student in the area should take advantage of the opportunity to attend them.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER has informed National Headquarters that its slate of officers elected to serve the Chapter for 1962 is as follows: George Fulks, Chairman; Harry Straub, Vice-Chairman; Harold Rosenberger, Secretary; Howard Sheeler, Corresponding Secretary; and Reginald Ankeney, Treasurer. Our congratulations to these officers!

Following the election and installation of the officers, Chairman George Fulks gave a demonstration on servicing the sync section of a TV receiver.



Mr. George Chapman, General Motors Institute Electronics Instructor, during a lecture and demonstration he gave before the Saginaw Valley Chapter.

LOS ANGELES CHAPTER enjoyed a Walt Disney Studios' thirty-minute film entitled "Man With Wings." It was all about the progress of aviation from 1600 AD to the present time, starting with hot air in bags to the balloons in space. The members are enthusiastic about these films, look forward to them, and find them fascinating and instructive as well as entertaining.

Plans were completed to attend the Pacific Electronic Trade Show, for which tickets were provided to the Chapter for wives as well as the members.

MINNEAPOLIS-ST. PAUL (TWIN CITY) CHAPTER completed plans to hold its annual banquet at Holcum's Restaurant in Stillwater, Minn., in March. Members' wives were invited to attend the banquet. Their presence certainly makes this annual affair much more interesting and attractive than it otherwise would be.

The officers newly elected to serve the Chapter for 1962 are: Paul Donatelli, Chairman; Melvin Menk, Vice-Chairman; Francis Frazer, Secretary; Elmer Bush, Treasurer; and Mel Lundgren, Sergeant-At-Arms. Our congratulations to these gentlemen!

NEW ORLEANS CHAPTER has for quite some time featured what is known as its TV Clinic at all its meetings. This is a continuous series of lectures and demonstrations on TV servicing conducted by Mr. Gaston Galjour, a Radio-TV Technician of wide knowledge and experience. Any NRI students or graduates in the New Orleans area who have not been attending the meetings are missing out on an excellent opportunity to increase their theoretical and practical knowledge of TV servicing. All students and graduates are wel-

come at the meetings, either as guests or prospective members.

The Chapter is considering changing its meetings from Tuesday to Wednesday nights because of the color broadcasts on Wednesday. If the change is made, notice of it will be published in the NRI News.

NEW YORK CITY CHAPTER Executive Chairman Tom Hull has continued his series of lectures in connection with which he has used the Chapter's RCA Dynamic Demonstrator Board. In these lectures he has been reviewing the basic fundamentals of radio and assigning "home-work" to be done by the members in order to refresh their memories on these all-important fundamentals. Upon collecting the members' homework at one meeting it was discovered to everyone's surprise that all the members should review and study Ohm's Law. This has proved the value of Tom Hull's lecture series and the assignment of homework.

The chapter had a very pleasant surprise in the form of a visit from a former leading member, Phil Spampinato. He was warmly welcomed and delivered a fine talk and demonstration on Industrial Electronics and sound, and of the many ways in which Electronics can be used. All the members thoroughly enjoyed his talk and expressed the hope that he could find time to visit the Chapter soon again.

PHILADELPHIA-CAMDEN CHAPTER members were enthusiastic about another of the Chapter's excellent programs, this time on Multiplex. Guests of honor were: Chief Engineer of Bogen Presto Company, Mr. Norman Kornetz, whose talk greatly impressed the members; Al Steinberg of Alasco Electronics



A meeting of the New Orleans Chapter.

did a very good job in explaining Multiplex and Stereo; Harry Barton, Sales Manager for Bogen Presto, devoted his talk to the sales aspect and made it sound very profitable; Jock Brittain of University Speakers also said a few words. Marty Weisberg of Bogen Presto was also present.



Guest speakers at a recent meeting of the Philadelphia-Camden Chapter. L to R; Marty Weisberg, representative of Bogen Presto Co., University Speakers and Jackson Instruments; Al Steinberg of AlSCO Electronics; Norman Kornetz, Director of Engineering, and Harry Barton, Sales Mgr., Bogen Presto Co.

A real treat was in store for the members at the next meeting. Chris Urback, one of the newer members of the Chapter, gave an engaging talk all about when he got into Electronics back in 1918 and the changes that have been made since then, and on Electronics in Europe. He told the members in detail some of the high lights of his job and it is no wonder he likes it; he travels all over the world. Some of the experiences and encounters he talked about were indeed unusual and entertaining. The members want to hear more from Chris.

