NRI news

April/May 1963

PHIL LAWSON - NRI'S CHIEF OF QUALITY CONTROL · · · READ ABOUT JOB OPPORTUNITIES IN INDUSTRY ON PAGE 1.

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UNDERSTANDING SERIES AND PARALLEL CIRCUITS
A SIMPLE APPROACH TO TRANSISTORS

NRI NEWS

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Editorial: PROFITS IN THE SKY

I am sure that most of you will agree with me when I say "This has been a cold, wet, and windy winter." The ravages of snow, sleet, and ice - coupled with abnormally high winds, have, in most parts of the country, caused many TV and FM antennas to topple and to become useless. And ice-loading has taken its toll by building up on fragile tubing and snapping these elements like toothpicks.

In our own experience, these same conditions played havoc with our own TV and CB antennas on NRI's roof. So we can share feelings with others who have been mistreated by the weather in like manner.

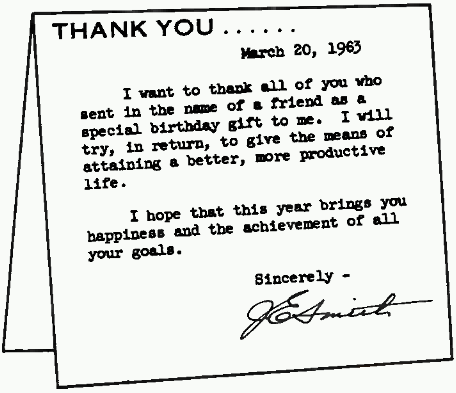
There's an old saying that "One man's misfortune is another man's luck." And indeed it is for service technicians who are aggressive enough to survey their customers and to determine the condition of each antenna installation.

The importance of an efficient antenna has increased many times during the past two years. Color TV and, more recently, FM multiplex both require substantial signals in order to function properly. The customer does not know this in most cases and blames his receiver for generally poor reception.

Most monochrome sets, too, can be pepped up when used with a new and improved antenna. And don't forget to replace the lead-in - especially in neighborhoods where carbon has deposited from coal-burning furnace smoke.

Extra profits await the technician who is willing to "Climb the mountain top and look around" - as the saying goes.

J. M. Smith
President


THANK YOU ......

March 20, 1963

I want to thank all of you who sent in the name of a friend as a special birthday gift to me. I will try, in return, to give the means of attaining a better, more productive life.

I hope that this year brings you happiness and the achievement of all your goals.

Sincerely -

Job Opportunities in Industrial Quality Control

By
Boyd Daugherty
NRI STAFF

Most electronics students and technicians know something of the opportunities for employment in research and development laboratories as engineering assistants or technicians. These same people are also aware of the need for assembly technicians in the production of electronic equipment. Likewise, they are aware of the great number of men employed in installing and maintaining complex electronic systems once they have been developed and produced.

There is, however, a major area of technical employment in the electronics industry with which these men are generally unfamiliar. That area is Quality Control. Quality Control (QC) is a major area of employment in that it often claims as many as ten or fifteen percent of the total technical personnel within a company doing research and development or manufacturing electronic equipment.

Just what is Quality Control? Well, QC generally includes everything that a company does specifically to insure an adequate and consistent level of quality for the company's products. This usually includes all inspection of raw materials and parts, overseeing the development and manufacturing processes to eliminate the causes of low or varying quality, the inspection of products during manufacture and after assembly, and the testing of the first items built from a given design to prove that the design meets the customer's specified requirements. Although it is a mouthful, this is not meant to be a complete picture of Quality Control. However, it should give you some idea of what we mean by QC.

QC PAYS

Quality Control is important to a company only because it will help that company make a satisfactory profit. This it does in two ways. It reduces production costs. It increases and maintains sales.

Manufacturers are concerned with producing goods of acceptable quality at the lowest possible cost. If a large percentage of a company's products must be scrapped rather than sold, or if a high percentage of those sold are returned, the company loses money. For example, if ten items are produced and only eight are saleable, the cost of producing the two items which wind up on the scrap pile must be divided among the eight that can be sold. In this case, the cost of producing the eight items is effectively increased by 25%. This means that the company must either accept less profit (maybe a loss) or sell the items at a higher price. Raising the price will quite likely result in fewer sales, which will also reduce the profits.

On the other hand, if all ten of the units which were produced are saleable, the per-unit production cost will be less than was the case where only eight of the ten could be sold. In addition, the company has two or more items than before on which to make a profit. Obviously it is wasteful for a company to use labor and materials to manufacture equipment which must be scrapped.

Now, what of unsatisfactory or borderline equipment that actually gets delivered to the customer? This can cause far more serious, long-range trouble for a company than the simple increase in production costs discussed previously.

Let's consider a manufacturer who has held a fair reputation over the years for producing a product line that is of satisfactory and reasonably consistent quality. Suppose that through a change of management policy or production methods, this producer allows equipment of poor design or of inferior materials and workmanship to reach the consumer. Although the results may not be felt immediately they can be disastrous to the manufacturer. People will buy the product for a while. The manufacturer may even make a tremendous profit for a year or two. Once the consumer "wises up", however, it's probably too late for the producer. A reputation can be lost far more quickly and easily than it can be built or rebuilt.

QUALITY CONTROL ORGANIZATION

Within a given company, QC activities are, for the most part, the responsibility of a specifically designated group. If the company is of medium to large size, the QC group will actually be a department. This department will include such personnel as electrical and mechanical inspectors, electrical test technicians, environmental test technicians, test equipment repairmen, and electrical and mechanical engineers.

To better understand the QC setups, let's examine a typical electronics company of medium size which develops and manufactures complex equipment. A high percentage of this company's sales is to the Federal Government.

In this company, the QC department is made up of several sections, each of which has primary responsibility in some area of quality control. These sections are:

1. Quality Engineering
2. Incoming Inspection
3. Vendor Quality Control
4. Shop and Assembly Inspection
5. Electrical Test
6. Environmental Test
7. Test Equipment Maintenance

The supervisors of Incoming Inspection, Vendor Quality Control, and Shop and Assembly Inspection report to a Chief Inspector. The supervisors of Electrical Test, Environmental Test, and Test Equipment Maintenance report to a Chief Test Supervisor. In turn, the Chief Inspector, Chief Test Supervisor and the Manager of Quality Engineering report to the Director of Quality Control.

The Quality Engineering Section deals with QC at the philosophical level, so to speak. This group is concerned with such tasks as the interpretation of specifications, the analysis of test reports, the prediction of equipment reliability, and deciding borderline cases involving acceptance or rejection of equipment. This group also prepares the procedures for carrying out quality control functions throughout the company. This group is largely made up of electrical and mechanical engineers, many of whom have had years of industrial experience.

Incoming Inspection makes certain that the company receives what it pays for in the parts and materials which it buys. This is done by inspecting parts and materials when they are received to determine that they have been properly built to specification and that they have not been damaged in storage or shipment. See Fig. 1.

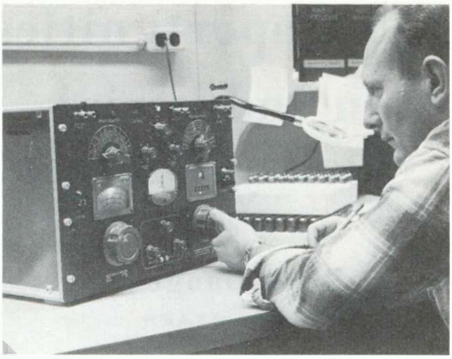


FIG. 1. Incoming inspection at CONAR.

Vendor QC "rides herd" over suppliers of parts and materials to make certain that quality is maintained during manufacture. Typically, Vendor QC will inspect the supplier's plant and evaluate his QC setup before an order is even placed. The manufacturing operation, including inspection and test, is then monitored by Vendor QC while the materials or parts are being produced. In some cases Vendor QC personnel perform "source inspection" before the items are shipped to the purchaser's plant. This may be desirable if the equipment is heavy or cumbersome and therefore difficult or expensive to ship. Source inspection may also be necessary in those cases where specialized test equipment is required to check a particular item.

Shop and Assembly Inspectors work hand in hand with the machinists, sheet metal workers, welders, painters, assemblers, etc., to make certain that no faulty parts or materials get assembled into a finished product. Normally, during manufacturing many separate operations are involved. After each major operation has been completed, the work is inspected before the next step is begun. For example, suppose we have a part which is first cast, then machined, and finally plated. If the casting has a crack, it would be much cheaper to determine this before commencing to machine the part. Likewise, why waste time and materials to plate the part if it was ruined during the machining operation? Another example would be a chassis which is formed, welded, punched, plated and then has parts mounted and wired. What happens if no one determines that the chassis is oversize, has been improperly welded or has been punched incorrectly, until assembly has been completed? The company loses money. Shop and assembly inspection reduces such waste to a minimum.

The engineers and technicians of the Electrical Test Section test each item of equip-

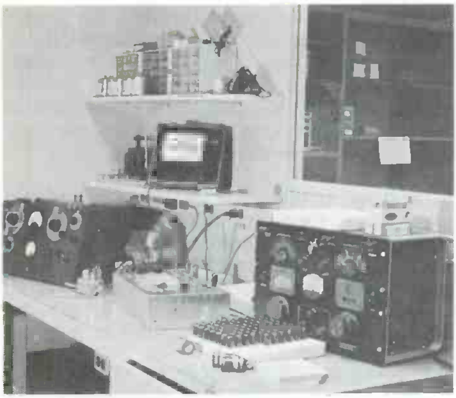


FIG. 2. Production test bench in CONAR Quality Control.

ment which this manufacturer delivers to his customers. Some tests are simple; others are complex. Sometimes individual units or chassis are tested. Again, testing may be done on a complete electronic system. See Fig. 2. In any case, the necessary tests are made to prove the equipment operates according to the customer's specifications.

In addition to testing each item produced for proper operation, this group performs design tests sometimes referred to as "qualification" tests. These tests are performed on one or more of the first items built to a new design to demonstrate that the design meets the requirements of the customer's specifications. See Fig. 3. In general, design tests are more complete, more exacting, and far more rigorous than any tests which are performed on equipment to be delivered to the customer for actual use. Typical electrical tests for design evaluation include:

1. Life tests to determine the probable life of the equipment. Life testing quite often consists of operating the equipment continuously for many weeks. This frequently is done at voltage extremes and under such hardships as being exposed to high and low temperatures, vibration, etc.

2. Power tests to determine whether the equipment is sensitive to input voltage or frequency variations.

3. Radio frequency interference (RFI) tests which determine if the equipment produces interference which could interfere with other equipment or if the equipment being tested is unduly affected by interference produced elsewhere.

At the completion of design testing, the electrical test group generally prepares a detailed test report which is submitted to the customer.

The Environmental Test Group operates a laboratory where equipment may be tested under artifically produced environmental conditions. If a customer's specifications state that an item of equipment must operate at a certain altitude, at a specified temperatures and while being subjected to vibration at a certain frequency, this can be determined right in the plant. Environmental test personnel generally work closely with the engineers and technicians of the Electrical Test Group. This is necessary because many electrical and environmental tests must be performed simultaneously. The major types of equipment found in the environmental test laboratory include:

1. Temperature Altitude Chambers. These are well insulated, pressure tight compartments fitted with heating and refrigerating equipment and vacuum pumps. Automatic controls are used to maintain the chamber at a specified temperature-altitude condition. Electrical connections are provided so the item being tested can be operated while in the chamber.

2. Humidity Chambers. These boxes provide a specified humidity at a required temperature.

3. Salt Fog Chambers. This equipment permits exposing the test item to a simulated marine environment.

4. Vibration Machines. These are used to simulate conditions found in aircraft, missiles, etc. The rate of vibration is generally variable from a few cycles per second to as high as, perhaps, 2000 cycles per second. The amplitude of vibration is also variable.

