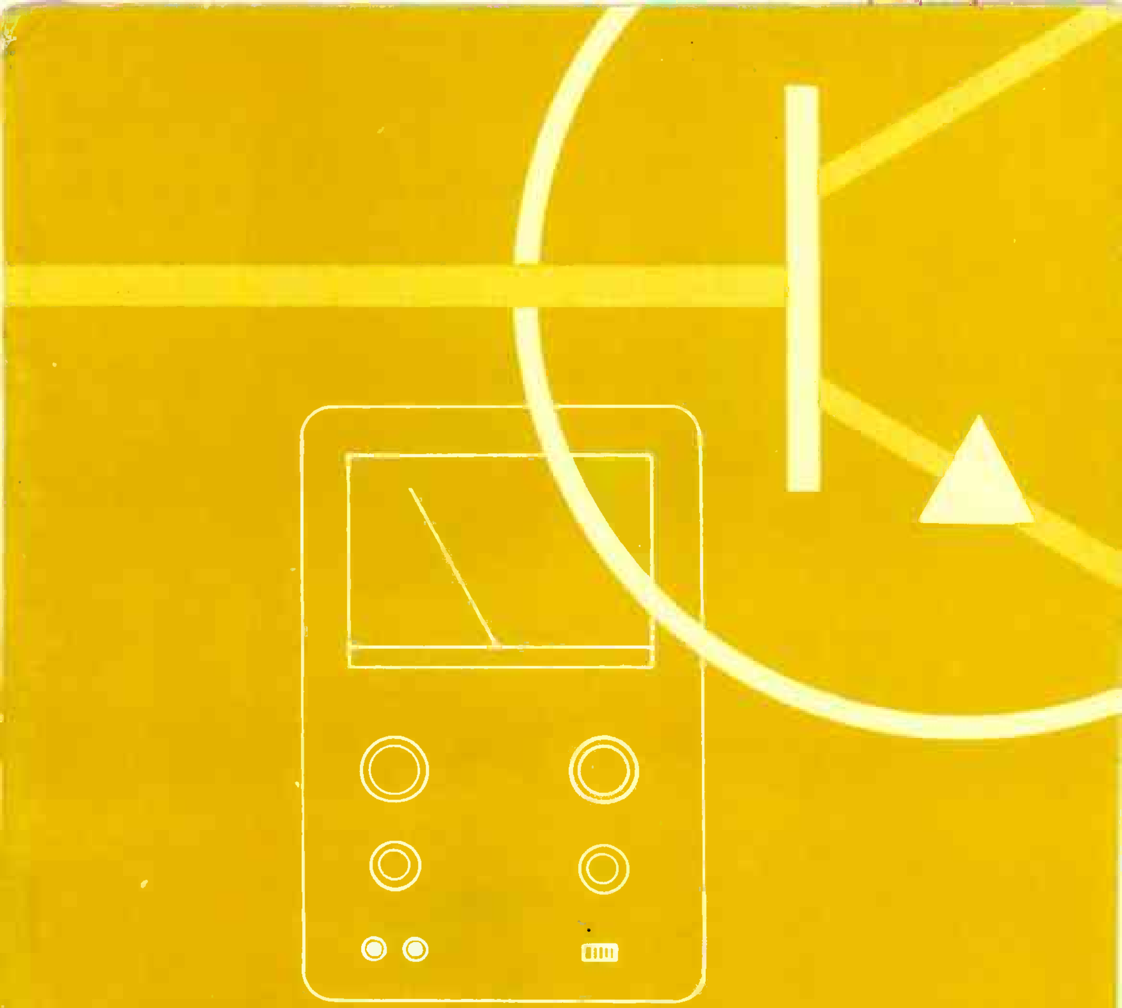

- Transistor Troubleshooting with a Voltmeter
- Servicing Record Changers

nri journal

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May/June 1976
Volume 34, No.3

McGraw-Hill

In this issue, NRI development engineer James Crudup shows us how to locate those faulty transistors easily and quickly. And NRI stalwart Elmer Blush offers us a photoillustrated guide to servicing that oft-neglected component, the record changer.

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Transistor Troubleshooting with a Voltmeter

by
James
Crudup C.E.T.

If you are planning to work as an electronic technician, you should know that the primary purpose of any service business is to pinpoint troubles as quickly as possible, and then repair the fault. Wasted time amounts to inefficiency, and inefficient businesses don't last long.

Many novice technicians waste time when troubleshooting solid-state circuits by removing and testing parts unnecessarily. Troubleshooting solid-state equipment doesn't have to be a hit-and-miss proposition. In most cases the dc voltages at the emitter, base, and collector can be used to determine if a stage is operating properly. You should remove parts for further testing only if the stage is not properly biased or if the voltages in the stage deviate more than 20 percent from published values.

Let's examine a few transistor circuits and see how to pinpoint typical transistor troubles by using voltage readings.

SOME BASIC FACTS

To make sure we all leave from the same starting point, let's begin with a few basic facts about transistors. A transistor is properly biased if the emitter-base junction is forward-biased and the collector-base junction is reverse-biased. Forward bias can be applied by connecting the negative terminal of a battery to the emitter of an npn transistor and the positive terminal of the battery to the base. This will cause the emitter-base diode to conduct, producing forward bias. To reverse-bias a junction, the negative terminal of the battery is connected to the base and the positive terminal to the collector. The proper biasing for an npn transistor is shown in Figure 1. Note the directions of the currents in the circuit. Resistors are used to limit the current in the base and collector circuits.

The rule for properly biasing the transistors is easy to remember: negative to n, positive to p, for forward bias. To reverse-bias the junctions, reverse the rule. The proper biasing of a pnp transistor is similar to that shown in Figure 1, except that the polarities of both batteries should be reversed.

FORWARD BIAS

The transistor in its basic form, npn, pnp, germanium, or silicon, acts like a variable resistor whose resistance from emitter to collector changes in proportion to a change in voltage between the base and emitter. Although transistors are current-operated devices, it's much easier for the technician to measure voltages than it is to measure currents.

A silicon transistor requires an emitter-base forward-bias voltage of 0.6 to 0.7 volt before it will conduct and a germanium transistor requires approximately 0.2 or 0.3 volt to conduct. Just as an absence of heater voltage renders the electron tube

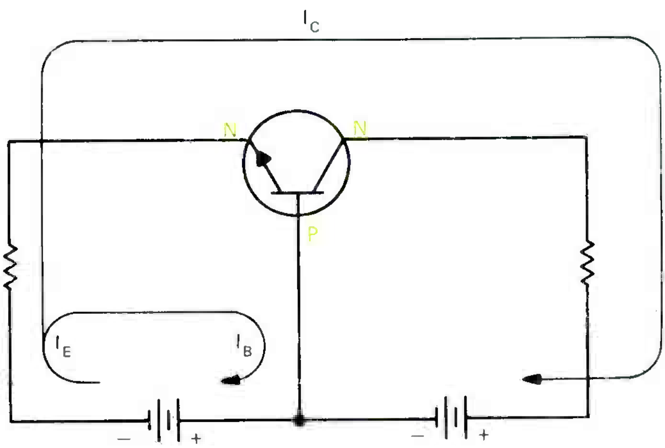

FIGURE 1. PROPER BIAS FOR AN NPN TRANSISTOR.

inoperative, an absence of forward bias at the transistor's base-emitter junction renders the transistor inoperative. Service technicians have always looked at a tube to see if it is lit. It is an equally good technique to determine whether a transistor has a forward bias as a first step.

Now that we have covered the basics, let's examine a typical transistor circuit. Figure 2 shows an npn common-emitter amplifier, a very common circuit. If you have a high-impedance voltmeter with a low dc scale such as the tvom or a vtvm, you can easily check the voltages at the emitter, base, and collector of the transistor to determine if it is operating correctly. In this particular circuit the emitter goes to ground through R4 and the collector ties to a positive dc voltage through R3. Since this is an npn transistor, the voltage at the base must be positive with respect to the voltage at the emitter. The voltage divider consisting of R1 and R2 provides a low positive voltage at the base.

Capacitors C1 and C2 provide signal coupling and C3 is the emitter bypass capacitor. Its purpose is to keep the voltage at the emitter stable. The voltages listed in the circuit are for a typical Class-A amplifier. As you know, all circuits are not amplifiers, but if you have a schematic of the equipment you are repairing you can measure the voltage in a circuit and quickly determine if the stage is functioning properly.

As we have said, a transistor is nothing but a variable resistor. This variable resistor has the highest emitter-to-collector resistance when there is zero voltage between the base and emitter. The emitter-to-collector resistance decreases when the

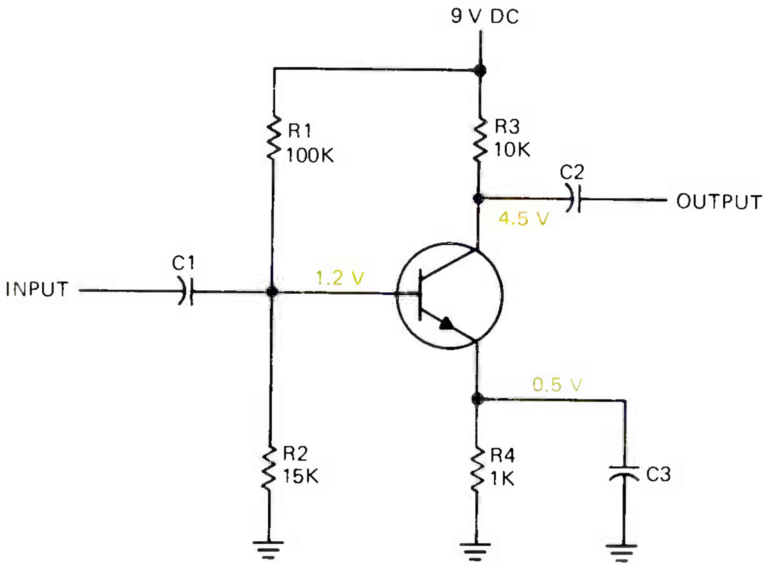

FIGURE 2. A TYPICAL COMMON-EMITTER NPN AMPLIFIER.

base-to-emitter voltage is increased. For example, a transistor with no bias has little or no emitter-collector current flow, and so it has high resistance. A transistor with correct bias voltage and polarity has current flow from emitter to collector (or vice versa) depending on the type of transistor. If transistor Q1 in Figure 2 is not conducting (cut off), the full supply voltage will be measured at the collector. Cutoff will occur if there is an absence of bias voltage between the emitter and base, which can be caused by a defective component in the bias circuit, a shorted emitter base junction or open element within the transistor.