Secretary Jules Cohen has been trying with the G.E. Company to put on a program on color TV for the Chapter. This meeting may have been held by the time this issue of the News is distributed.

The Chapter members were very pleased to receive a visit from Harold Liles of Dover, Del., who comes to Philadelphia occasionally. The members made him welcome and cordially invited him to come to its meetings whenever he is again in Philadelphia on a meeting night.

The most recent new member to join the

Chapter is David Maher of Philadelphia. A warm welcome to you, Dave!

PITTSBURGH CHAPTER enjoyed a real "first" in that its officers elected to serve for 1962 were sworn in by NRIAA President Frank Skolnik. This was one of the best meetings the Chapter has ever had. There were 47 members at the meeting. The program was handled by the Radio Parts Company of Pittsburgh. Tom Drapra of the Radio Parts Company delivered a talk on ordering replacement parts and also on the collection of bills. Each of the members present received a Thordarson-Meissner Perpetual Parts catalog. The company also distributed four other parts catalogs useful in TV servicing, along with some attractive prizes. The meeting ended with coffee and refreshments.

At the next meeting, James Goldbach gave a talk on speakers and how to recone them; Tom Schnader, on speaker connections for high fidelity and the installation of earphone jacks.



NRIAA President Frank Skolnik congratulating Chairman Howard Tate following installation of Pittsburgh Chapter officers.

The Chapter has observed a notable increase in attendance at the meetings since it began having representatives of manufacturers and distributors as guest speakers. More such meetings have been planned.

SAN ANTONIO ALAMO CHAPTER is another Chapter of the NRIAA which enjoys films. Two that were recently shown were particularly interesting. The first was "The Effects of the Ionosphere on Radio Wave Propagation" and the second one was "Microwave Oscillators," which dealt with the basic theory of the magnetron and the klystron.

Two Navy films were featured at another meeting, one on the construction of a regenerative receiver and the other was an explana-

tion of the sine wave.

Chairman Tom DuBose is furnishing the Chapter with a Radio receiver from which some of the members will construct a bread-board to be used in connection with future discussions and lectures.

SAN FRANCISCO CHAPTER'S meeting at which the officers for the current year were



Chairman of Entertainment and Refreshment Committee Isaiah Randolph presiding over the refreshment table at San Francisco Chapter's third anniversary celebration.

installed was also the occasion for the Chapter's Third Anniversary Celebration. Much cake, pie (prepared by the wives of the members) coffee and ice-cream were in evidence. And the members did a workman-like job of consuming them. As usual, Isaiah Randolph was in charge of the refreshments. He is Chairman of the Entertainment and Refreshment Committee, a post which he has conscientiously and faithfully filled since the establishment of the Chapter.

At the next meeting Andy Royal undertook a thorough discussion of basic transistor theory. He was unable to complete this discussion in one meeting, so he was scheduled to complete it at the following meeting and then devote the remainder of the meeting to a talk on TV servicing.

The latest member to join the Chapter is Alfred Sheridan. Welcome to the membership, Alfred;

SOUTHEASTERN MASSACHUSETTS CHAPTER reports its officers for 1962 as follows: James Donnelly, Chairman; Daniel DeJesus, Vice-Chairman; Oliva LaPrise, Secretary;

and John Nery, Treasurer. Our best wishes to these officers!

After the elections and the swearing-in ceremonies were over, the meeting resolved itself into a bull session over an excessive current drain problem in an auto Radio. The discussion got nowhere; the problem stumped every member taking part in it.

At the next meeting John Alves brought forth a Philco 19-inch Briefcase Portable Radio Receiver for the members present to practice trouble-shooting on. Compactness was a big problem -- that is, getting into the tuner with probes. Using isolation methods during the trouble-shooting, the defect was found to be in the tuner.

Much interest on the part of the members has been indicated in the coming meetings to be devoted to color Television, record changers, and transistor circuitry.

SPRINGFIELD (MASS.) CHAPTER held one of its shop meetings at the home of Secretary John Park. Three TV receivers, one transistor radio and one high fidelity phonograph were brought in to test the skills of the members. All were diagnosed with the exception of one which gave the members a bad time of it. Finally Joe Gaze in desperation put his finger on the control grid terminal and presto! - the problem was solved. Within the socket, invisible to the eye, a socket terminal was broken in two -- proving that not all TV troubles are electronic, that some mechanical failures are common.