5. Mechanical Shock Machines. This equipment simulates the shock that a piece of equipment might receive from being dropped or from sudden stops such as in a collision.

FIG. 3. Art Widmann testing the CONAR Custom 70.

6. X-ray Equipment. After a piece of equipment has been "tortured" on the vibration or shock machines it is x-rayed to determine if flaws have been produced at welds or within structural members. Again, the x-ray is sometimes used to determine if electronic parts or assemblies within a sealed unit have been damaged.

Environmental test equipment is very expensive. A completely equipped laboratory can cost several millions of dollars. For this reason, many companies which do not have a continuous need for such equipment subcontract their environmental testing to commercial testing laboratories.

In the company we are discussing, all maintenance and calibration of test equipment is done by the Test Equipment Maintenance Section. In many companies these activities are QC functions. However, this is not always the case. Quite often test equipment will be repaired and calibrated by the production or engineering departments. In this case, calibration is spot checked by QC.

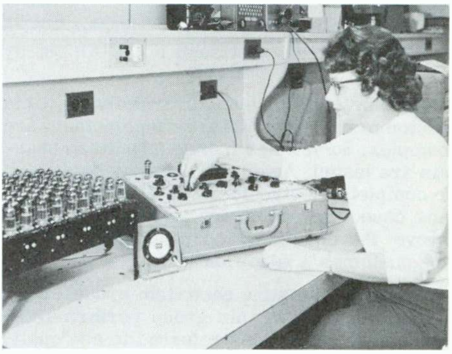
GETTING INTO QC

Where would you fit into Quality Control? Well, many NRI students and graduates are successful electrical test technicians. Indeed, many have been promoted to more and more responsible supervisory positions at exceptionally high salaries. You can easily see that a man must have technical training that is both broad and thorough if he is to devise and carry out test procedures on the wide range of electronic equipment that is produced today. Employers know that NRI training meets these requirements.

If you have had mechanical training or experience in addition to your electronics studies, you may find a rewarding career as an environmental test technician. Experience in refrigeration, or automotive, or aircraft maintenance can be directly applied in the test laboratory. And what of your electronics training? This will not be wasted in environmental work. Most of the equipment found in an environmental test laboratory is electronically controlled. Many electrically operated recorders are also used. Please note also, that the typical vibration machine consists of a variable frequency audio oscillator feeding a gigantic power amplifier which in turn drives the "shake table"; the shake table being essentially a giant loudspeaker with the table top taking the place of the cone. Obviously, if you are going to operate such equipment it will be helpful if you know how it works.

If you have done instrument repair or are experienced in meter calibration, the possibility of getting into a test equipment group is obvious. On the other hand, if you enjoy assembling equipment, and have a professional interest in seeing that everything is put together properly, you might find the work of an inspector rewarding.

In addition to technical training and suitable experience, there are other skills which are quite useful in a quality control career. Perhaps skill in technical writing is the most important of these secondary abilities. True, many men have been quite successful as technicians without developing skill in writing.



Helen Gillespie checking mutual conductance of pre-cooked tubes for use in NRI training kits.

However, many of these could undoubtedly have gone further up the ladder had they been able to write.

To make certain that testing is performed uniformly and fairly, a written test procedure is prepared. This procedure must state clearly what tests are to be run, the order in which they are to be run, exactly how they are to be performed, and the results which must be obtained for acceptance of the unit or design being tested. Test procedures are generally prepared by the electrical or environmental test groups of the manufacturer. Such procedures are submitted to the customer for his approval before the tests are performed.

At the conclusion of a testing program, a report is generally prepared by the group which performed the testing. This test report is then submitted to the customer.

As in other technical areas, the writing done in connection with quality control should not be fancy. Rather, if it is useful it must be easily understood. This suggests the use of short, simple phrases made up of words in general usage. Evasive, round-about expressions should be avoided. The ability to write acceptably is not beyond the reach of most NRI men, if they really wish to learn.

DESIRED PERSONAL TRAITS

Now, let's list some of the more important personal traits that are important to a successful career in quality control. Probably no one would be rated favorably in all the traits listed below. Also, some are obviously more important than others:

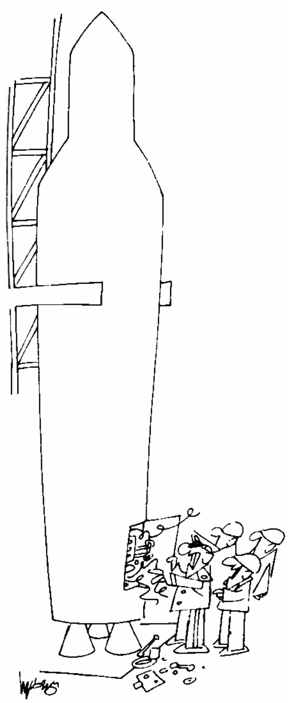
1. Honesty - This is, no doubt, most important of all. You must be honest for you must "call 'em as you see 'em."
2. Tact - This is very important, for much of what you must say, orally or in writing, will pertain to the skills, abilities, and attitudes of others.
3. Courage - You must be ready to defend your decisions whenever they are challenged.
4. Expression - You must be able to explain simply and accurately why you have rejected (or accepted) a given piece of equipment.

There are many other personal traits of importance in QC work. However, we feel that most of the others are obviously important in every area of work as well as in QC. On the other hand, we have not meant to imply that the four listed above are applicable only to quality control. They are essential in all areas of work, but the absence of any one of the four in the personal makeup of a QC man is painfully conspicuous.

SUMMARY

In this article, we briefly defined quality control and then attempted to show why QC is important to any company producing equipment. We have shown that QC will more than "pay its way" by reducing production costs and increasing sales.

Next, we described in detail the functions of the major groups making up the QC Department in a typical company producing electronic equipment. We then discussed the QC areas most likely to offer rewarding job opportunities to NRI men. Finally, we listed the more important personal traits desirable in a man planning to work in quality control.



"Sir, would you like me to show you how we did it back at Deer Run Technical Institute?

Why Not Retire To - Instead of From?

Washington (Special) - Peace Corps has just announced that at least 6000 new Volunteers will be needed during 1963 to fill its many project posts overseas in some 44 countries throughout Latin America, Africa and Asia. Hundreds of these posts could be filled by men and women now planning to retire from their regular occupations.

Teachers of all kinds, doctors, dentists, nurses, laboratory technicians, auto mechanics, builders, electricians, farmers, radio and TV mechanics, engineers, geologists, lawyers, city planners, social workers - just to mention a few, can all be used. These posts are rated high for successful retirement to a field, rather than from it - provided of course, the volunteer is in good health and possesses a skill or knowledge that has been requested by an overseas host country.

Any U. S. citizen possessing one of the above or similar skills, but who dreads the thought of retirement, and would prefer thus to add a fitting climax to a successful career within the field of public service, should secure a copy of the brochure "Older Volunteers in the Peace Corps" plus a Questionnaire, by writing to PEACE CORPS, SENIOR MANPOWER RECRUITMENT, WASHINGTON 25, D. C.

Understanding Series and Parallel Circuits

by

Richard Stanchik

NRI STAFF

We frequently receive letters from NRI students who ask "What good is it to know how to calculate formulas for resistors, condensors, and inductors? What I want to do is learn how to fix Radios and TV's." They are eager to do practical work without knowing what to expect when they take measurements and readings. A technician will probably not be required to make calculations of resistors in various circuits. But knowing how it is done and how these circuits act helps the technician solve his servicing problems better. It also shows him what to expect when taking ohmmeter readings. There are still many "oldtimers" in the servicing field who go about taking ohmmeter readings without really understanding why a reading was erroneous and not like the schematic called for.

Let's first see how the basic ohmmeter operates. Then we shall look at how series, parallel, and series-parallel circuits are identified and calculated in electronic circuitry.

The ohmmeter is an instrument that measures the dc resistance of a circuit element or network. The value of resistance is read on the meter scale in ohms. It can be used to measure open circuits, the continuity of a circuit and also give a rough idea if a capacitor is in good shape.

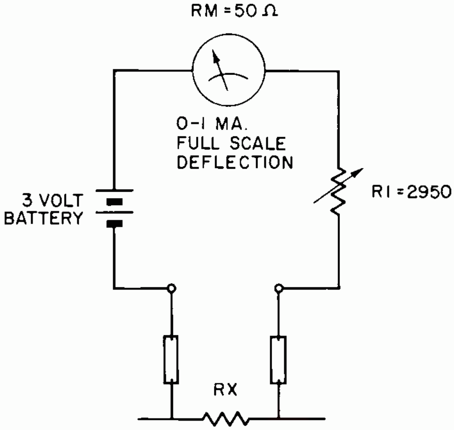


FIG. 1. Basic ohmmeter circuit.

A basic ohmmeter consists of a sensitive meter movement, a low voltage dc source, such as a small battery, and a current-adjusting resistor. Fig. 1 shows a simple ohmmeter circuit. It consists of a 3V battery in series with a 0-1 ma meter movement and an adjustable resistor, R1. If the probes are shorted together, current will flow through the meter. We can adjust this current by varying the total resistance in the circuit. This is done by adjusting R1 so there is a full-scale deflection of 1 ma. The point where the needle rests on full-scale deflection is marked as zero resistance on the dial. This indicates we have zero resistance in the external circuit when the probes are shorted together. When the probes are opened, there is no current flow and the needle rests on the opposite side of the dial. This is marked "Infinite Resistance."

The amount of resistance required to have 1 ma of current flowing can be found by Ohm's Law,

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

Therefore,

$$R = \frac{3}{.001} = 3000\Omega$$

Since we already have a 50 Ω meter coil resistance in the circuit, the value R1 should be adjusted to (3000 - 50) = 2950 Ω.

If we put a known resistor, say 3000Ω, across the probes we will have half the current flowing through the meter. This will give us a half-scale deflection. By Ohm's Law

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

$$I = \frac{3}{6000} = .0005 \text{ amp or } .5 \text{ ma.}$$

The dial can be marked at this half-scale position as 3000 Ω. Using a known resistor twice as large as the total meter circuit resistance causes one third of the current to flow which deflects the meter only one third of the way.

So you see we have a convenient calibration system for the simple ohmmeter. There are variations in ohmmeter circuits. But, basically, they operate on the idea of varying the current flow in the meter by inserting known or unknown resistors.

Now that we know how a basic ohmmeter operates, the next step is to understand the basic circuits of resistance that a service technician will find in electronic equipment. These basic circuits are called series, parallel, and series-parallel circuits.

Let's take the series circuit first. A good definition of a series circuit is one in which the same current passes through each circuit element in completing its path to reach the source of supply.

Fig. 2 is a typical series circuit. It consists of three resistors connected together to form a continuous path. Our source of current consists of a battery connected across points A and B. The current, I, has to pass through each resistor (R1, R2, R3) to reach the positive pole of the battery or the source of supply.

The total resistance that the current I has to overcome is found by adding all the separate resistors together in this series circuit. Therefore,

$$RT = R1 + R2 + R3$$

$$= 50 + 100 + 10$$

$$= 160\,\Omega.$$

If there were a greater number of resistors connected together, the total resistance would still be found by adding them together.

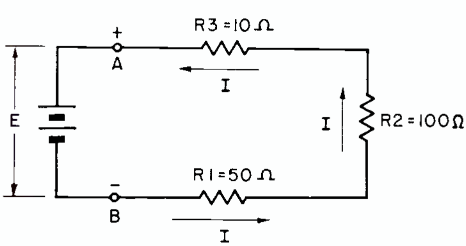


FIG. 2. Series circuit.