On the other hand, if all of the supply voltage is dropped across the collector load resistor and the voltage at the collector approaches zero, the transistor is saturated. Let's take a look at a saturated transistor circuit.

A SATURATED TRANSISTOR

In Figure 3 this defect is easy to spot. Obviously the transistor is saturated. Notice that the collector and the emitter are at the same potential. In most circuits, saturation will result when:

1. The emitter-base bias divider resistor or circuit opens (for example, if R2 opened).
2. The collector-base bias divider resistor or circuit shorts.
3. The emitter resistor or bypass capacitor shorts.

A quick check to isolate the problem when you have this symptom is to short the base to the emitter.

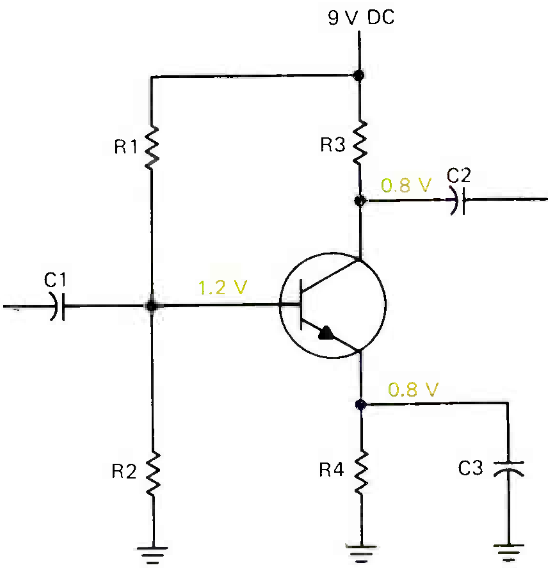

FIGURE 3. A SATURATED TRANSISTOR.

This is a check many technicians make in order to determine if the trouble is in the transistor or in the external bias circuit. With the emitter shorted to the base, the forward bias is removed. A transistor will not conduct without forward bias. With no forward bias, the voltage at the collector should rise to B+. If so, the problem is not caused by the transistor. The trouble is in the external bias circuit. If we tried this in Figure 3 and the voltage reading did not change, of course, this would indicate that the transistor is shorted from emitter to collector. Otherwise, the collector voltage would rise to 9 volts.

In some transistor circuits it is not safe to short the emitter to the base because the rise in collector voltage might cause damage to a dc coupled stage. For example, if the collector of Q1 were tied directly to the base of another transistor, the increased voltage might damage the next stage or additional components. A schematic diagram of the circuit being tested is a valuable aid when troubleshooting using dc voltage measurements. Normally, all of the dc voltages for the transistors are shown. By checking the schematic diagram you should be able to remove any doubt as to whether or not a transistor will be destroyed by shorting the emitter to the base for testing purposes. If the transistor can be cut off by shorting the emitter to the base, it is usually safe to assume that the transistor can also amplify. Then, troubleshooting can be confined to external components.

CUTOFF

Earlier you learned that a transistor is cut off when a voltage check indicates the full supply voltage at the collector. Apparently this is the fault in Figure 4. Let's take a closer look and see.

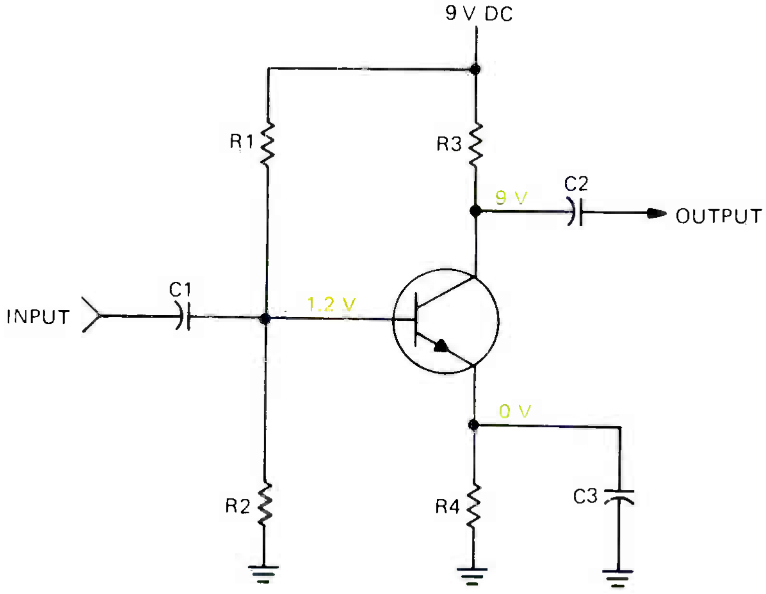

FIGURE 4. A NONCONDUCTING (CUT OFF) TRANSISTOR.

After some thought we can tell from the voltages that more than likely Q1 has an internal emitter to base open. This can be determined because we know the base bias is present, which means the voltage divider is not at fault. A shorted R2 would cause zero volts at the base and an open R1 would cause zero volts at the base. It's unlikely that R4 is open because the high impedance of the voltmeter would cause a false voltage reading at the emitter when measured. This voltage would depend on the meter impedance. With this information it would be safe to remove the transistor for testing. The trouble is more than likely the result of an open base, emitter, or collector lead internally.

LEAKY TRANSISTOR

In small signal amplifier stages a leaky transistor generally causes loss of gain. This defect is one of the most difficult to pinpoint. In power transistors a leaky transistor may cause excessive heating which may cause the transistor to completely short. In some stages a completely shorted transistor will cause enough current flow to blow a fuse or circuit breaker. A suspected transistor should be removed from the circuit for testing. Leakage results from a partial short between the emitter and collector.

This is demonstrated in Figure 5. The npn transistor has developed a partial short, causing the collector current to increase. The high collector current produces larger-than-normal voltage drops across the collector and emitter resistors, causing a decreased collector and an increased emitter voltage. The base, which is tied to its

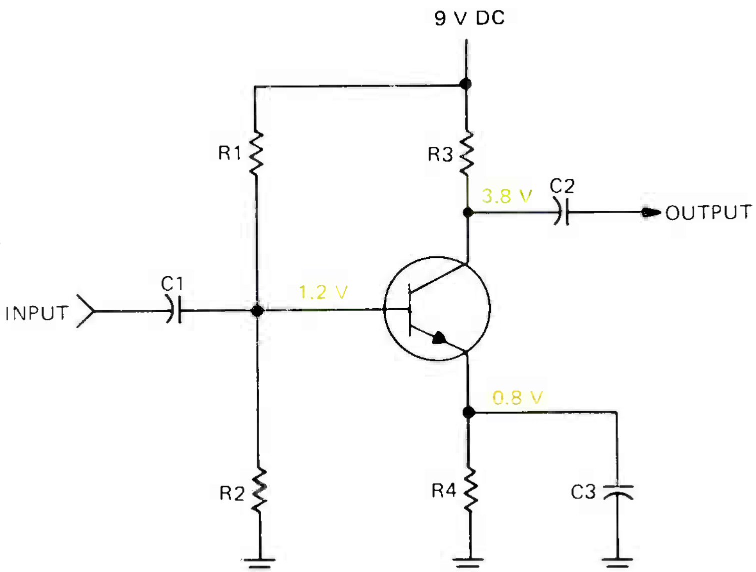

FIGURE 5. A LEAKY TRANSISTOR.

voltage divider, remains fairly constant. This means the emitter voltage may rise above the base voltage, causing a reversed bias between base and emitter. The transistor should be cut off; however, collector current continues to flow through the leakage path between emitter and collector.

A signal fed into the stage will be lost because of the wrong bias polarity between base and emitter, and because the collector current cannot be controlled. The increased collector current, without proper bias, leads us to suspect a leaky transistor.

The trick for spotting leaky transistors is the increased current which can easily be determined by using Ohm's law. The voltage dropped across the emitter resistor is the key. Notice in the normally operating circuit the emitter voltage is 0.6 volt which results in 600 μa of emitter current. In Figure 5 the emitter voltage has increased to 0.8 volt, which results in 800 μa of emitter current and a larger-than-normal voltage drop across the collector resistor, the most obvious clue to the problem. An ohmmeter test will almost always pinpoint a leaky transistor.

We have taken a look at three common troubles that are often found in transistor circuits. Understanding basically how a transistor works and what to expect when the circuit does malfunction can greatly reduce troubleshooting time. The information presented here, of course, doesn't cover all situations nor does it cover all types of circuits. It does, however, give you enough information to troubleshoot one of the most popular configurations, the common emitter amplifier.

Once you have located the defective stage, a transistor tester can be used to confirm your diagnosis, or the device can be removed for testing or substitution.

CHECKING A TRANSISTOR WITH THE TVOM

Although direct substitution is the best method for determining if you have a defective transistor, it can become rather expensive. Several other alternatives are available such as a transistor tester or ohmmeter test. For simplicity and for testing purposes with an ohmmeter, a transistor can be treated as two back-to-back diodes with the base common to each diode. These are the emitter-base diode and the collector-base diode.

With one polarity of your ohmmeter you should measure a low diode resistance between the base-emitter and the base-collector (Figure 6). With reversed ohmmeter polarity the resistance measured should be much greater. If both diodes have a high resistance regardless of polarity, the base is open. You can use the NORM-REV switch to change the ohmmeter polarity without moving the test leads. In the NORM position the probe is positive and the clip negative. In the REV position the probe is negative and the clip is positive.