San Francisco Chapter's experimental transistor kit and a pair of loudspeakers attached to a stereo amplifier built by Chairman Ed Persau, which he demonstrated to the members.

Tom Glog, throughout the course of the evening, kept hold of a rubber mallet with which he intended to use brute force on an old RCA chassis. Eventually, a tap on an audio amplifying tube disclosed an intermittent condition and this problem was also solved.

The evening terminated with a delicious luncheon for which the members expressed their appreciation to Mrs. Park.

Directory of Local Chapters

Local chapters of the NRI Alumni Association cordially welcome visits from all NRI students and graduates as guests or prospective members. For more information contact the Chairman of the chapter you would like to visit or consider joining.

CHICAGO CHAPTER meets 8:00 P. M., 2nd and 4th Wednesday of each month, 666 Lake Shore Dr., West Entrance, 33rd Floor, Chicago. Chairman: Edwin Wick, 4928 W. Drummond Pl., Chicago, Ill.

DETROIT CHAPTER meets 8:00 P. M., 2nd and 4th Friday of each month, St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Mich.

FLINT (SAGINAW VALLEY) CHAPTER meets 8:00 P. M., 2nd Wednesday of each month at Chairman Andrew Jobbagy's Shop, G-5507 S. Saginaw Rd., Flint, Mich.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month, at homes or shops of its members. Chairman: George Fulks, Boonsboro, Md., GE2-8349.

LOS ANGELES CHAPTER meets 8:00 P. M., 2nd and last Saturday of each month, 5938 Sunset Blvd., L. A. Chairman: Eugene DeCaussin, 5870 Franklin Ave., Apt. 203, Hollywood, Calif.

MILWAUKEE CHAPTER meets 8:00 P. M., 3rd Tuesday of each month, at home of Treasurer Louis Sponer, 617 N. 60th St., Wauwatosa, telephone SP4-3289. Chairman: Phillip Rinke, RFD 3, Box 356, Pewaukee, Wis.

MINNEAPOLIS-ST. PAUL (TWIN CITIES) CHAPTER meets 8:00 P. M., 2nd Thursday of each month, Walt Berbee's Radio-TV Shop, 915 St. Clair St., St. Paul. Chairman: Paul Donatell, 1645 Sherwood Ave., St. Paul, Minn.

NEW ORLEANS CHAPTER meets 8:00 P. M., 2nd Tuesday of each month, home of Louis Grossman, 2229 Napoleon Ave., New Orleans. Chairman: Herman Blackford, 5301 Tchoupitoulas St., New Orleans, La.

NEW YORK CITY CHAPTER meets 8:30 P. M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: David Spitzer, 2052 81st St., Brooklyn, N. Y.

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

PITTSBURGH CHAPTER meets 8:00 P. M., 1st Thursday of each month, 436 Forbes Ave., Pittsburgh. Chairman: Howard Tate, 615 Caryl Dr., Pittsburgh, Pa., PE-1-8327.

SAN ANTONIO ALAMO CHAPTER meets 7:30 P. M., 2nd Thursday of each month, National Cash Register Co., 436 S. Main Ave., San Antonio. Chairman: Thomas DuBose, 127 Harcourt, San Antonio.

SAN FRANCISCO CHAPTER meets 8:00 P. M., 1st Wednesday of each month, 147 Albion St., San Francisco. Chairman: E. J. Persau, 1224 Wayland St., San Francisco, Calif.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets 8:00 P. M., last Wednesday of each month, home of John Alves, 57 Allen Blvd., Swansea, Mass. Chairman: James Donnelly, 30 Lyon St., Fall River, Mass.



SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., 1st Friday of each month, U. S. Army Hdqts. Building, 50 East St., Springfield, and on Saturday following 3rd Friday of each month at a member's shop. Chairman: Norman Charest, 43 Granville St., Springfield, Mass.

SOLUTION OF AMPLIFIER PROBLEM

$R_L = 14K \text{ ohms}$
 $E_{bb} = 350 \text{ volts}$
 $E_{cc} = -4 \text{ volts}$

SIGN at the bottom of a steep hill in West Virginia, "Resume Breathing."

SIGN near a New Jersey crossroads, "Cross Road 200 Yards Ahead. Better Humor It."

NRI NEWS

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