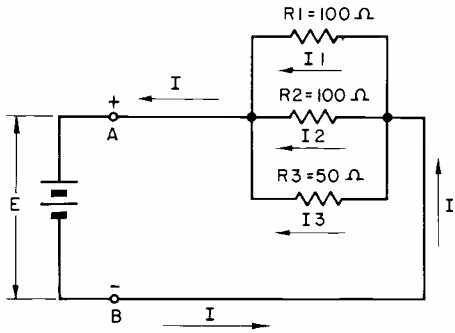


FIG. 3. Parallel circuit.

The next circuit we need to understand is a parallel circuit. A parallel circuit is a circuit in which there are two or more paths for a current to follow in completing its path to the source of supply.

In Fig. 3 we have three resistors connected together to form a parallel circuit. The current I splits up into three separate branches. It divides up into I1, I2, and I3. The three separate currents then re-combine as current I to reach the source of its supply.

We have to use a different means of determining the total resistance value of parallel circuits. This can be done by using the formula

$$\frac{1}{RT} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \ldots \text{ etc.}$$

As you can see, this involves a lot of handling of figures, and a much easier method of finding the value of a number of parallel resistors is available.

We do this by grouping the resistors in sets of two and then use the formula for two resistors in parallel which is:

$$RT = \frac{R1\,R2}{R1 + R2}$$

After we find the value for two resistors, the result is combined with the third, again using the formula for two resistors in parallel.

Take the resistors in Fig. 3 and, using the formula

$$R_T = \frac{R1\,R2}{R1 + R2} \quad \text{we have}$$

$$R_T = \frac{100 \times 100}{100 + 100} = 50\Omega$$

This is the value of R1 and R2 in parallel.

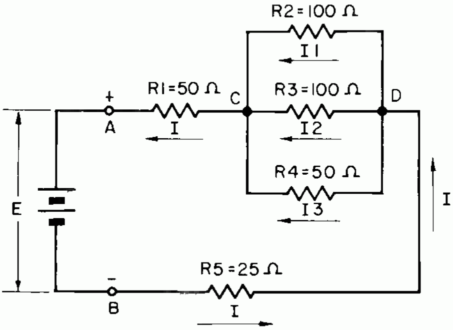


FIG. 4. Series-parallel circuit.

To find the total value for all three of the resistors, we re-apply the formula and find

$$RT = \frac{50 \times 50}{50 + 50} = 25\ \Omega$$

If there had been a fourth resistor, we could continue on with this grouping process to find a new total value.

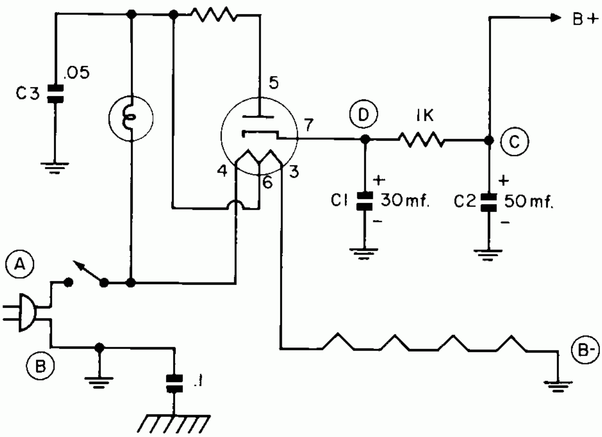


FIG. 5. AC-DC power supply.

An important fact to remember about parallel circuits is that the total resistance of the group will be lower in value than the smallest value resistor in that group.

Since we have covered the makeup of a series and a parallel circuit, it should be easy to see what a series-parallel circuit consists of.

We have a series-parallel circuit when there are three or more circuit elements connected in such a way that at least two of the elements are in a parallel connection.

Fig. 4 gives us a better picture of what a series-parallel circuit looks like. The parallel branch of resistors between C and D are in series with resistors R1 and R5. The total current, I, has to pass through the series resistor R5, the parallel branches R2, R3, R4, and through the series resistor R1 to reach its source of supply.

Since we know how to find the total resistance of parallel and series circuits, determining the total resistance of a series-parallel circuit is made easy. The parallel circuits are handled first and reduced to a single value resistor. The parallel circuits then become part of an element in a series connection.

In Fig. 4 the parallel branch between C and D can be reduced to a single value resistor by applying the parallel formula

$$RT = \frac{R1\ R2}{R1 + R2}$$

Doing this gives us an equivalent resistance of 25 Ω between points C and D. This 25 Ω resistor is in series with R1 and R5. The total resistance of the series circuit is found by using the series formula

$$RT = R1 + R2 + R3 + \ldots \text{etc.}$$

In our example,

$$RT = 50 + 25 + 25$$

$$= 100\ \Omega$$

Let's take a number of typical electronic circuits and, with an ohmmeter, see how our new-found knowledge can be put to good use.

Remember to remove the power from a circuit being measured by opening the power switch or pulling the power cord from the wall receptacle. The ohmmeter could be damaged if this is not done. The ohmmeter furnishes its own current and any other current flowing in the circuit would cause inaccurate readings.

Fig. 5 is a diagram of a half-wave power supply of the type found in AC-DC receivers. You will encounter many radios of this type in your servicing career.

The filaments are connected in series. You should obtain a reading of about 100 ohms if you close the switch and place the ohmmeter leads across points A and B. This would indicate the filament circuit is continuous. Notice that the pilot lamp is in parallel with one half of the filament in the rectifier tube. The filaments plus the pilot lamp constitute a series-parallel circuit. Part of the total filament circuit current also flows through the pilot lamp. If the pilot lamp should burn out, the 35W4's filament would open shortly.

Another point we can check with our ohmmeter is between point C and B-. A reading of no less than 100K ohms should be seen here. The reading of 100K or even a megohm is the total leakage path made up of the filter capacitors and circuit components. A lower reading would indicate a low resistance leakage path or a short in parallel with the output of the power supply.

You might find that when you first apply the probes to points C and B the pointer has a tendency to swing off-scale. This is due to the capacitors C1 and C2 still being charged. You can correct this by discharging them.

Knowing the parallel circuit concept gives you a clue to why a low reading is present. The only way you can reduce the value of a measured resistance is by shunting a resistor in parallel with this resistor. In Fig. 5 the reading of 100K at points C and B- could be reduced by one of the following: leaky or shorted filter capacitors C1 or C2, shorts in one of the receiver tubes to B-, leaky or shorted bypass capacitors elsewhere in the circuit.

Fig. 6 gives a better picture of the parallel branches that exist in an AC-DC radio receiver. If the bypass capacitors C3 or C4 were shorted or leaky, an ohmmeter check across the B+ to B- would show a lower-than-usual reading.

If we connect an ohmmeter between pin 6 of V9 and B- in Fig. 7 you might obtain a low reading of about 230Ω. Immediately you would suspect C61A, the 20-mfd filter capacitor, of

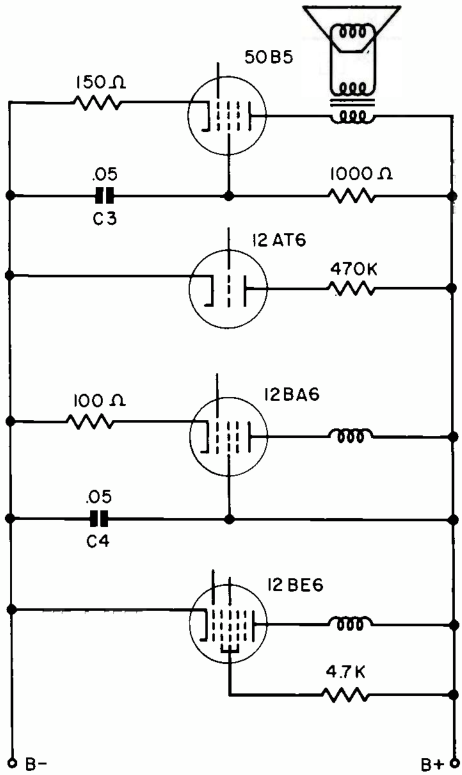


FIG. 6. Parallel branches of an AC-DC receiver.

being very leaky. If this wasn't the solution, what else could be giving this reading? Look closely and you can see another possibility. The suppressor grid is connected internally to the cathode. A screen grid to suppressor short in the 6AQ5A tube would place the 220 Ω cathode resistor in parallel with the screen grid. The defect could be verified by pulling the tube out of its socket and watching the pointer of the ohmmeter.

The secondary winding and the voice coil of the speaker constitute a parallel circuit. To determine whether the voice coil is open with an ohmmeter requires unsoldering the leads from the secondary of the output transformer. The secondary has a resistance of around several ohms. It is lower in value than the speaker voice coil. At these low values of parallel resistance it is difficult to tell whether the voice coil is open unless we measure the voice coil and output transformer secondary separately.

In servicing television receivers you will find many examples of parallel, series, and series-parallel circuits. Fig. 8 consists of a two-stage video amplifier used in our popular

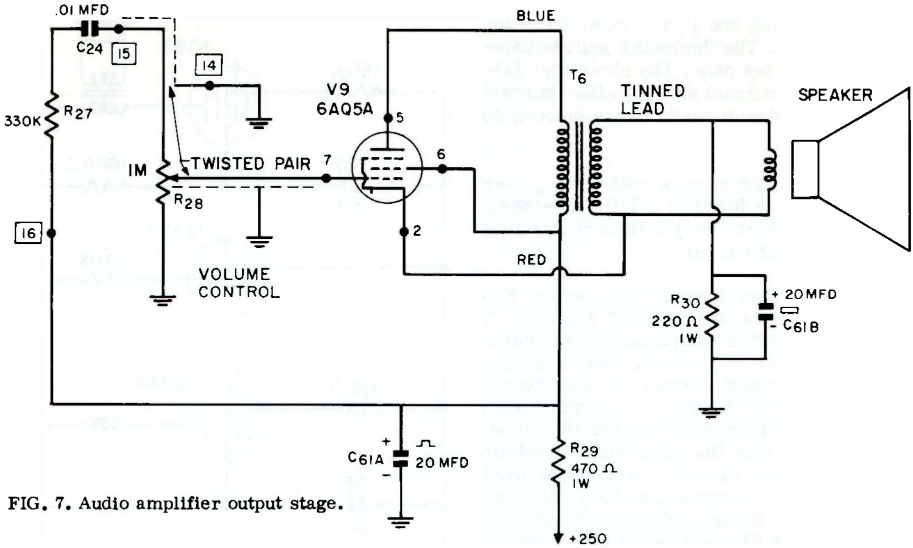


FIG. 7. Audio amplifier output stage.

CONAR Custom 70 TV Kit. The peaking coils and plate load resistors, R15 and R16, form a series-parallel circuit. A complaint of lack of fine detail in the picture can sometimes be traced to one of the peaking coils being open. An ohmmeter placed across the parallel combinations of L7 or L8 will quickly tell you which one is open. The resistance of each coil is very low; therefore, if either coil is open, you would measure only the value of the resistor in parallel.

A complaint of a very grainy picture or sound bars in the picture gives a possibility that the sound trap L6 is misadjusted or shorted out. The sound trap does not usually short internally. However, suppose we disconnected the sound trap from the cathode, measured its resistance, and found it to be correct. Then we placed the probe on the cathode and measured zero resistance. This could only be due to the cathode being grounded to the grounded side of the filament in the tube. The grounded cathode would then ground out the sound trap. Here a knowledge of parallel circuitry helps to pinpoint an unusual servicing problem.