The emitter-to-collector resistance should be high, regardless of polarity, although one polarity may result in higher resistance measurements than the other. If the emitter-to-collector resistance is low, the transistor is leaky. Ohmmeter transistor readings are best made with the transistor removed from the circuit. It is important

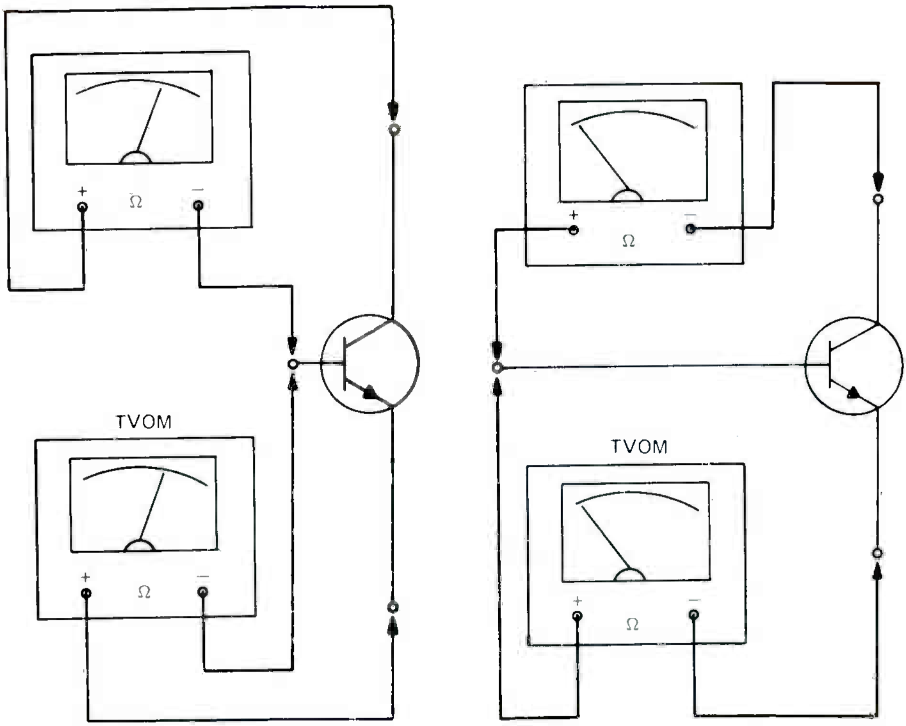

FIGURE 6. HOW TO TEST A TRANSISTOR WITH A TVOM. (L.) REVERSE BIAS, HIGH RESISTANCE. (R.) FORWARD BIAS, LOW RESISTANCE.

to keep in mind that it is the *ratio* between two readings which is significant rather than the exact resistance readings. If the ratio of the readings is less than 10 to 1, the transistor is almost certainly defective.

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Servicing Record Changers

elmer h. blush jr. c.e.t.

Servicing record changers is easy and can be profitable if performed in the proper manner. In this article, you will be given specific instructions, both in words and pictures, of the proper techniques to use in servicing a typical inexpensive record changer. The particular changer described in this article is the Motorola model MP100BN and is representative of the type of record changer used by a large number of manufacturers.

Now, let's get on with the specific "how to's" of servicing record changers.

Figure 1. The Motorola MP100BN has a hinged record changer which is easily removed from the cabinet. The electronics are housed in the upper part of the cabinet. For this particular unit, the complaint was mechanical—the changer would not go through its change cycle and the arm did not set down on the record in the right place. The changer is removed from the cabinet by pressing down on the changer base and pulling the whole unit forward. The ac power cord and the phono cartridge leads must also be disconnected to remove the changer from the cabinet.

Figure 2. Some of the readily available tools and supplies needed to repair record changers. Across the back are two six-inch-long 2x4's used to support the changer, a can of tuner wash, a roll of paper towels and a bottle of spray-type household detergent. Across the middle are a soldering iron, a neon strobe light, a tube of light grease, a bottle of "Non-Slip," a can of household oil and a stylus pressure gauge. Next is a pair of small slip-joint pliers, a 1/8th-inch screwdriver, small needlenose pliers, a small warding file, an ice pick, a small brush and a strobe disc. In the center is a "universal" power cord to power the changer while it is out of the cabinet.

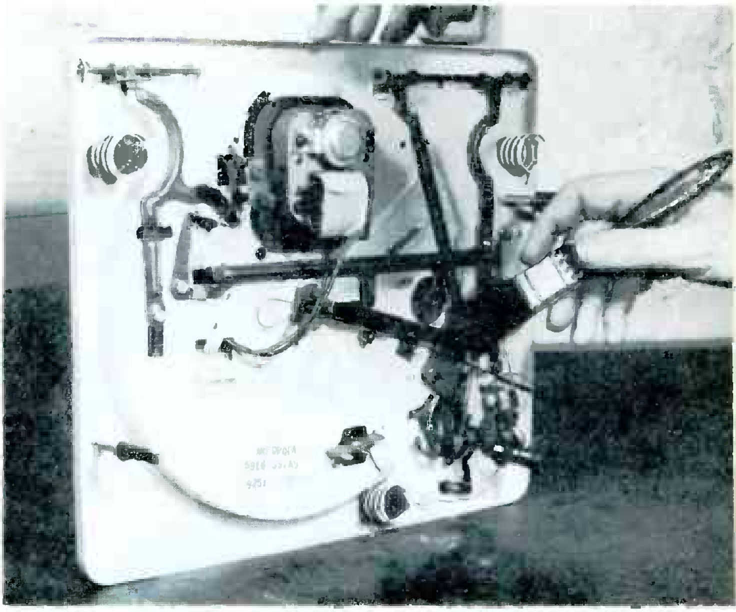
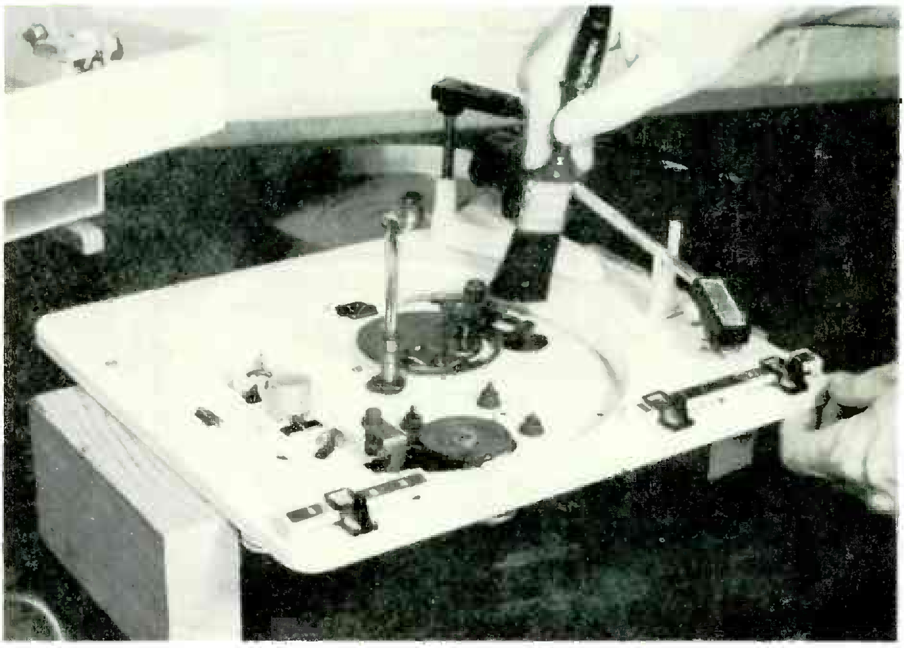


Figure 3. The first step is a thorough cleaning of both the top and bottom of the chassis. Begin with the small brush to remove built-up dirt and lint from the mechanism. Perform this routine on the top of the changer as well, after removing the turntable. For really dirty changers, it doesn't hurt to use a vacuum cleaner to remove dirt and grit buildup. Notice the two wood blocks used to support the changer. I use these rather than a commercial changer holder since the price is much better for the wood blocks!



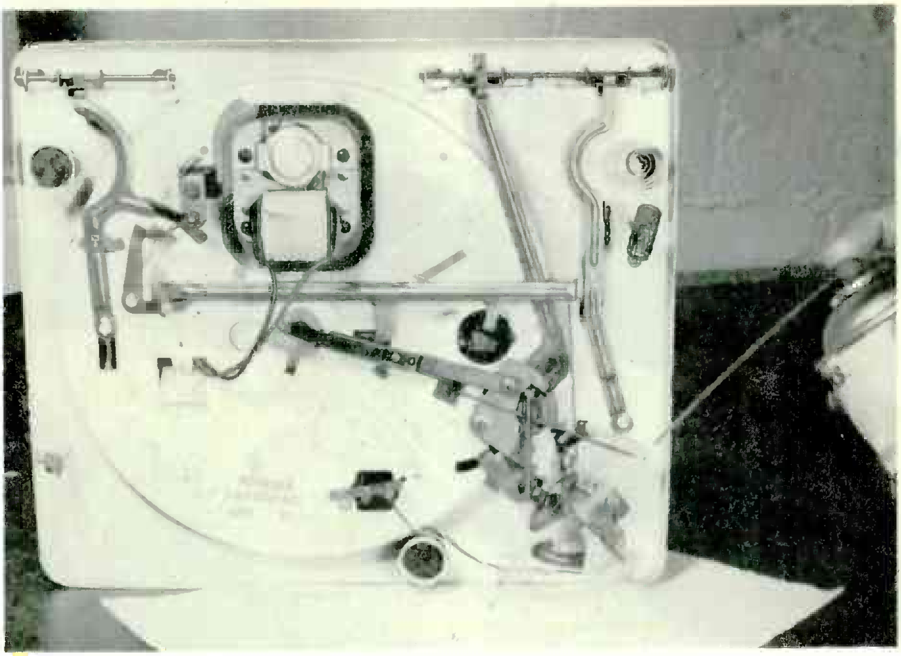
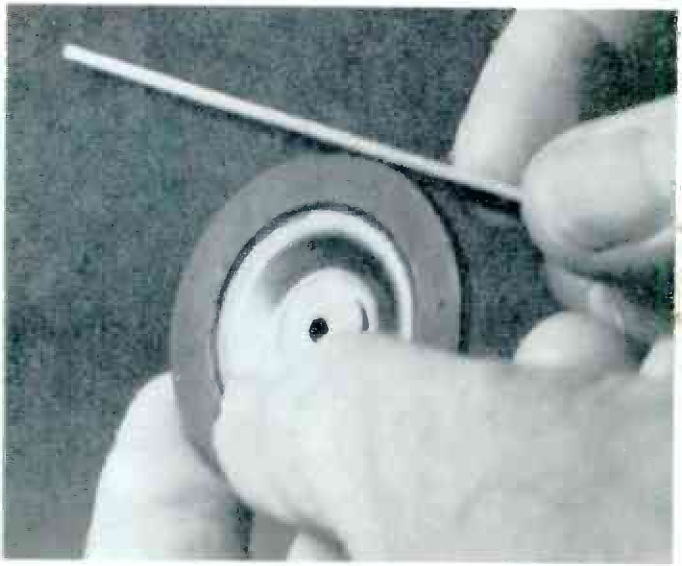