To check the resistance of vertical output transformer T8, shown in Fig. 9, requires

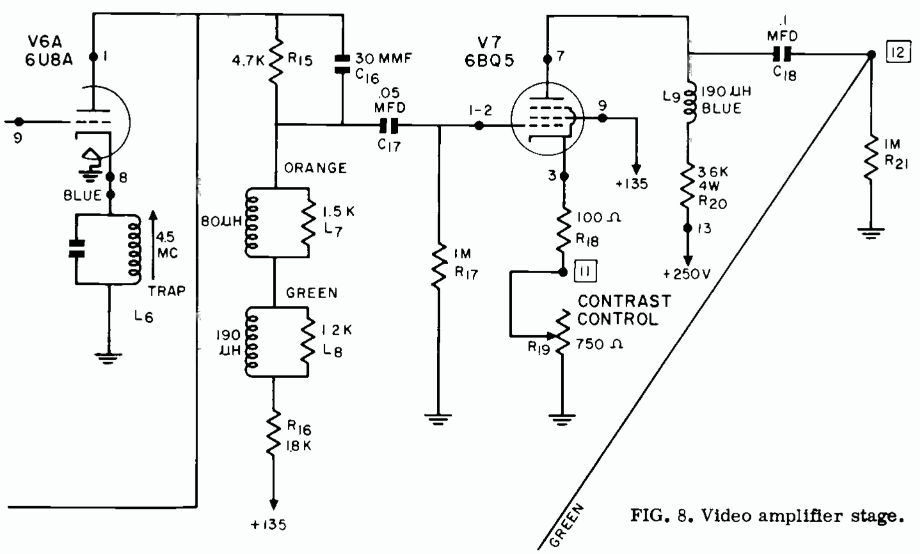


FIG. 8. Video amplifier stage.

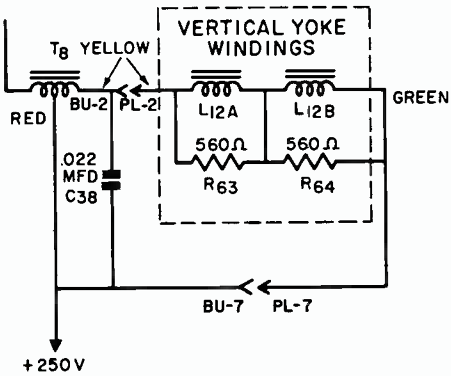


FIG. 9. Vertical deflection yoke.

disconnecting one side of the vertical yoke winding from the transformer. The yoke windings and shunt resistors are in parallel with the transformer. Without disconnecting the yoke windings you would have an erroneous reading on the ohmmeter.

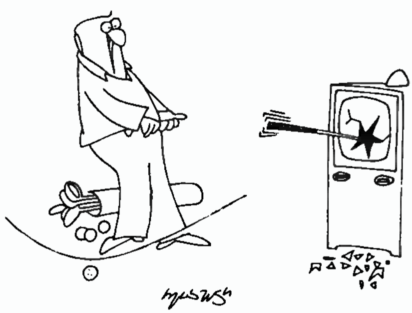
We can check the resistance reading obtained across the secondary of the output transformer without disconnecting the yoke leads. Just apply the parallel circuit resistance formula to the output circuit. If all components are at correct resistance value, the calculations you obtain should check with the ohmmeter reading.

Taking a few extra moments of reviewing the operation and calculation of series, parallel, and series-parallel circuit increases the knowledge of a technician considerably. These are simple concepts that can be used to break down complex circuits into simple circuits. It is much more interesting to service radios and television receivers when you understand "how" and "why" circuits act as they do.

YOU CAN'T WIN!

If a man's after money, he's money-mad; if he keeps it, he's a capitalist; if he spends it, he's a playboy; if he doesn't get it, he's a ne'er-do-well; if he doesn't try to get it, he lacks ambition. If he gets it without working for it, he's a parasite; and if he accumulates it after a lifetime of hard work, people call him a fool who never got anything out of life.

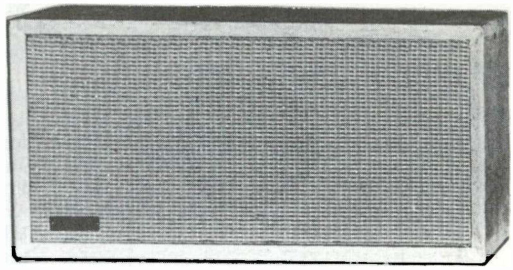
Victor Oliver.

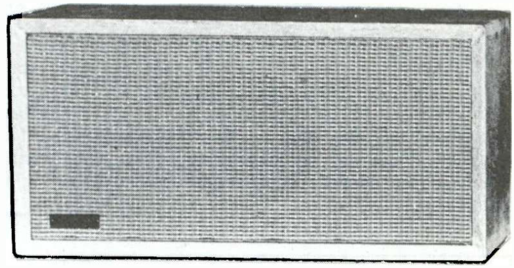


HOW TO ESTIMATE PARCEL POST CHARGES

WEIGHT 1 Lb. and Not Exceeding	Local	1st-2nd Zone, up to 150 mi.	3rd Zone 150 to 300 mi.	4th Zone 300 to 600 mi.	5th Zone 600 to 1000 mi.	6th Zone 1000 to 1400 mi.	7th Zone 1400 to 1800 mi.	8th Zone Over 1800 mi.
2	$0.24	$0.33	$0.35	$0.39	$0.45	$0.51	$0.58	$0.64
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

NOTE: The method of shipment is shown in the description of each item listed. Please do not remit shipping charges for items shipped via Express. These charges will be collected on delivery at no extra cost to you.





MODEL 300 STEREO AMPLIFIER

CONTROLS: Phono-Tuner switch, Balance, Loudness, Bass, Treble, on-off switch
TUBES: 2-7025, 2-6BQ5
CABINET: Steel, baked-on deep gray finish
PANEL: Steel, off-white finish
DIMENSIONS: 4½" x 13" x 9"
POWER SOURCE: 110-120 volts, 60 cycle AC
ACTUAL WEIGHT: 7 lbs.
SHIPPING WEIGHT: 8 lbs.
(other specifications—see opposite page)

MODEL 300 SPEAKER ENCLOSURES

DIMENSIONS: 24" x 12" x 10"
SPEAKERS: 8" extended range (19-21,000 cps.)
GRILLE CLOTH: Gold texture
CONSTRUCTION: 3/4" wood (ready for finishing)
ACTUAL WEIGHT: 21 lbs. each
SHIPPING WEIGHT: 24 lbs. each

LESA CD2/21 RECORD CHANGER

MOTOR: Heavy-duty 4-pole motor (balanced within 100 micro-inches), rubber idle wheel, automatic disengage
SPEEDS: 78, 45, 33⅓ & 16⅔ rpm; constant speed change cycle; automatic intermix 7", 10" & 12" records
TONE ARM: Balanced, no resonance
DIMENSIONS: (overall) 8½" x 16" x 13"
ACTUAL WEIGHT: 14 lbs.
SHIPPING WEIGHT: 16 lbs.

STEREO CARTRIDGE

ELECTRO-VOICE MODEL 0126A: 0.7 mil diamond (lp), 3 mil sapphire (78); tracking force 3-6 grams; response 20-20,000 cps; matched channel output for monaural records

Complete System Stock #300UK. Low as $10.90 down, $10.00 monthly. Shipped via Express for safest handling. Total shipping weight: 72 lbs.

$109.00

NEW from NRI - Conar research and development

"300" stereo system

The shock of common sense in STEREO — you *must* hear it to believe it!

Conar proudly presents an outstanding, quality, yet amazingly economical stereo system — guaranteed to satisfy.

The "300" Stereo System is designed for those who consider their *ears* as the best judge of true stereo reproduction. It is not for people who insist on spending $400 or more for stereo — or people who thrive on long lists of specifications, technically accurate or not.

Here is quality stereo to compliment your tastes for good listening and fit any budget. A precision engineered system with carefully matched components; yet ruggedly built as a home entertainment center for the entire family. With the "300" in your home, you can *afford* to let the wife, children or friends use it (at least on rare occasions).

Whether it's violin, piano solo or bass drum — Beethoven, Belafonte or Brubeck — the "300" urges and invites your comparison with stereo systems costing considerably more. We repeat, let your EARS judge the living sound, superb channel separation, the startling realism that only good component stereo can bring.

The "300" Stereo System includes:

- Conar power amplifier kit, beautifully styled in circuitry and outside appearance. Build it one evening with time left over for a trial run. Reserve output for "concert hall" volume in 30 x 30 living area. Frequency response 50 cps to beyond audible limits. 50 db or better channel separation. (Hum, noise and distortion *not distinguishable* at full output.) Amplifier price if bought separately — $31.50.
- Two, fully assembled bookshelf enclosures with pre-mounted, 8" extended range speakers. Not the usual midget enclosures you'd expect in a low priced system — each is a full 24" x 12" x 10". Sturdily constructed of 3/4" wood ready for finishing to match any decor. (Enclosure and speaker price if bought separately — $19.95 each)
- Electro-Voice Model 0126A diamond-sapphire cartridge; reg. manufacturer's price — $16.50.
- Well-known LESA Model CD2/21 4-speed changer. Fully automatic, heavy-duty 4-pole motor, balanced tone arm, high inertia turntable, automatic intermix and shut-off, constant speed change cycle. Pre-finished walnut base included. (Sells nationally at $49.25.)
- All hook-up wire, coaxial cable, plugs, jacks, etc.

The "300" Stereo System was recently demonstrated at meetings of hi-fi enthusiasts, dealers and service technicians (dates and places upon request). Audience response was *overwhelming*.

Your own 30-day "listener's" test will show you WHY — you *must* hear the "300" to believe it!

CONAR tuned signal tracer

A breakthrough in the servicing of transistor, vacuum tube, or hybrid receivers! Only *tuned* tracer on the market anywhere near the price. Exclusive cathode-follower probe gives outstanding sensitivity for tracing complete circuit from antenna to speaker.

Easily connects to any RF or IF stage with absolute minimum of detuning. Features audio tracing method through built-in PM speaker plus visual indicator using "eye" tube. Quickly locates sources of hum, noise and distortion. Tracks down intermittents, measures gain per stage, accurately aligns radios without signal generator. (Tracer may also be used as sensitive AM radio.) Has *two* stages of RF amplification.

Assembly-operating instructions include more than 12 pages on uses of Model 230. For beginners as well as experienced technicians. Illustrations give test points in different types of receivers. Here's a sensibly engineered instrument designed to pay for itself many times over through years of time-saving, dependable service. (Of course, all parts are U.S. made, top quality.)

$4.00 down, $5.00 a month.
Use order blank page 17.

$39.95 **Kit Stock #230UK. Assembled Stock #230WT—$57.50**

CONAR resistor-capacitor tester

The Model 311 gives fast, accurate, reliable test on all resistors and capacitors. Measures capacity of mica, ceramic, paper, oil-filled and electrolytics from 10 mmfd. to 1500 mfd, 0-450 volts. Checks for leakage, measures power factor and useful life. Shows exact value of resistors from 1 ohm to 150 megohms. Clearly indicates opens and shorts.

Has "floating chassis" design to greatly reduce shock hazards. The Model 311 will also apply actual DC working voltage to capacitors to reveal break-down under normal circuit conditions, a feature far superior to many R-C testers which give low voltage "continuity" tests.

Can be used for in-circuit tests in many applications and circuits. All U.S. made, name-brand components with 1% precision resistors in range circuit.

A basic test instrument that won't become obsolete!

$2.20 down, $5.00 a month.
Use order blank page 17.