Figure 4. With most of the dirt removed, spray the moving parts with a tuner cleaner and lubricant to remove any deep-down dirt and lint. This will also remove caked grease if done properly.

Figure 5. Now go over the top side of the changer with the spray detergent and a paper towel. Do the entire top of the changer base and the tone arm itself. This won't make the changer work any better, but the customer will surely appreciate the neat, almost-new look the cleaning will impart to the machine.

Figure 6. The idler wheel is usually held on its shaft with a small "C" clip which you can remove with the point of an ice pick. Don't lose the clip! Remove the idler wheel and carefully inspect the condition of the rubber drive surface. If it is hard and cracked, it should be replaced. If the surface is hard and slick, but otherwise in good condition, you can rough up the surface with a small file to restore the unit. This is what I did for this particular changer.



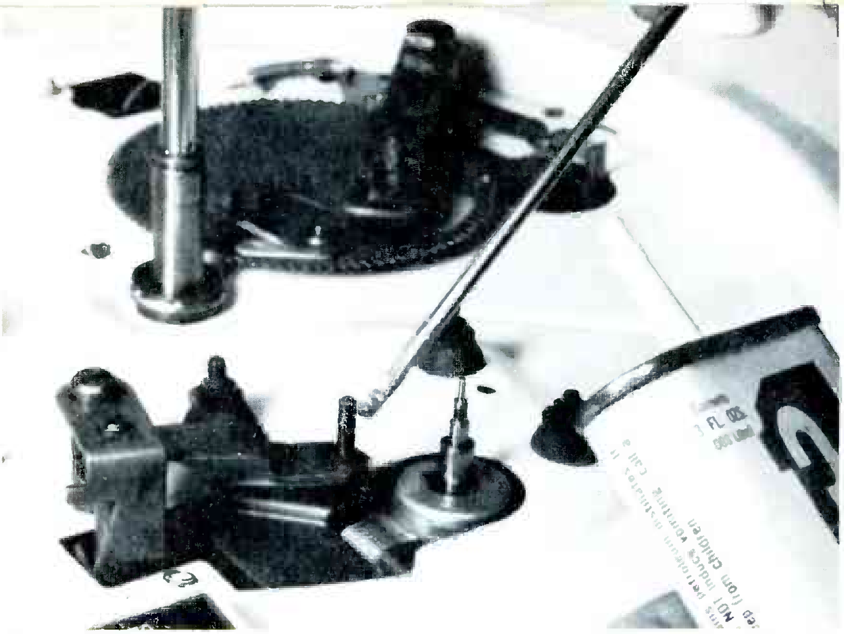


Figure 7. Clean both the hole in the idler wheel and the shaft on which it revolves with your tuner cleaner and then lightly oil both the shaft and the hole in the wheel. Reinstall the idler wheel and the "C" clip and spin the wheel to make sure it turns freely.

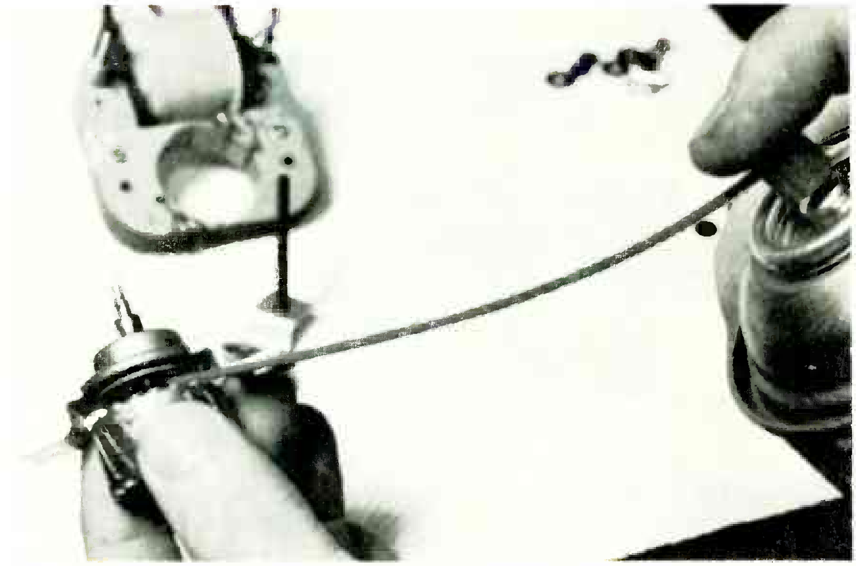


Figure 8. As a matter of general policy, if the changer is very old and there is a large buildup of lint and dirt, you should remove the motor from the changer and disassemble the rotor and bearings to give the bearings a thorough cleaning. Even if applying oil to the assembled motor appears to help fix the motor speed, you can be sure the fix is strictly temporary unless you clean the bearings thoroughly. The tuner cleaner makes this an easy job. It isn't necessary to completely remove the bearing to do the cleaning job. As shown here, the upper bearing was held captive by the four-step driving pulley but could be slid up and down the shaft enough to do the job. Notice the small parts carefully laid out on a clean paper towel so they will easily be found when it comes time to reassemble the motor.

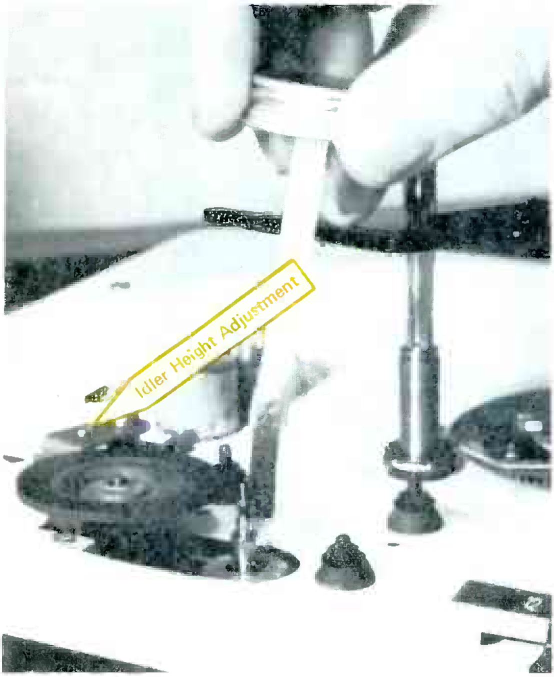


Figure 9. With the motor back together again and running smoothly, apply a small amount of Chemtronics Non-Slip to the surfaces of the driving pulley and to the idler wheel. Do this with the motor running. Now run the speed change lever through its positions and check to be sure that the idler wheel sits squarely in the middle of each step of the driving pulley. If it does not, adjust the idler height screw with a screwdriver.

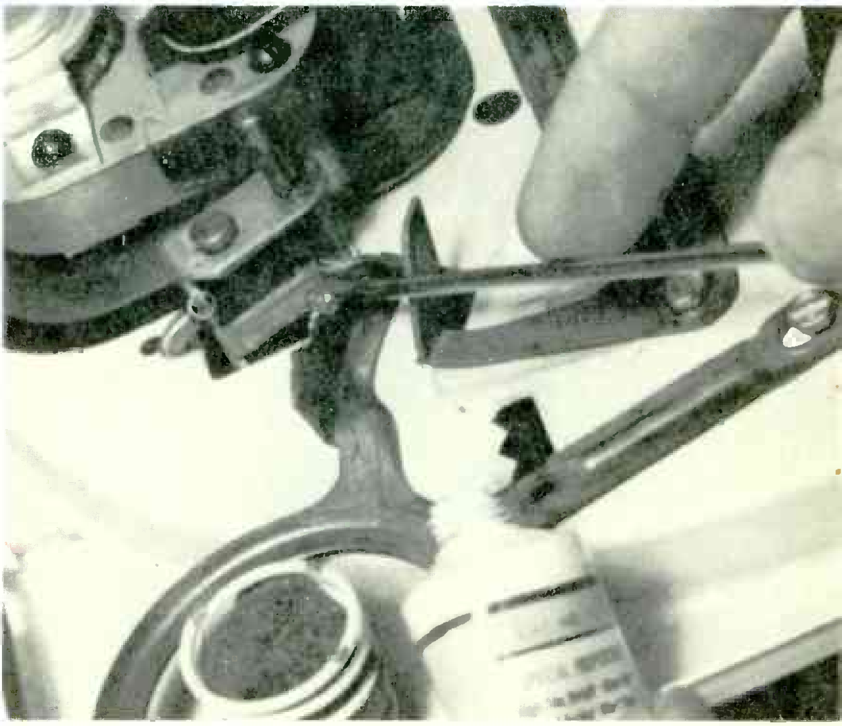


Figure 10. With the changer turned off, turn it over so you can inspect the sliding mechanical parts on the underside. Apply a small amount of non-hardening grease to all sliding surfaces which appear to transfer any amount of force.