$21.95 **Kit Stock #311UK. Assembled Stock #311WT—$29.95**

SPECIFICATIONS

FREQUENCY: 170 kc to 1500 kc (2 bands)

TUNING: Planetary Drive, 3:1 ratio

SPEAKER: 4" PM left side of cabinet (not shown in illustration)

RF TRANSFORMERS: Permeability tuned

ATTENUATORS: Tuned RF and AF

CATHODE FOLLOWER PROBE: (6AB4 tube in special circuit: shipped assembled)

TUBES: (2) 6GM6, (1) 6AV6, (1) 6AQ5, (1) 6E5, (1) 6X4, (1) 6AB4

CONTROLS: Volume, Band Selector, Main Tuning, Fine Attenuator On-Off, Coarse Attenuator, RF-AF switch

CABINET: Steel, black wrinkle finish

PANEL: Steel w/satin finish, black lettering

DIMENSIONS: 9⅞" x 7½" x 6½"

POWER SOURCE: 110-120, 60 cycle AC

SHIPPING WEIGHT: 12 lbs., parcel post

SPECIFICATIONS

RESISTANCE RANGES: 0-500 ohms, 100-50K, 10K-5M, 1.8M - 150M (extended range)

CAPACITY RANGES: 0.1-50 mfd, .001-.5 mfd, .00001-.005 mfd, 18-1500 mfd (extended range)

CONTROLS: Range Selector, Leakage Test Voltage (0-450), Power Factor (0-60%)

TUBES: 6E5 "eye" indicator, 6X4

BINDING POSTS: Special 5-way type

CABINET: Steel w/black wrinkle finish

PANEL: Steel w/satin finish and black lettering

DIMENSIONS: 9⅞" x 7½" x 6½"

POWER SUPPLY: 110-120 V, 60 cycle AC

SHIPPING WEIGHT: 8 lbs., parcel post

CONAR

tuned signal generator

Widely acclaimed as most accurate signal generator near the price.

Uses Hartley type oscillator circuit with *six* separate coils and capacitors to give accuracy *within 1%* after easy calibration. All coils are carefully pre-aligned, double-checked before shipment.

High output of the Model 280 simplifies signal injection for rapid alignment and troubleshooting of transistor and tube receivers. Covers 170 kc to 60 mc in six ranges with harmonic frequency coverage over 120 mc. Ideally suited as marker generator for TV alignment.

Tuning dial features planetary drive with 6:1 ratio for greater accuracy and elimination of backlash. Scale is full 9″ wide with transparent hairline pointer for readings at a glance. Has a single cable for all outputs, no need to change leads when switching from 400 cycle audio to modulated or unmodulated RF.

The Model 280 is a companion instrument to the Model 230 Signal Tracer and Model 311 Resistor-Capacitor tester with the same built-in quality, ruggedness and U.S. made, name brand components.

SPECIFICATIONS

FREQUENCY COVERAGE: 170 kc to 60 mc on 6 bands, 60 mc to over 120 mc on harmonics

CONTROLS: High-Low Output Selector, Main-Tuning Dial, Band Selector — A thru F, Output Selector — Mod, RF, Audio, Attenuator/On-Off switch

TUBES: 6BE6, 12AU7

POWER SUPPLY: solid state

CIRCUIT: Tuned RF coils with mica trimmers on low bands, Ceramic trimmers on high bands, Transformer power supply (isolated from power line)

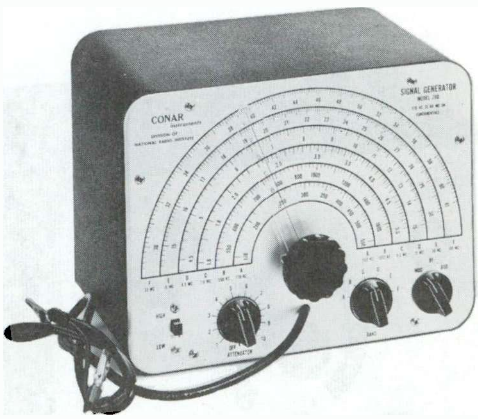
CABINET: Steel, baked-on black wrinkle finish

PANEL: Satin finish steel, black lettering

DIMENSIONS: 9⅞″ x 7½″ x 6½″

ACTUAL WEIGHT: 8 lbs.

SHIPPING WEIGHT: 9 lbs., shipped parcel post insured



$2.15 down, $5.00 a month.
Use order blank page 17.

$21.50 **Kit Stock #280UK. Assembled Stock #280WT—$29.50**

CONAR *instruments*

DIVISION OF THE NATIONAL RADIO INSTITUTE
3939 WISCONSIN AVENUE WASHINGTON 16, D. C.

ORDER BLANK

1- PLEASE PRINT OR WRITE NAME AND ADDRESS PLAINLY

2- SHIP TO ANOTHER ADDRESS? Give directions here.

3- PLEASE CHECK ONE:
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EASY PAYMENT PLAN ☐

4- IF THIS IS YOUR FIRST ORDER TO US
please check here: ☐

5- NRI STUDENT NUMBER

SHIPPED	B. ORD'D	QUANT.	MODEL	NAME OF ITEM	PRICE EACH	TOTAL
Please Do Not Write In This Space. Only Items In This Column Are Charged For	Items Listed In This Column Are Temporarily Out Of Stock. They will Follow Shortly, Unless Cancelled.					

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IMPORTANT. Please use a separate sheet for all correspondence, to speed your order and assure a prompt reply.

All prices are net F.O.B. Washington, D. C.

Include postage for weight shown and insurance on Parcel Post orders. Often orders for two or more kits can be shipped in a larger single carton.

Express Orders should not include shipping charges. They will be collected on delivery at no extra cost to you.

A 20% deposit is required on all C.O.D. orders.

ON TIME PAYMENT ORDERS please be sure to complete the Easy Payment Plan on the reverse side.

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YOU REMITTED		
BALANCE DUE		
REFUND		

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Add sales tax on all deliveries in Dist. of Col.	
Amount for Parcel Post. Please don't remit for express shipments.	
TOTAL AMOUNT ☐ Remitted ☐ Ship Bal. C.O.D. 20% deposit required	
DOWN PAYMENT (at least 10% of total)	

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Unpaid Balance	Carrying Charge	Monthly Payments	Unpaid Balance	Carrying Charge	Monthly Payments
Up to $20.00	$ 2	$ 5	160.01-170	$ 17	$ 16
$ 20.01-30	3	5	170.01-180	18	17
30.01-40	4	5	180.01-190	19	18
40.01-50	5	5	190.01-200	20	19
50.01-60	6	6	200.01-210	21	20
60.01-70	7	7	210.01-220	22	21
70.01-80	8	8	220.01-230	23	22
80.01-90	9	9	230.01-240	24	22
90.01-100	10	10	240.01-250	25	23
100.01-110	11	11	250.01-260	26	24
110.01-120	12	11	260.01-270	27	25
120.01-130	13	12	270.01-280	28	26
130.01-140	14	13	280.01-290	29	27
140.01-150	15	14	290.01-300	30	28
150.01-160	16	15			

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1. Fill in Order Blank on the reverse side of this sheet, listing equipment you wish to buy.
2. In the Easy Payment Agreement below, insert amount of your down payment (at least 10% of your total order).
3. Find your monthly payment for the unpaid balance in the Easy Payment Table. Insert the monthly payment in Agreement below. Note: If you pay the balance in 60 days, handling charge will be refunded.
4. Sign the Easy Payment Agreement with your usual signature in ink and fill in the credit application completely.
5. Mail order and your down payment to Conar Instruments, 3939 Wisconsin Avenue, Washington 16, D. C.

Additional purchases—Once your credit is established and you have made at least three payments on your account, you can "add-on" to your account with purchases of $20.00 or more. No down payment is required for add-ons of less than $100.00. Just list items you want on the Order Blank on reverse side and check box marked "add-on" above. Sign Easy Payment Agreement below and mail order to us.

IF THIS IS A NEW ACCOUNT, PLEASE FILL IN THE SECTIONS BELOW COMPLETELY. If you have an account open or recently paid in full, just sign the Easy Payment Agreement.

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Note: Easy payment contracts cannot be accepted from persons under 21 years of age. If you are under 21, have this sheet filled in by a person of legal age and regularly employed. He can make the purchase for you, and will be responsible for payment.

Enclosed is a down payment of $________ on the equipment I have listed on the reverse side. Beginning 30 days from the date of shipment I will pay you $________ each month until the total payment price is paid. You will retain title of this equipment until this amount is fully paid. If I do not make the payments as agreed, you may declare the entire unpaid balance immediately due and payable, or at your option, repossess the equipment. Your acceptance of this order will be effected by your shipment to me of the equipment I have listed.

Date________________ Your written signature________________________

CREDIT APPLICATION

Print Full Name______________________________ Age________

Home Address______________________________________

City & State________________________ How long at this address?________

Previous Address____________________________________

City & State________________________ How long at this address?________

Present Employer__________________ Position__________ Monthly Income________

Business Address________________________ How long employed?________

If in business for self, what business?________________ How long?________

Bank Account with____________________________ Savings ☐ Checking ☐

CREDIT REFERENCE (Give 2 Merchants, Firms or Finance Companies with whom you have or have had accounts.)

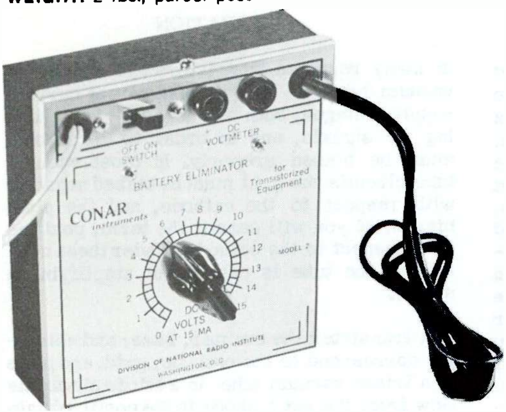
Credit Acct. with______________________________ Highest credit________
(Name) (Address)

Credit Acct. with______________________________ Highest credit________
(Name) (Address)

USE ORDER BLANK PAGE 17

SPECIFICATIONS

OUTPUT: 0-15 volts DC, fully variable, maximum 100 ma
INTERNAL IMPEDANCE: below 2 ohms
DC RESISTANCE: below 100 ohms
JACKS: Pos and neg plug-in type for DC voltmeter readings
SWITCH: slide type on-off
CASE: Steel with black wrinkle finish
PANEL: Polished steel, etched lettering
DIMENSIONS: 4½" x 5"
POWER SUPPLY: 110-120 volts, 60 cycle
WEIGHT: 2 lbs., parcel post



CONAR transistor battery eliminator

Used for designing, servicing, operating any type of portable battery operated, transistorized equipment.

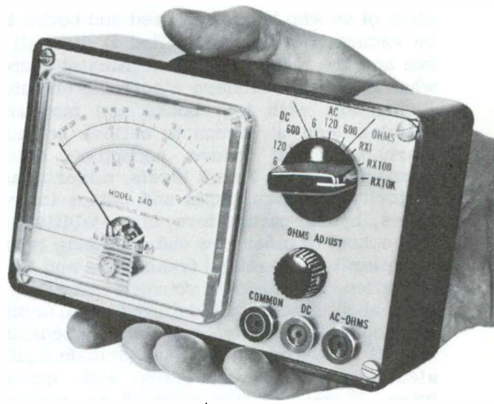
Ideal for repairing transistor radios. No need to stock and run-down expensive batteries. Continuously variable output permits circuit measurements at exact voltages recommended by manufacturer.

Not a kit. Shipped fully wired, ready to use. Price includes 40" red and black test leads with insulated alligator clips. (Note: This unit not designed for automobile radios.)

$13.67 **Stock #2WT**

SPECIFICATIONS

DC SENSITIVITY: 20,000 ohms per volt
AC SENSITIVITY: 5,000 ohms per volt
DC RANGES: 0-6-120-600 (30,000 volts with optional TV probe)
AC RANGES: 0-6-120-600
OHMMETER RANGES: 0-1,000 ohms, 0-100,000 ohms, 0-10 meg (will estimate ½ ohm at low end, 20 meg at high end)
DIMENSIONS: 3¾" x 6¼"
CASE: Black bakelite
PANEL: Satin-finish aluminum, etched lettering
ACTUAL WEIGHT: 2 lbs.
SHIPPING WEIGHT: 3 lbs., shipped parcel post insured



CONAR volt-ohmmeter

Compact, precision, yet rugged 3-in-one instrument. Easily fits in coat pocket or tool box.

Completely portable, uses 9 volt battery on ohms ranges with hundreds of hours life. A stock battery size available anywhere. Has jeweled D'Arsonval meter, 1% resistors, all U.S. made quality parts.

Easily assembled in less than one hour. Low price includes 48" test leads and 9 volt mercury battery.

Assembled Stock #240WT—$19.95

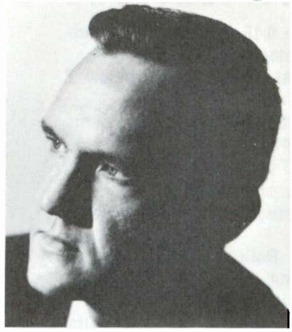
$17.95 **Kit Stock #240UK.**

A Simple Approach To Transistors

By

Ted Beach

NRI STAFF



INTRODUCTION

Most of us who have been bred and bottle fed on vacuum tube circuits, find it difficult to see how the ridiculously tiny transistor does what it does in modern electronic circuits. Encounters with text books and magazine articles lead a person to believe he must learn all about donors, acceptors, holes, semiconductors, Fermi levels, minority and majority carriers, input and output impedances, hybrid parameters, bias stabilization and a host of other new and confusing terms in order to understand transistors and their operation. Stop and ask yourself just what you know about electric field distribution, mutual transconductance, dynamic load impedance, transit time effects, μ_{sg}, and pentode equivalent circuits in connection with vacuum tubes. If you are like most of us, you may have been exposed to all these things at one time or another, but just because we don't fully understand these engineering terms does not mean we don't know how a tube should operate in a given circuit, or what to expect of it. The same thing is true regarding transistor circuits; you don't have to be a physicist or an engineer to be able to analyze transistor operation in basic circuit configurations. This article will, with as little pain as possible, show you how you can become more familiar with transistors and transistor circuits.

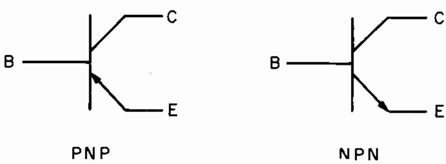


FIG. 1. PNP and NPN transistor symbols.

OPERATION

In many respects transistors are similar to vacuum tubes -- both require direct current supply voltages, both are capable of amplifying ac signals, and in order to do so both must be biased properly. In most vacuum tube circuits the grid must be biased negative with respect to the cathode, and the plate biased, if you will permit the term, positive with respect to the cathode. Under these conditions the tube is capable of amplifying a signal.

In a transistor the emitter, base, and collector correspond to the cathode, grid, and plate of a triode vacuum tube. In a triode electrons flow from the hot cathode to the positive plate and are controlled by a negative grid. In transistors electrons do not necessarily flow from the emitter to the collector. In the NPN transistor shown in Fig. 1 electrons do flow from emitter to collector. However, in the PNP transistor electrons flow from collector to emitter! These facts make possible circuits for which there is no equivalent vacuum tube circuit, as we shall see. Fig. 1, then, shows the two transistor types currently available, the PNP and the NPN. The direction in which the emitter arrow points gives the type of transistor; in for PNP and out for NPN. These symbols are always used for these two types regardless of the physical size, method of construction, type of material, frequency characteristics, or gain.

The facts mentioned above also supply information about the polarity of the various supply voltages. In an NPN transistor we said that electrons flow from emitter to collector through the transistor, or AGAINST the direction the emitter arrow points. This means that for this direction of electron flow the supply voltage must make the collector positive and the emitter negative as shown in Fig. 2. Similarly since electrons flow from collector to emitter in the PNP transistor the collector must be negative and the emitter positive as in Fig. 2. Electrons in the PNP type also flow AGAINST the emitter arrow.

A milliameter connector in either of the circuits of Fig. 2 would show very little current present. In fact, theoretically there would be no current at all. If a second battery were connected between the emitter and the base of either transistor with a polarity such that the emitter current were caused to increase, the collector current would also increase. Fig. 3 shows batteries connected to properly bias the base. These are the relative voltages that must be present in order for a transistor to operate, regardless of how the transistor is used in a given circuit. Both the collector-emitter supply and the base-emitter supply are always connected to cause a current in the emitter that will flow AGAINST the emitter arrow.

The collector current that flows when the base-emitter voltage is applied will be much larger than the small base current. This is the basis of how the transistor amplifies; a small base current produces a much larger current in the collector circuit. The ratio of the collector current to the base current is called β or h_{fe}, the forward current gain. This corresponds to the μ of a vacuum tube which is the ratio of plate voltage to grid voltage and is a measure of the tubes amplifying ability.

Impedance. An important point to note here, and one often overlooked, in studying transistor circuits, is that a transistor amplifies CURRENT and a vacuum tube amplifies VOLTAGE. The biggest single result of these facts is that a transistor must necessarily be a low impedance device while a vacuum tube is a high impedance device. This is easy to see when you look at the basic definition of impedance: The ratio of voltage to current, or

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

For example, plate voltages may be on the

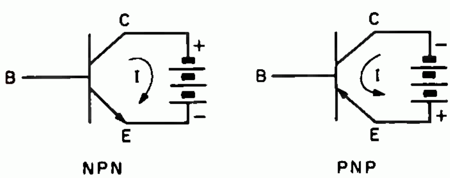


FIG. 2. Collector-emitter voltages.

order of a hundred volts or more with currents in the milliamp range. Transistors seldom operate with more than 12 or 15 volts but may have large currents; in the ampere range. As an example, assume a vacuum tube operates with 100V plate voltage and 1 ma plate current. This would be an impedance of:

$$Z = \frac{E}{I} = \frac{100}{.001} = 100{,}000\Omega$$

A typical low level transistor might operate with 2V collector voltage and 5 ma collector current. This sould be an impedance of:

$$Z = \frac{E}{I} = \frac{2}{.005} = 400\Omega$$

quite a bit lower than the vacuum tube.

Input impedances are even more dramatic. Normally vacuum tubes do not draw grid voltage, hence the grid resistor determines the input impedance in most cases. This is usually on the order of 100 k to 1 meg. Transistors, on the other hand, draw considerable input current at very low voltages. This results in very low imput impedances. For example, .05V and .5 ma. This is an impedance of:

$$Z = \frac{.05}{.0005} = 100\Omega$$

These low impedances account for many of the difficulties encountered in designing transistor circuits. At the same time several advantages arise as a result of the low impedances. For example, transistor circuits very seldom require shielding for hum pickup. Low impedance microphones and phono pickups may be matched very effectively by a low impedance transistor. Output transformers may be eliminated by the transistor's low output impedance. On the other side of the balance, coupling networks and control circuits become cumbersome and complex. RF tuned circuits must be very carefully designed because of the low impedance transistor. All in all, however, the many advantages of transistors make these small inconveniences seem very minor in the overall picture.

TRANSISTOR ANALYSIS

While there are three possible ways a transistor may be connected in a circuit: common base, common collector, and common emitter, we will concern ourselves only with the common or grounded emitter circuit since it is the one most frequently used. It corresponds to the normal grounded cathode vacuum tube hookup.

Phase relations. Referring again to Fig. 3 you will recall that when the base voltage

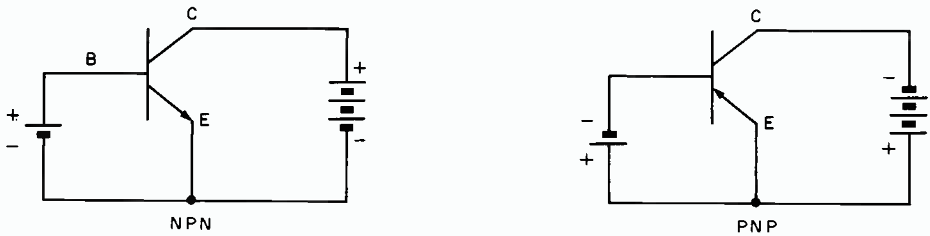


FIG. 3. Properly biased transistors.

was applied to the common emitter stage the collector current jumped to a large value.

By putting in a load resistor and making the base voltage variable as shown in Fig. 4A, we can see what happens as V_{be} is varied to represent an ac input signal. Making V_{be} larger increases the forward bias and thus increases the collector current. Output voltage E_o becomes more negative. If we make V_{be} less positive than at first we decrease the forward bias and collector current so E_o becomes less negative as shown in Fig. 4B. Thus it is apparent that the common emitter amplifier inverts the phase of the input 180° just as a grounded cathode vacuum tube amplifier does.

If a PNP transistor were used in the circuit of Fig. 4, the same thing would happen, only the two supply voltages would be reversed.

Transistor Characteristics. Even though there are only three elements in a transistor: base, emitter and collector, the behavior is similar in many respects to a tetrode or pentode vacuum tube. That is: the collector current is determined almost exclusively by the base current and is relatively unaffected by collector voltage variations. This is a very desirable characteristic since transistor circuits will usually operate satisfactorily even if the supply voltage drops to one half the rated value. This is true, however, only when the base bias voltage is obtained from the same source as the collector voltage and decreases proportionately. This is the usual case.

Like the pentode, the transistor has high gain. Typical current gains vary from 10 to 70 or more. Unfortunately these wide variations can be experienced among transistors of the same type. This is especially true when dealing with the less expensive transistors: the so-called "experimenter" type transistors. Variations in transistors of the same type are due primarily to the manufacturing processes used, it being very difficult to control transistor structure and characteristics on a mass production basis.

For this reason the curves published by manufacturers, when available, should only be used as a guide rather than as a model for design characteristics. What you should be guided by in experimenting with transistors are the manufacturer's maximum ratings for collector current, collector dissipation, collector voltage, and operating temperature. You will seldom have trouble with a transistor if you faithfully observe these ratings.

Notice above that it is the operating temperature that is important, and not any other temperature. Much has been said concerning the sensitivity of transistors to heat. Actually they are quite rugged individuals and can withstand a considerable amount of heat in soldering and unsoldering, etc. After all, the leads of most transistors are welded to the elements within the case, and you know this required more heat than your soldering iron is likely to produce.

In addition, the leads of transistors are made

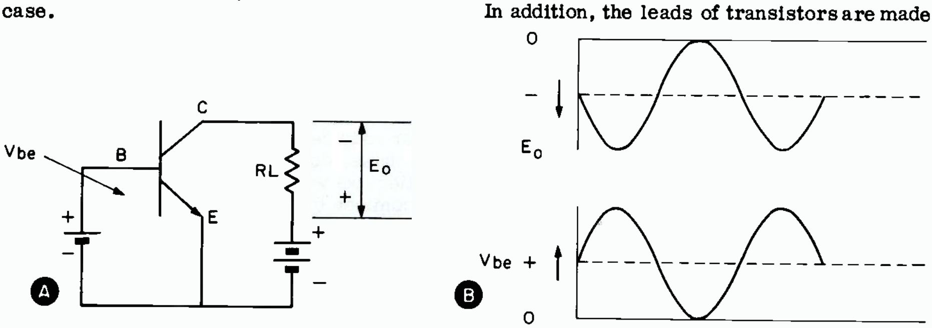


FIG. 4. Phase relations in a CE stage.