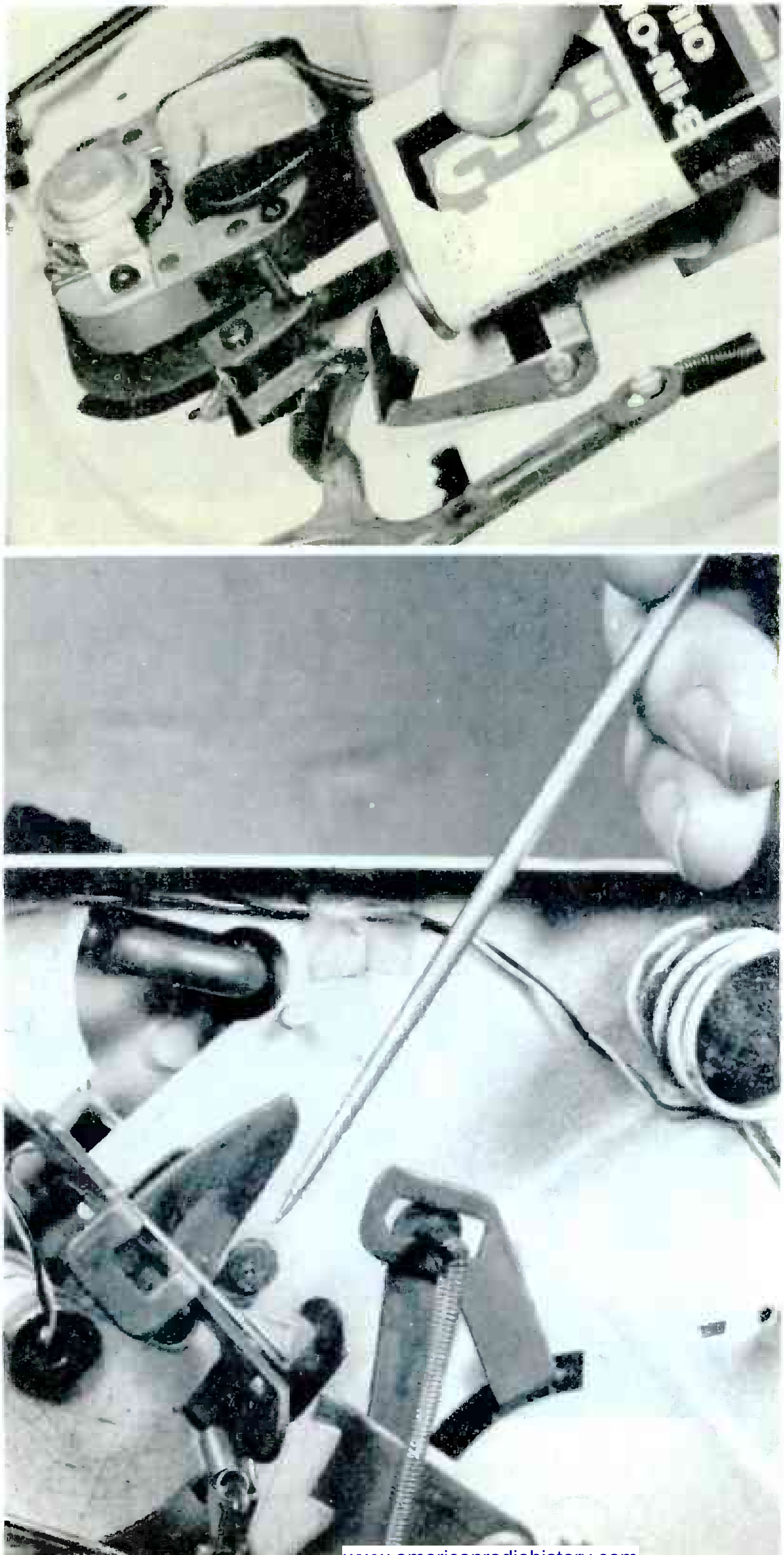


Figure 11. Parts that slide freely should be given a drop of oil. Give the various springs a drop of oil to prevent the formation of rust. Some moving parts should *not* receive any type of lubricant at all. One such part is the clutch pad being pointed to with the ice pick. While you have the oil and grease out, be sure to put a little of both on the turntable shaft as well as in the hole of the turntable (see Figure 3).

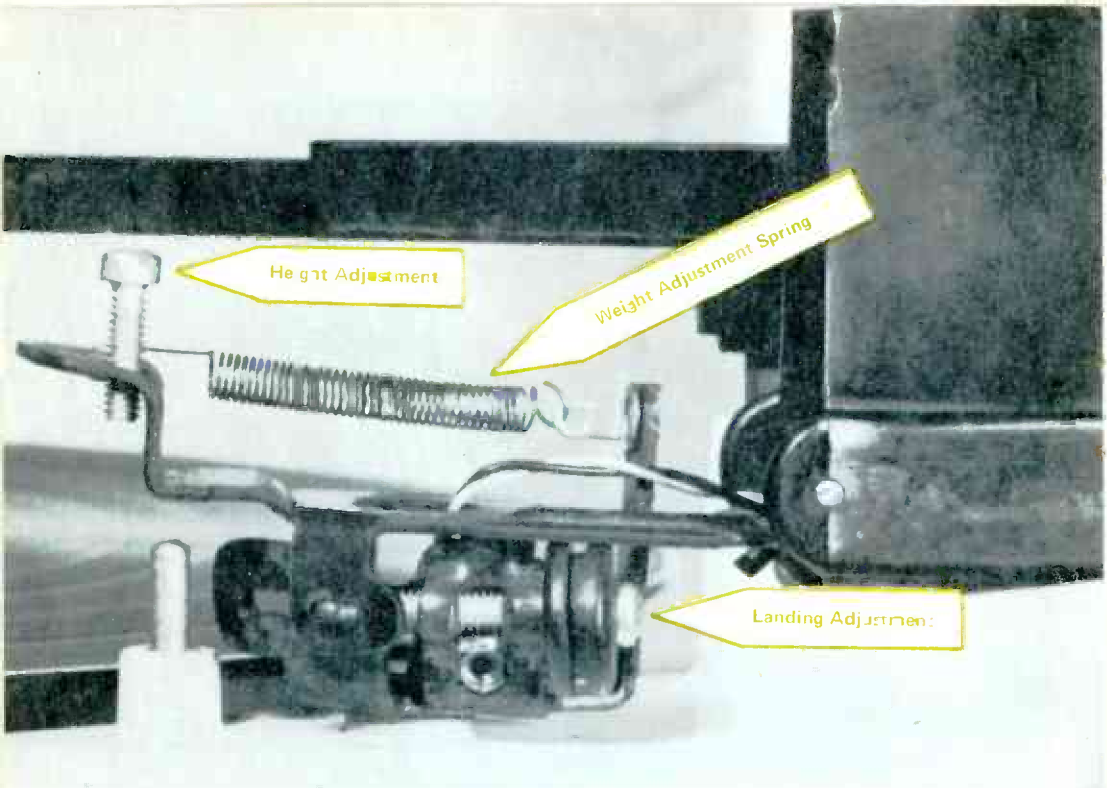


Figure 12. Replace the turntable, and with the changer in the operating position put a couple of 12-inch records on to check the overall cycle operation of the machine as well as the tone arm lift height adjustment and landing position. The arm should not hit the next record on the stack when it lifts from the record being played and should drop into the lead-in groove of the record being played. These two adjustments are reached by raising the tone arm up all the way to expose the adjusting screws. Also shown is the stylus weight adjustment.

Figure 13. Place the stylus on the stylus gauge, which should be resting on a record on the turntable (not moving!). This one weighed in at 9 grams but the book called for 8 grams. The weight is adjusted first by moving the spring from one hole to another (see Figure 12) to get in the ballpark. The final adjustment is made by bending the lug to which the spring is attached to slightly vary the spring tension.

Figure 14. The final test is to check the turntable speed. Do this with a record in place and the strobe disc in place. You can use the special neon lamp to check each speed, or if your shop is equipped with fluorescent lights you probably will not need the neon lamp. Before reinstalling the repaired changer in the cabinet, run a couple of various size records through the change cycle to be absolutely certain that everything is working properly. You may have to make a compromise setting of the landing adjustment to accommodate all sizes of records. Good luck with your changer servicing!

HAM NEWS

By Ted Beach K4MKX

I certainly hope that this spring is being as nice to you as it is to me so far. We have been having such fabulous weather around these parts that I have been finding it very difficult to stay in and do the things that I want to do—there are just so many beautiful days that I have been tending to my long-neglected outside chores at the home QTH, an may even get around to doing a little antenna work one of these days if this keeps up.

At any rate, I *did* manage to spend a few hours down in the shack working on the home power supply for the mobile gear I mentioned last time. My first attempt was somewhat less than successful, as I'll point out later.

Figure 1 is a diagram of the dual-voltage charger as it was originally connected. My first step was to clip out the fuse in the "6-volt" position of the primary switch so the switch now functions as an on-off switch. I don't think I'll ever have a need for the 6-volt charge feature, so I saved an on-off switch this way.

Notice that the rectifiers are wired in "backwards," with the positive voltage being taken from the center tap of the transformer. This is done, I think, so

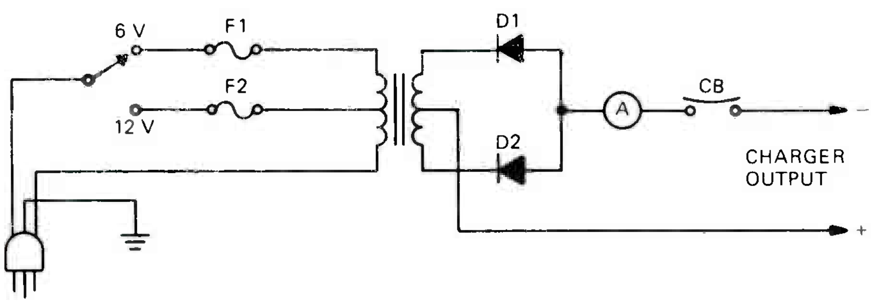


FIGURE 1. BASIC CHARGER CIRCUIT.

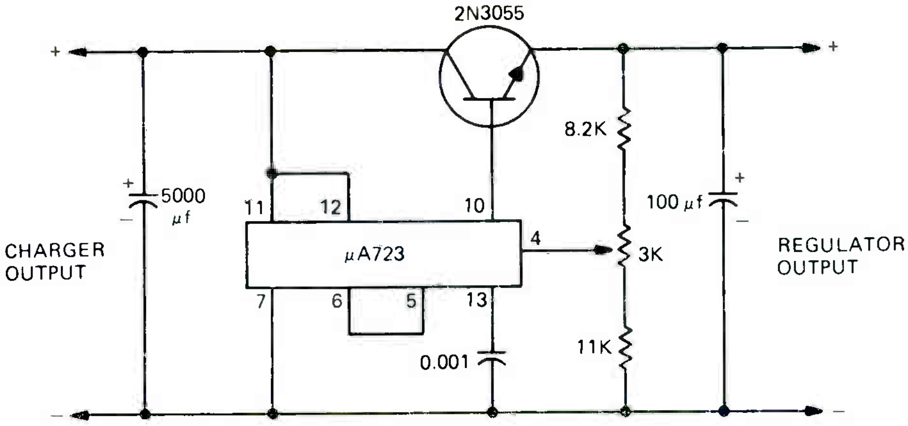


FIGURE 2. REGULATOR HUNG ACROSS CHARGER OUTPUT.

the two single-plate rectifiers could share a common anode heat sink. No big deal, it all comes out in the wash!

My first effort to regulate the charger is shown in Figure 2. Unfortunately, the no-load output of the rectifier was only 18 volts, and with a small (5000 µf) input capacitor, I could draw only about an ampere and a half before the input ripple became so great that the input voltage dropped below 13.8 volts, so I lost regulation and had ripple on the output. The obvious answer is to use a larger input capacitor, but the fact is my junk box was fresh out of larger capacitors. Besides, when you use very large capacitors the initial surge of charging current can be destructive for the poor unprotected rectifiers.

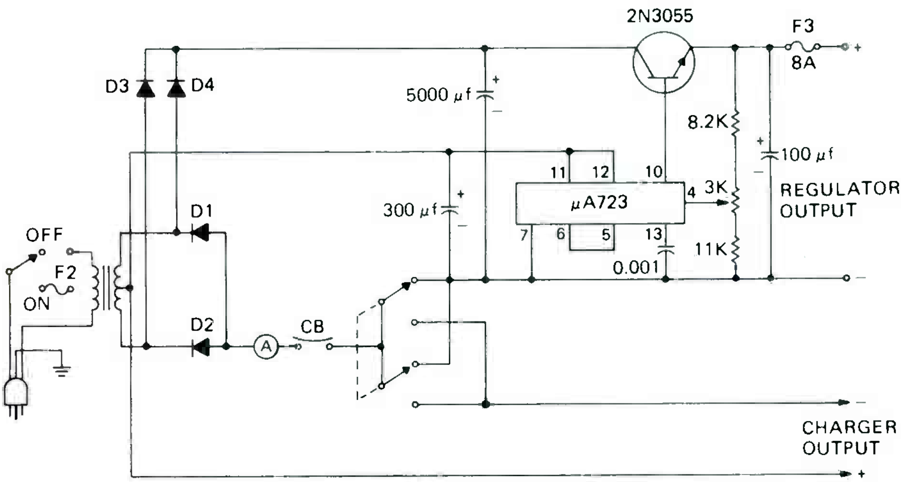


FIGURE 3. DUAL-PURPOSE SHOP SUPPLY.

I did find a pair of very large (unmarked) silicon diodes in the junk box, however, so I next tried the circuit shown in Figure 3, which is the one I ended up with. This one works great. It can deliver in excess of six amperes with no detectable ripple or loss of regulation with the output voltage set at 13.8 volts.

I installed the parallel connected dpdt switch in the negative lead so that I could take advantage of the ammeter and circuit breaker, paralleling the switch contacts only for the expected large currents so there would be little if any drop in the switch contacts. D3 and D4 convert the rectifier to a bridge circuit which will produce twice the output voltage for the regulator. The integrated circuit regulator (μA723) still operates from 18 volts and is separately filtered. Now, even though the input voltage drops considerably under load, the actual regulator voltage remains stable because the base drive of the 2N3055 is clean and steady. Sneaky, eh?

I didn't take any photos of this rig since they really wouldn't show a great deal. From the outside the charger looks just like it came from the factory, except for the pot, switch and fuse holder on the rear panel and the regulator output terminals. The vast interior is now well filled up with parts. I really thought there was a lot of room inside the box, but in fact I had a hard time squeezing all the parts in. All the small parts mount on a perfboard and the transistor heat sink fastens to the rear wall of the box, straddling D1 and D2 which are also mounted on the rear wall. The main filter capacitor sort of dangles from one spot to another. Anyway, it works satisfactorily and I am putting it to good use.

One of our readers, Frank, K9FEI, had also had similar urges to build a shop supply from a charger and detailed how he went about it in a very nice letter. Frank used the charger diodes alone with a 16,000-μf filter, a two-transistor series pass driven by a fixed (three-terminal) IC regulator. The basic circuit was in the December 1974 *Popular Electronics,* but Frank says he made a few modifications of his own. Very nice, Frank.

Now with all the power supply business out of the way, let's see who else we've heard from since last time. As usual, the first names in the list are students and graduates of our Amateur License courses while those listed last are students and graduates of other courses.

WN3AAC writes that he has also been quite lax since getting his Novice ticket about a year ago. Getting on the air and operating is much more fun than studying. Besides, Rich is kept very busy with his job servicing IBM equipment at all hours. He does most of his operating on 15 meters since "40 is too much of a zoo in the evening." Rich uses an old HQ 170 receiver and a Heath Apache transmitter along with a multi-band dipole made from TV lead-in fed with coax. He hasn't yet found time to use the Conar receiver and transmitter since he is always lending them out to other interested people.

It certainly is nice to see another YL in the list this time. Irene, WB4QZO, writes "With the help of this course, I am encouraged to go ahead and try for my Advanced Class license in April." Hope you made it, Irene, and do let us know when you made it.

Although WB5MMM is presently a

Rich	WN3AAC	N	Pittsburgh PA
Robby	WN4DHC	N	Martinez GA
Tim	WN4HZT	N	Marietta GA
Irene	WB4QZO	G	Live Oak FL
Jerry	WB5MMM	T	Altus OK
Wayne	WN6GZT	N	Colma CA
Ronald	WN7DDS	N	Mesa AZ
**	WB8OUD	G*	Cincinnati OH
Chuck	WB8UJP	A	Breckenridge MI
Everett	WN8YAG	N	Midland MI
Ken	WBØIGN	A*	Sidney NB
Ichizo	WH6JAH	N	Honolulu HI
Dave	W2HML	T	Spotswood NJ
Leslie	WA4MVL	G	Virginia Beach VA
Clarence	WB4VAP	-	South Daytona FL
Dick	W6BKY	-	Palo Alto CA
Frank	K9FEI	A	Indianapolis IN
Steve	WN9RQD	G*	Rock Falls IL

* Just upgraded - congratulations! ** See Text.

Tech, Jerry hopes soon to be upgrading so he can use the HW101 he has to go along with his two-meter HW202. For antennas, he has four 11-element beams at 51 feet and a Hustler 4BTV for listening (at present) on the low bands. Keep plugging, Jerry, you'll make it fine.

Once again Sister Marjorie Kramer, WB8OUD, has gotten an advancement in the amateur ranks, this time to General. Our sincerest congratulations Sister Marjorie, and best of luck in the next step up the ladder.

I believe that WH6JAH is the first Hawaii Novice we have had listed here since this column began back in 1968 (could it be that long?). At any rate, congratulations, Ichizo, and thank you for the kind words in your note about the course you are taking.

W2HML is a student in the Communications Course and writes that he is very active in the Navy MARS program using the call NNNØZTT. Dave's Ham activities on two meters are carried out with an HR2B and either a Ringo antenna or an 11-element beam. He also operates two meters MARS frequencies with a four-channel GE Prog line. Even though Dave is a Tech, he can work the lower frequencies on the MARS net, which he does using a Drake TR4 on 4015 kHz. Very fine, Dave, and we'll be pulling for you when you take that FCC test soon.

Dick, W6BKY, is one of the unfortunate apartment dwellers who has problems with erecting antennas. Despite this handicap he is able to operate his new TS520 on ten and forty meters using indoor antennas. The ten-meter antenna is a "sloping dipole" which runs up and down a stairwell, while half the forty-meter antenna runs through two bedrooms and the other half is "stuffed" into a crawl space above the apartment. Despite these handicaps Dave has been able to work into Canada and the East Coast, which just goes to show that perserverance and ingenuity will always prevail. Dick is interested in contacting other NRI students and/or alumni in the Palo Alto area. You can write to him at:

Box 1633
Palo Alto CA 94302

As mentioned earlier, Frank, K9FEI, sent in his version of the battery charger power supply. He built the regulator part on a piece of perfboard also, but mounted it along with the heat sink on the outside of the cabinet. His operating switch is wired so that the same output leads are used for both the charger and regulator. Very nice, Frank.