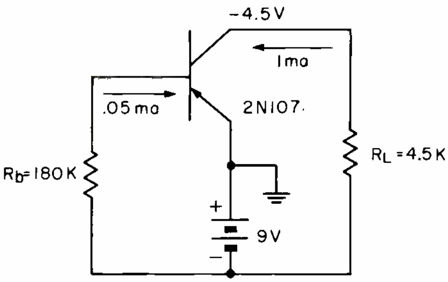


FIG. 5. Simple audio amplifier.

of a steel alloy rather than of copper, and steel is a much poorer conductor of heat than copper. As long as reasonable care is used when soldering and if the transistor is allowed to cool before applying power to the circuit, there is little to fear from external heat causing damage to a transistor. In the case of power transistors operated near maximum collector dissipation, an adequate heat sink should be used as recommended by the manufacturer.

Operation. Typically it can be said that transistors operated in low level stages operate with a collector current of about 1 ma. This is true of rf, i-f, oscillator, and audio stages. This is also true regardless of the supply voltage. For nearly all transistor types with small ac signals a collector current of about 1 ma puts the transistor in the middle of its linear range, or close to it.

The collector-emitter voltage of an operating small signal transistor circuit is typically one half or less of the supply voltage. This again is for considerations of linearity. These points are mentioned because they provide a good starting point in checking an inoperative circuit if data is not available with the correct operating voltages and currents.

As examples of this design philosophy we will examine a one stage audio amplifier and an i-f amplifier using a 2N107 transistor. (This transistor type is not really suitable for use as an i-f amplifier but for our purposes we will use it.) The specifications for this transistor are as follows:

V_{ce} max = 12V h_{fe} = 20
I_c max = 10 ma P_c = 50 mw

Let us assume a supply battery of 9V, a collector voltage of 4.5V and a collector current of 1 ma. Half the supply voltage, or 4.5 volts, will be dropped across the collector load resistor if we are to have a collector-emitter voltage of 4.5V. With a collector current of 1 ma the collector load resistor must be:

$$R = \frac{E}{I} = \frac{4.5}{.001} = 4.5K$$

For a current gain, h_{fe}, of 20 the base current needed to produce a collector current of 1 ma would be:

$$I_b = \frac{I_c}{h_{fe}} = \frac{1 \text{ ma}}{20} = .05 \text{ ma}$$

Using the same 9V battery to supply the .05 ma base current, the series resistance necessary is determined by:

$$R = \frac{E}{I_b} = \frac{9}{.00005} = 180K$$

This value of base resistor will at least provide a good starting point in the design, and should be varied, if necessary, to produce

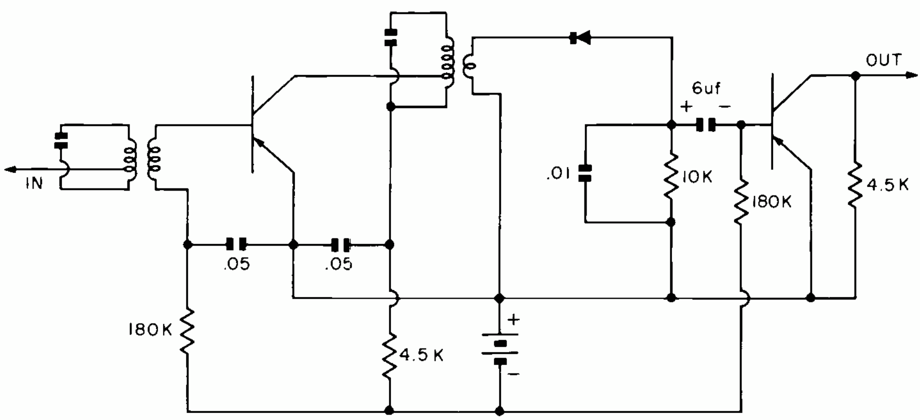


FIG. 6. I-F and af amplifier.

linear operation. The final circuit is shown in Fig. 5.

Fig. 6 shows an i-f amplifier, diode detector and the af amplifier of Fig. 5. Notice that the same value base and collector resistors are used here as in the audio amplifier. This is only to establish the same operating point, since both resistors are bypassed with capacitors. The transformers are the input source and collector load for the i-f signal, not the resistors.

Transistor Circuits. We have already looked at some typical transistor circuits in Figs. 5 and 6. As noted earlier, the i-f amplifier circuit is not exactly as you would encounter it in an actual circuit. More elaborate bias arrangements will be used and most PNP i-f stages will require neutralization to operate properly. NPN amplifiers usually have less junction capacity and do not always require neutralization.

The i-f transformer of Fig. 6 is single tuned with a tapped primary. Vacuum tube circuits would normally use a double tuned untapped transformer in the same application. The transistor transformer is tapped to prevent the low output resistance of the transistor from loading the tuned circuit too much. At the same time, the tap is located so the response will be broadened enough without using a double-tuned transformer. The base (or diode detector) is link coupled to the tuned circuit. The extremely low input impedance of a transistor would load a tuned circuit so much that no signal would pass if the secondary were tuned and even tapped. All this results in fairly low gain through the stage with a rather wide bandwidth. In order to get enough gain, most transistor radios use two or more i-f amplifiers.

Fig. 7 shows a phase inverter circuit which cannot be duplicated with vacuum tubes. It is called a complementary symmetry phase inverter and uses a PNP and NPN transistor. Supply voltages and bias voltages have been omitted for clarity. As the input signal swings positive, the NPN becomes forward

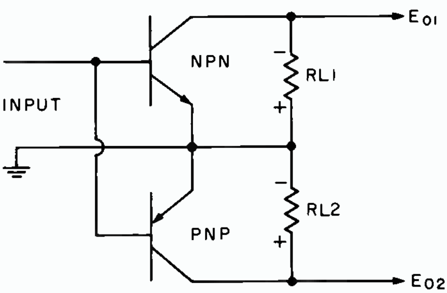


FIG. 7. Complementary symmetry phase inverter.

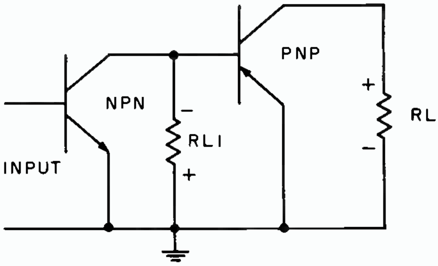


FIG. 8. Direct coupled NPN/PNP amplifier.

biased and conducts while the PNP is reversed biased and goes toward cutoff. As the input swings negative, the PNP conducts and the NPN goes toward cutoff. The two output signals, E_o1 and E_o2, are 180° out of phase.

This same complementary symmetry arrangement allows a direct connection to be made from one stage to the next as shown in Fig. 8. The negative collector current is in the proper direction to forward bias the base of the following PNP stage. The roles of the two transistors could be reversed with the same results.

BIAS STABILIZATION

Even with transistors operated so that the collector input ratings are not exceeded there is a very critical dependance of the transistor on temperature. If a transistor is connected as in Fig. 9A with the base open circuited, there will be some small value of leakage current present which is called I_{ceo}.

Since there IS a current present, and since the base is between the emitter and the collector, it will have some slight negative voltage simply as a result of normal voltage divider action. Any negative voltage on the base acts as forward bias for the transistor, however, so the collector current is higher than if the base were truly "open". An increase in temperature will tend to increase the base emitter junction resistance. So the base would become more negatively biased because of the larger IR drop and I_{ceo} would increase with this increase in forward bias. If the temperature became sufficiently high, I_{ceo} would increase until it exceeded the rated current and the transistor would be damaged. If the base were shorted to the emitter, the emitter and base would both be a zero potential and I_{ceo} would be smaller.

Any increase in temperature would not affect I_{ceo} at all and all would be well. Unfortunately we cannot operate a transistor with a direct short between base and emitter. However, two things may be done, separately or together,

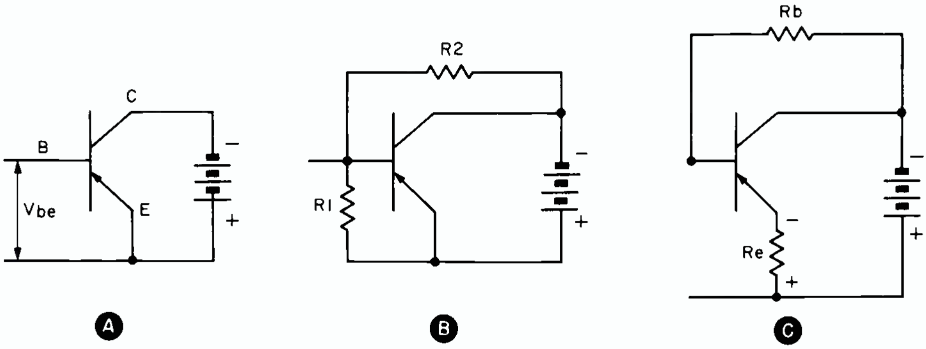


FIG. 9. Transistor bias.

to help in this problem. First, by making the base-emitter resistance as small as possible we approach the ideal short circuit discussed above. Second, by putting in an emitter resistor in the circuit any increase in emitter current will tend to reverse bias the base emitter junction and will "swamp" any tendency for the forward bias to increase. These stabilizing circuits are shown in Figs. 9B and 9C.

In practice both types of bias stabilization are used together. Re is normally selected so that from 1/10 to 1/5 of the supply voltage is dropped across it. Rb is normally 5 to 10 times the value of Re. Unless the loss in gain caused by Re is not serious, this resistor should be bypassed since it will introduce degeneration of the input signal similar to an unbypassed cathode bias resistor of a vacuum tube.

CONCLUSION

While being far from the complete story on transistors, this discussion should help you get your feet wet without making you catch pneumonia. The important things for technicians to know about transistors and transistor circuits are not so much HOW and WHY they work, but what the operating conditions are and how these conditions are indicated by instruments. These are the things you must know to begin "thinking" transistors as you now think vacuum tubes.

Some Suggestions Regarding Long Distance Telephone Calls To NRI

Occasionally we receive a long distance telephone call from an NRI student or graduate -- for something that he needs in a hurry, or to discuss an urgent problem.

Because such calls cost the student or graduate quite a bit, we feel that they should be made only when absolutely necessary. And -- particularly where a consultation problem is involved, our reply by letter will be more complete, and therefore more satisfactory than an answer given in a hurry over the phone. That's why we suggest that it may be better to write us Air Mail rather than telephone, except where an immediate reply is required.

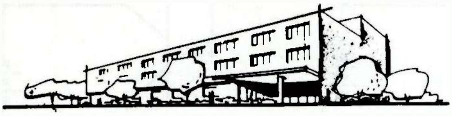
If you do find it is necessary to call, we shall of course, be glad to help you in any way we can. In that case, please keep in mind the following because it will enable us to handle your call most efficiently and save you money on the cost:

1. Tell our switchboard operator -- the one who answers "National Radio Institute" -- your name, address, student number, and that you are calling long distance. The way the Telephone Company handles calls nowadays, she won't know that it is long distance unless you tell her.

2. Explain the purpose of your call. Tell her whether you are seeking technical information, inquiring about a matter pertaining to your records, or whatever the specific reason may be. The operator won't be able to give you the information or handle your problem herself, but she must know its nature so as to refer you to the proper individual or department.

3. Remember that the Institute is open from 8:15 AM to 5:00 PM, Monday through Friday -- closed completely Saturday and Sunday. Outside of these office hours, the switchboard is also closed, and there will not be anyone here to handle your call.

NRI ALUMNI NEWS



John Berka.........President
Howard Tate.........Vice President
James Kelley.........Vice President
Eugene DeCaussin.........Vice President
David Spitzer.........Vice President
Theodore E. Rose.........Executive Sect.

CHICAGO CHAPTER members have been concentrating on a television receiver that they have on hand. Secretary Charlie Mead remarks that it is both interesting and fascinating as well as beneficial in applying knowledge acquired from the NRI course of training.

DETROIT CHAPTER devoted most of one meeting to a thorough discussion on the theory and use of the vtvm as compared to a conventional multimeter. This discussion was led by Asa Belton, who made a very good job of it. He was assisted by Chairman Kelley. In a question and answer period the members got into a discussion about how a stereo pick-up worked and how it was wired in the circuit. Chairman Kelley and John Nagy teamed up on that one. This was a lively and interesting meeting.

At the following meeting, Messrs. Oliver and Umbreit demonstrated the B and K 750 Test Equipment Calibrator. They checked a vtvm and the conventional type of meters. They also checked the Chapter's NRI Signal Generator. This was also an interesting demonstration.

Like quite a few of the other chapters, the Detroit Chapter has purchased a still projector for projecting schematics, etc., on a 6' × 6' movie screen. These projectors are a great aid in pointing out the various sections of schematics while demonstrating the project under discussion.

FLINT (SAGINAW VALLEY) CHAPTER members were guests at a meeting of the Electrical Engineering Club of the General Motors Institute. The featured speaker of the evening was Mr. O. N. "Ole" Ibsen, Application Engineer of the General Electric Co., whom GE considers one of the foremost authorities on static control in the United States. Mr. Ibsen gave a talk and demonstration on "Design and Application of Static Control." The members were surprised to learn to what extent they can apply their TV training to industrial use. Mr. Ibsen pointed out how the transistor takes the place of relays and motors, how silently it works and how economical it is to operate. The attending members found this a fascinating lecture and an enjoyable evening.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER has announced an important change. The Chapter formerly met at the homes or shops of its members. From now on meetings will be held at the YMCA in Hagerstown. The time will remain the same: 7:30 P. M., second Thursday of each month. All members and all interested students and graduates in the area, please take notice.

Chairman George Fulks took up the better part of a meeting with a demonstration on aligning an FM receiver with a scope and signal generator.

LOS ANGELES CHAPTER was pleased to inform National Headquarters that several new members have joined its ranks. They are Daryl Phillip, James E. Law, Nicholas Andreadakis, James Lunsford, and Phillip Sollars. A warm welcome to you gentlemen! Incidentally, the Chapter thinks that Phillip Sollars is probably the youngest member of any local Chapter, only 14 years old. Can any Chapter boast a younger member?

Members elected the following officers for 1963: Eugene DeCaussin, Chairman; Bill Edwards, Vice Chairman; Fred Tevis, Treasurer; and George Lee, Secretary. Congratulations to you gentlemen!

After elections there followed an informal discussion on the front-panel operational features of an NRI Oscilloscope for some of the new members who are not too familiar with scopes yet.

Mrs. DeCaussin and Mrs. Tevis then served barbecued beef sandwiches, coffee, and cake, all of which were thoroughly demolished by the members.

At the next meeting Chairman DeCaussin gave a short talk on multiple troubles in TV Receivers, which was followed by a general, informal discussion on on the circuitry of the Conar Custom 70 Television Receiver recently completed by the Chapter for use at the meetings.

The Chapter is considering making slides of various TV stages to project on a screen for discussion purposes.

MINNEAPOLIS-ST. PAUL CHAPTER has long been indebted to one of its most outstanding members, John Berka, for his many valuable services and loyalty to the Chapter. A skillful and thoroughly experienced Radio-TV Serviceman, he is tireless in his efforts to impart the fruits of his experience to his fellow-members. The members were naturally overjoyed, therefore, when he was elected as National President of the NRIAA.

Former Chairman Kermit Olson for the second time won a $20 door price awarded the winner by the Chapter on condition that it be spend for Electronic equipment. Lucky Kermit!

The newest member to join the Chapter is Jim Mulvehill. Our congratulations, Jim!

NEW ORLEANS CHAPTER wishes to call attention of its members to an important change. In recent months it has held its meetings at several different places. But it now has a new permanent meeting place. The meetings will hereafter be held at Galjour's TV, 809 North Broad St., New Orleans. The time remains the same: 8:00 P. M. on the second Tuesday of each month.

NEW YORK CITY CHAPTER's Joe Mikulski, in response to the interest of the members in demonstrations of servicing techniques, brought in an old Traveller 17" set with a burned out tube and no sound, and both old and new members contributed their efforts and suggestions for restoring it. Chairman Spitzer directed and supplemented the actual work with helpful suggestions from his wide experience. Such matters as why a series string will light when the picture tube is out, if a booster is used, were brought out. This was an interesting and helpful session.

Paul Donatell, Chairman of the Minneapolis-St. Paul Chapter, administering the oath of office to John Berka as National President of the NRI Alumni Association for 1963.

J. B. Straughn, NRI Chief of Consultation Service, demonstrating servicing techniques on a CONAR Custom 70 TV at a recent meeting of the New Orleans Chapter.

Tom Hull's talks on methods of FM detection have been masterpieces of clarity and have corrected a lot of fuzzy thinking.

A number of members have reported on construction projects, their difficulties and solutions. A breadboarded transistor AM receiver has been loaned to the Chapter for the season to visually aid discussions of servicing techniques in this field.

PHILADELPHIA-CAMDEN CHAPTER was pleased to have Mr. Bernie Bycer, design Engineer for RCA, give a talk on servicing a dead receiver and high voltage troubles. Mr. Bycer has a way of putting things over that is easy to follow and the members are always eager to have him as a guest speaker. In fact, the members think so highly of him that they made him a lifetime honorary member of the Chapter.

The Code class being conducted by Chris Urback is still going strong. It is surprising how many of the members have become interested in learning code since Chris undertook the project.

Secretary Jules Cohen had hopes of arranging for a tour of the Communications Department of the new Philadelphia Police Department. This event may have taken place by now. If so, it should have been a fascinating tour.

Many members have been requesting a session on good, old-fashioned radio receivers. With all the new type radio receivers coming on the market and the troubles encountered with printed circuits in the cheaper sets, servicemen are running into all kinds of troubles. Harvey Morris, who gets all kinds of radios to fix and none has ever stumped him yet, has been prevailed upon to give the members the kind of meeting they like on this subject.

This is a belated report on the officers elected to serve the Chapter for 1963, since this information did not reach National Headquarters in time for the previous issue of the News. The officers, all holdovers from 1962, are: John Pirrung, Chairman; Fred Seganti, Vice Chairman; Jules Cohen, Recording Secretary; Joe Burke, Financial Secretary; Charles Fehn, Treasurer; George Dolnick, Librarian; and John Krepol, Sgt. At Arms. Our congratulations to you gentlemen!

Joseph C. Adams was recently admitted to membership in the Chapter. Welcome Joe!

A group of members' wives at the San Francisco Chapter's Fourth Anniversary Celebration.

PITTSBURGH CHAPTER has been plagued with the handicaps brought on by the extremely severe weather they had during the winter. In spite of this, the meetings were well attended and lively, considering the difficulties the members had to go through in order to get to the meetings. There could hardly by any greater proof of how highly the members think of the meetings and how much they get out of them.

Any NRI students and graduates in the area who have never attended a meeting cannot realize what they are missing. They should take advantage of the Chapter's invitation to come to a meeting as a guest.

One of the important features of membership is that the members receive the CIRCUITER, a publication edited and published by Secretary Howard Tate. It contains a wealth of practical information of value to anyone engaged in or interested in Radio-TV Servicing.

The Chapter recently welcomed George W. Beike as a member. Congratulations George!

SAN ANTONIO ALAMO CHAPTER has changed both the date and place of its meetings. They are now held at 7:30 P. M. every 3rd Tuesday of the month at Secretary Sam Stinebaugh's TV Shop, 318 Early Trail, San Antonio.

The Chapter has asked the NRI News particularly to carry the announcement that students and graduates in the area interested in attending a meeting of the Chapter as guests or prospective members are invited to contact any of its officers. They are: Chairman Jesse De Lao, 606 Knotty Knoll, ED 3-8894; Vice Chairman Albert F. Sustak, 411 W. Baylor St., CA 6-6459; Treasurer Sidney D. Autry, 303 Rector Drive., DI 4-7544; Secretary Sam Stinebaugh, 318 Early Trail, GE 3-3188.

At a recent meeting Chairman Jesse De Lao discussed the use of a scope as an inductance tester. At the same meeting Secretary Sam Stinebaugh delivered a talk on using a signal generator in TV servicing.

As we go to press a Radio Engineer from a local broadcast station was scheduled to speak at a meeting of the Chapter on FM Multiplex broadcasting. The Chapter plans to obtain such special speakers for as many meetings as possible.

SAN FRANCISCO CHAPTER'S Art Ragsdale explained in detail and demonstrated the general nature of AGC systems and the principles upon which they operate. He made the discussion easier to follow by drawing a schematic diagram of a simple AGC system in a TV Receiver on the blackboard, also

San Francisco Chapter officers. Seated are the newly-elected officers for the current year: Isiah Randolph, Vice Chairman; Peter Salvotti, Chairman; and Willie Hawkins, Secretary. Standing are the outgoing 1962 officers.

used a signal generator and the picture tube for troubleshooting through the rf and i-f circuits. He pointed out that some of the symptoms due to AGC troubles were weak, snowy or fading pictures. The members were so pleased with Art's presentation that they voted unanimously to give him more time to prepare for another demonstration later.

Ross Alexander was also assigned to lead a discussion on the vacuum tube voltmeter at the next meeting.

The latest member to join the Chapter is G. Mereland Moore. Welcome to the Chapter, Mereland.

SOUTHEASTERN MASSACHUSETTS CHAPTER reports that its officers elected to serve for the current year are: Manuel Figueiredo, Chairman; Manuel Sousa, Vice Chairman; Ernest Grimes, Secretary; and John Nery, Treasurer. The oath of office was administered to the newly-elected officers by former chairman John Alves.

A seminar on FM multiplex was scheduled to be held at Providence, R. I. This must have been very interesting indeed.

SPRINGFIELD (MASS.) CHAPTER held its annual banquet this year at Betty's Town House in Agawam, Mass. It brought the largest turnout of members in recent years. The magnet must have been the excellent food. At any rate, those who attended spent a most enjoyable evening.

As we go to press former Secretary John Parks was scheduled to give another of his excellent talks and demonstrations, this time on the scope.

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: Frank Dominski, 2646 W. Potomac, 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., VI-1-4972.

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., OW 46773.

HAGERSTOWN (CUMBERLAND VALLEY) CHAPTER meets 7:30 P. M., 2nd Thursday of each month at the YMCA in Hagerstown, Md. Chairman: George Fulks, Boonsboro, Md., GE 2-8349.

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., HO 5-2356.

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., PR 4-6495.

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

NEW YORK CITY CHAPTER meets 8:30 P.M., 1st and 3rd Thursday of each month, St. Marks Community Center, 12 St. Marks Pl., New York City. Chairman: David Spitzer, 2052 81st St., Brooklyn, N. Y., CL 6-6564.

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: Thomas Schnader, RD 3, Irwin, Pa., 731-8327.

SAN ANTONIO ALAMO CHAPTER meets 7:30 P. M. 3rd Tuesday of each month, Sam Stinebaugh's TV Shop, 318 Early Trail, San Antonio, GE 3-3188. Chairman: Jesse De Lao, 606 Knotty Knoll, San Antonio, Texas.

SAN FRANCISCO CHAPTER meets 8:00 P.M., 1st Wednesday of each month, 147 Albion St., San Francisco. Chairman: Peter Salvotti, 2534 Great Hwy, 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. OS 2-5371.

SPRINGFIELD (MASS.) CHAPTER meets 7:00 P. M., 1st and 3rd Saturday of each month at shop of Norman Charest, 74 Redfern St., Springfield, Mass. Chairman: Steven Chomyn, Powder Mill Rd., Southwick, Mass.

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