Steve, presently WN9RQD until his new call arrives, said it took three months to get his Novice after sending in the test back in April of last year. And now he passed the General test in December and still hasn't gotten the new ticket. Oh well, maybe someday they will speed things up a bit. Steve uses a homebrew vertical made of electrical conduit which he feeds with the tuner described in these pages some time ago. As all good Hams will do, Steve modified the design "slightly" to use what he had on hand and finds the system works beautifully on 80, 40, and 15 meters, with a "worst-case" SWR of 1.2:1 on some parts of 80.

We also had a note from Tim Richardson down in Marietta GA who said that at first he was quite discouraged because he couldn't find anyone to give him the Novice test. Then one day while listening to a two-meter repeater he heard of a local club. After contacting some of the members, he was finally able to take the Novice test which he is sure he passed. Just waiting, now, to receive the ticket from Uncle Charlie. Fine business, Tim, and we'll look for you here again real soon.

And that about wraps it up for this time. Do keep the cards and letters coming in as we always like to hear from you. In answer to numerous requests, we'll talk about some simple antenna systems next time.

Very 73 and BCNU.

Ted - K4MKX

NRI HONORS PROGRAM AWARDS

In the tradition of NRI's pursuit of excellence in training, the following graduates who earned NRI electronics diplomas in March and April also earned unusual recognition under the NRI Honors Program. On the basis of their grades, these graduates distinguished themselves by earning the right to the honors listed below and to the appropriate Certificate of Distinction in addition to their regular NRI diplomas. This distinction is made part of their permanent NRI records.

WITH HIGHEST HONORS

Gregg R. Cane, Kansas City, MO
Douglas G. Dooling, St. John's West NF
R. T. Quick, St. Petersburg, FL
Clarence E. Robinson, Jr., Harriman, TN
Abdo Y Sader, Palo Alto, CA
Carl E. Sellars, Cobden, IL
Stanley Stock, Chicago, IL
Kenneth Guy West, Hawthorne, NV

WITH HIGH HONORS

Carl A. Anderson, Dillon, MT
Gabriel C. Armijo, West Point, NY
Joseph K, Barker, Las Vegas, NV
Fred V. Bierschenk, Austin, TX
Alfred Blau, Cleveland, OH
Phillip D. Boone, Stillwater, OK
Laszlo Boros, Lacey, WA
C. Dwight Brown, Hixson, TN
Stephen D. Clinger, Canton, OH
George L. Demko, Sugarloaf, PA
A. L. Flickinger, Akron, OH
Jackson K. Fox, III, Page, AZ
David W. Goddard, Downers Grove, IL
Elton L. Greenwood, Orlando, FL
Steven Hanger, Universal City, TX
Thomas H. Harris, Bethesda, MD
James A. Hein, Mt. Holly, NJ
Jerry Lee Jones, Moore, OK
S. Eugene Koetitz, Gaithersburg, MD
Don Allen Libert, McDonald, PA
George E. McCarty, Jr., Groton, CT
W. G. Mitchelmore, Saskatoon SK Canada
Robert B. Monteith, West Granville, MA
Julius Oklamcak, Burlington ON Canada
Joseph A. Okun, Cranford, NJ
Joseph E. Poe, Galax, VA
John P. Schoonover, Towanda, PA
Eric Hubert Simms, Gander NFLD Canada
Russell F. Tackett, Fayetteville, AR
Wade L. Tombaugh, Vallejo, CA
Frieda J. Way, Greensboro, NC
Phillip R. Weidman, Wichita, KS
Norman H. Williams, Clinchport, VA

WITH HONORS

Donald R. Adams, APO San Francisco
Robert L. Ashford, Severna Park, MD
John Baron, Beaumont, TX
Charles V. Bezzina, Astoria, NY
James H. Bracker, Neenah, WI
Jed Brandes, Milwaukee, WI
Charles W. Carroll, Olla, LA
Samuel D. Christy, Van Nuys, CA
Marvin E. Clark, Angeles Camp, CA
Quentin A. Clark, Alexandria, VA
Kenneth J. Crandall, Bellevue, WA
Tom E. Cummins, Rawlins, WY
James Laurence Daft, Kansas City, MO
Steven G. Elliott, San Diego, CA
Ernest Foss, III, Philadelphia, PA
Jose Franquez, Caguas, PR
Charles S. Gilvert, Ft. Sam Houston, TX
Harold E. Goans, Oak Ridge, TN
Don Hammond, Faunsdale, AL
Alan G. Hardin, Dallas, TX
Albert F. Harsch, North Huntingdon, PA
W. W. Hart, Dalgren, VA
Richard Herrick, Auburn, ME
Robert C. Hicks, Tucson, AZ
Wayne E. Hill, Eldridge, IA
Robert L. Hudson, Great Falls, MT
John J. Jordan, Holliston, MA
Gary L. Kelley, Fort Bliss, TX
Frank W. Lambert, Jr., Garnerville, NY
John E. Lasky, Butte, MT
Gordon Mac Krith, Niagara-On-The-Lake ON
James J. Magnan, Great Lakes, IL
Robert D. Marken, Jonesboro, GA
Julian S. Martin, Sr., Charleston, SC
Edison F. Meissner, El Cerrijo, CA
Travis James Miller, Forestville, CT
Jimmie R. Mitchell, Richlanda, NC
Ronald Montgomery, Culpeper, VA
Marvin L. Morton, Carson, CA
Nicholas K. Mueller, Fenton, IA
Ronald Pearson, Martinsville, VA
Santiago Perez, Edcouch, TX
David R. Petrone, Carnegie, PA
Bobby N. Petrosky, Georgetown, TX
Donald Picard, Terryville, CT
Dominick L. Pirro, Solvay, NY
Robert W. Ronco, E. Corinth, ME
Irene E. Schmutz, Live Oak, FL
Richard L. Smith, Lufkin, TX
Timothy E. Smith, Aguadilla, PR
John T. Stanfield, Jacksonville, FL
Clyde R. Stewart, Courtenay BC Canada
Eric V. Tallberg, Jr., Eskridge, KS
Richard LeRoy Tellez, El Paso, TX
Brannon Thibeau, Prairieville, LA
Perry A. Towne, Munroe Falls, OH
Clarence W. Tucker, Ellsworth AFB, SD
Donald L. Upp, Trotwood, OH
Thomas H. Vaughn, Providence, KY
John White, Jr., Artesia, CA
John M. Whittington, Fall Branch, TN
Brooks Lee Wilson, Malta, OH

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets at 8 p.m. on the second Friday of each month at St. Andrews Hall, 431 E. Congress St., Detroit. Chairman: James Kelley, 1140 Livernois, Detroit, Michigan. 841-4972.

FLINT (SAGINAW VALLEY) CHAPTER meets 7:30 p.m. the second Wednesday of each month at Andy's Radio and TV Shop, G-5507 S.Saginaw Rd., Flint, Michigan. Chairman: Roger D. Donaven.

NEW YORK CITY CHAPTER meets at 8:30 p.m., first and third Thursday of each month, at 199 Lefferts Avenue, Brooklyn, New York. Chairman: Samuel Antman, 1669 45th St., Brooklyn, New York.

NORTH JERSEY CHAPTER meets at 8 p.m. on the second Friday of each month at the Players Club, located on Washington Square in Kearny, New Jersey. Chairman: Al Mould. Telephone 991-9299 or 384-8112.

PHILADELPHIA-CAMDEN CHAPTER meets on the fourth Monday of each month at 8 p.m. at the home of Chairman Boyd A. Bingaman, 426 Crotzer Avenue, Folcroft, Penna. Telephone LU 3-7165.

PITTSBURGH CHAPTER meets at 8 p.m. on the first Thursday of each month in the basement of the U.P. Church of Verona, Pa., corner of South Ave. and Second Street. Chairman: James Wheeler.

SAN ANTONIO (ALAMO) CHAPTER meets at 7 p.m., fourth Thursday of each month, at the Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels St. (three blocks north of Austin Hwy.), San Antonio. Chairman: Robert Bonge, 222 Amador Lane, San Antonio. All San Antonio area NRI students are always welcome. A free annual chapter membership will be given to all NRI graduates attending within three months of their graduation.

SOUTHEASTERN MASSACHUSETTS CHAPTER meets at 8 p.m. on the last Wednesday of each month at the home of Chairman Daniel DeJesus, 12 Brookview St., Fairhaven, Mass. 02719.

SPRINGFIELD (MASS.) CHAPTER meets at 7:30 p.m. on the second Saturday of each month at the shop of Norman Charest, 74 Redfern Drive, Springfield, Mass. 01109. Telephone (413) 734-2609. Chairman: Preston Atwood.

TORONTO CHAPTER meets at McGraw-Hill CEC, 330 Progress Avenue, Scarborough, Ontario, Canada. Chairman: Branko Lebar. For information contact Stewart J. Kenmuir, (416) 293-1911.

FLINT/SAGINAW CHAPTER BEGINS ACTIVE YEAR

At the January 21 meeting, Mr. Jobbagy informed the members of the loss of the Zenith franchise in their area. From now on, it will be necessary to get all of the Zenith parts by mail in the Saginaw area.

Mr. Jobbagy gave a demonstration on how to test television yokes and how to recognize which is vertical and which is the horizontal winding.

Dennis Besser brought in a solid-state stereo phonograph, one side of which did not operate. The members located the trouble, which turned out to be a defective Darlington transistor.

At the meeting on February 4, Steve Avetta brought in a Motorola TV. After examination by the members, it was found that an instant-on diode was bad, along with a fusible resistor and a line choke. Apparently the set had been hit by lightning.

Fred Malik brought in a Zenith portable with no raster. After replacing a neon bulb in the low-voltage section and a filter capacitor, the set was back in operation.

NRI AA OFFICERS	
Ray Berus	President
Earle B. Allen, Jr.	Vice President
J. S. Bartlett	Vice President
Homer Chaney	Vice President
Branko Lebar	Vice President
Tom Nolan	Executive Secretary

Alumni News

The Chapter initiated a new member, Mr. Dale Keys. Mr. Keys, a student, is a retired farmer and has taken an interest in electronics at the age of 71. He gets up at 3 a.m. to study his lessons, and when he does not understand some of the material he comes to chapter meetings to find the answers to his problems. It is necessary for him to drive 35 miles in all kinds of weather, and we welcome him at the Chapter whenever he can make it.

At the meeting on March 3, Mr. Douglas Gram, a field engineer, conducted a lecture on the oscilloscope. He demonstrated the use of a Conar trigger-type scope as well as dual-trace and wideband scopes.

The Chapter hired Mr. Gram for the next two meetings. He will give a lecture on alignment of TV receivers and a discussion of how to use a B&K analyst in troubleshooting.

Officers for 1976 are as follows: Roger D. Donaven, Chairman; Dale W. Keys, Vice Chairman; Andrew Jobbagy, Secretary; Frederick Malik, Treasurer; Steve Avetta, Board of Directors; Donald Stewart, Educational Director; Larry Myers, Goodwill Ambassador; Dennis Besser, Photographer; Henry Hubbard, Cash Lafferty, Larry McMaster, and Robert Newell, Membership Committee Members.

SAN ANTONIO CHAPTER WELCOMES OLDER MEMBERS

At the January meeting of the Chapter, ten members were present, including one who hadn't attended in so long that no one could remember his name. We finally remade his acquaintance, and found that our new policies had brought back a few members who would not otherwise have been there. We are making telephone calls to all the membership, as the postage is getting so high.

Our program for the evening was a CTC-38 RCA chassis with an AGC overload problem, and it was a good one. It was the first time we completely failed to solve a problem. Anyway, the coffee and doughnuts were good.

In thinking back to December, our Christmas party was a big success. We had a good crowd of nice, friendly people, and a surprise visit from our former Secretary and very good friend, Sam Stinebaugh. The supper was superb and there was a small bit of Christmas cheer passed around.

NORTH JERSEY CHAPTER STUDIES TV ALIGNMENT

At the meeting on February 13, Chairman Al Mould, a full-time TV serviceman, gave a very interesting and informative demonstration on the alignment of TV chassis.

At the same meeting the Secretary, Richard Wagstaff, demonstrated the usefulness of a tuner subber which he designed and built himself.

At next month's meeting, Mr. Mould will demonstrate the theory and operation of the new Zenith all-solid-state remote-control Space Command.

Reader Exchange

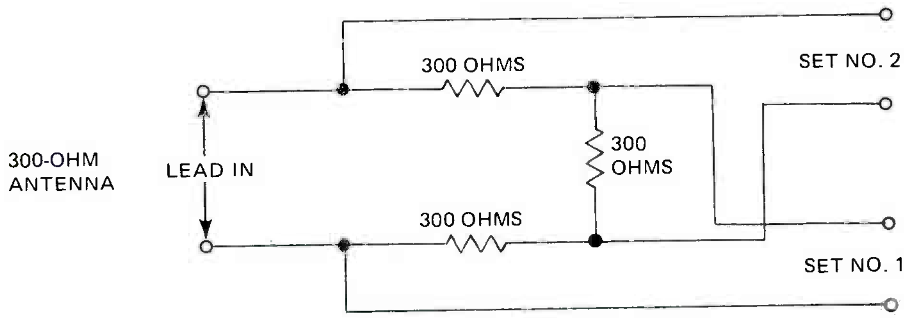
WANTED: NRI graduate with eleven years of television and two-way radio repair experience wishes to buy or manage small shop for profit. Contact Tom Bush, 8520 Lake Atkinson Drive, Tallahassee, Florida 32304.

Helpful Hints 6

How can I operate more than one TV receiver from the same antenna? This is a question I am asked quite frequently. The answer is simple—buy a signal-splitter. However, if you are economy-minded, you can make one. A signal-splitter for which you might pay $5 or more in the store is nothing more than a plastic box with a few passive components inside.

You can easily build the simple circuit shown below and it can be used to connect two sets to the same antenna. The resistors can be soldered right to a small terminal strip or to the back of a tuner. Tolerances are not critical and 10 percent resistors are okay.

The signal loss through this circuit is about 6 db. This is much less than it would be if you just used the lead-in to connect two sets in parallel.



—*James Crudup*

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Sharp put everything into this unit, and some of the outstanding features include a selective speaker switch for off/main/remote/matrix, bass and treble controls, illuminated slide-rule tuning, AFC for drift-free FM reception, 25-watt peak music power, a full range of input/output terminals, lighted FM stereo indicator, pushbutton function selectors, and much more. The built-in eight-track tape player has a manual program selector switch and headphone jack. The receiver has a beautiful wood cabinet and the matching speakers make this a system you'll be proud to see and hear.

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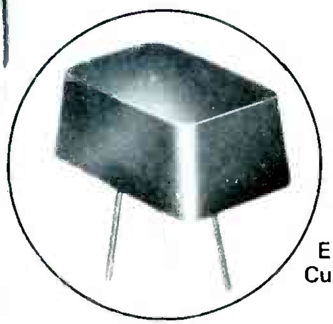

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- No key lock switch needed
- To install, simply mount siren and hidden interior switch
- Protect entire car and its contents with only two wire connections

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SIREN ALARM

Includes all of the above plus cast aluminum ultra-loud siren with 4½" rotor and heavy-duty 12-volt motor. Size 5¼" h x 4½" w x 7" d. Weight 4 pounds.

Stock No.AC348 Only $39.95

HORN ALARM

Includes interior mount hidden switch and encapsulated sensing module. Triggers car's own horn.

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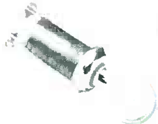

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- Protect entire car and its contents with only two wire connections

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Includes all of the above plus cast aluminum ultra-loud siren with 4½" rotor and heavy-duty 12-volt motor. Size 5¼" h x 4½" w x 7" d. Weight 4 pounds.

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9. Unpaid balance of cash price (Items 6 and 7 less item 8)		
10. Sales tax (Washington, D.C. residents only)		
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Enclosed is a down payment of $ ______ on the merchandise I have listed on the Conar Order Form. I will pay Conar a minimum payment of 7% of the beginning unpaid balance or $5 per month, whichever is greater, until the full balance plus applicable interest is paid. Title to and right of possession of the merchandise shall remain in Conar Instruments until all payments have been made. If I do not make the payments as agreed, Conar may declare the entire balance immediately due and payable. In satisfaction of the balance, Conar may, at its option, take back the merchandise, which I agree to return upon request. I agree that the above conditions shall apply to any add-on purchases to my account. The statements on my credit application are true and are made for the purpose of receiving credit.

Date ______ Buyer sign here ______

Please do not write in this space.

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The minimum monthly payment on a Conar account is 7% of the original unpaid balance or $5, whichever is greater. The 7% is calculated to the nearest dollar. For example, if your original balance is $140, your payment would be $10. If your original balance is $160, your payment would be $11.

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A →

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Home address ______________ City ________ State ______ Zip code ______

Home Phone ____________ How long at this address? __________ ( ) Own home ( ) Rent

Rent or mortgage payments $ ____ per month ( ) Married ( ) Single Wife's name ________

No. dependent children ______ Previous address ______________ How long? ______

WHERE DO YOU WORK?

B →

Your employer ______________________ Monthly income $ ______

Employer's address ______________________

How many years on present job? __________ Position ______________

Previous employer ______________________

Wife's employer ______________________ Monthly income $ ______

WHERE DO YOU TRADE?

C →

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Credit account with ______________ Address ______________

Total of all monthly payments including car $ ______________

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- Hooks up simply to any model television set. The screen actually becomes the playing field.
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- Game appears in color or black-and-white, depending on television set.
- Unmistakable "PONG" sound accompanies each volley.
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- Battery-operated by four size-D flashlight batteries included with the unit.
- No additional accessories necessary.

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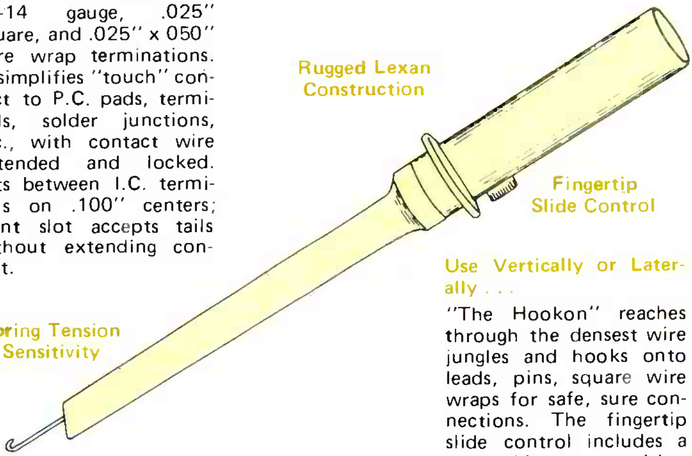
Test-Point Capability . . .

Connects to bare wires—26-14 gauge, .025" square, and .025" x 050" wire wrap terminations. It simplifies "touch" contact to P.C. pads, terminals, solder junctions, etc., with contact wire extended and locked. Fits between I.C. terminals on .100" centers; front slot accepts tails without extending contact.



Use Vertically or Laterally . . .

"The Hookon" reaches through the densest wire jungles and hooks onto leads, pins, square wire wraps for safe, sure connections. The fingertip slide control includes a self-locking open position and a "no hands spring grip" upon trigger release.

Contact Sensitivity . . .

"The Hookon" offers positive tensioned contact to all terminations without danger of damage or marring. The contact is made of corrosion-resistant steel, while the entire unit is precision-molded of sturdy Lexan for long-term durability, heat resistance, and high levels of insulation. The slide button is in white and the body mold in red.

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