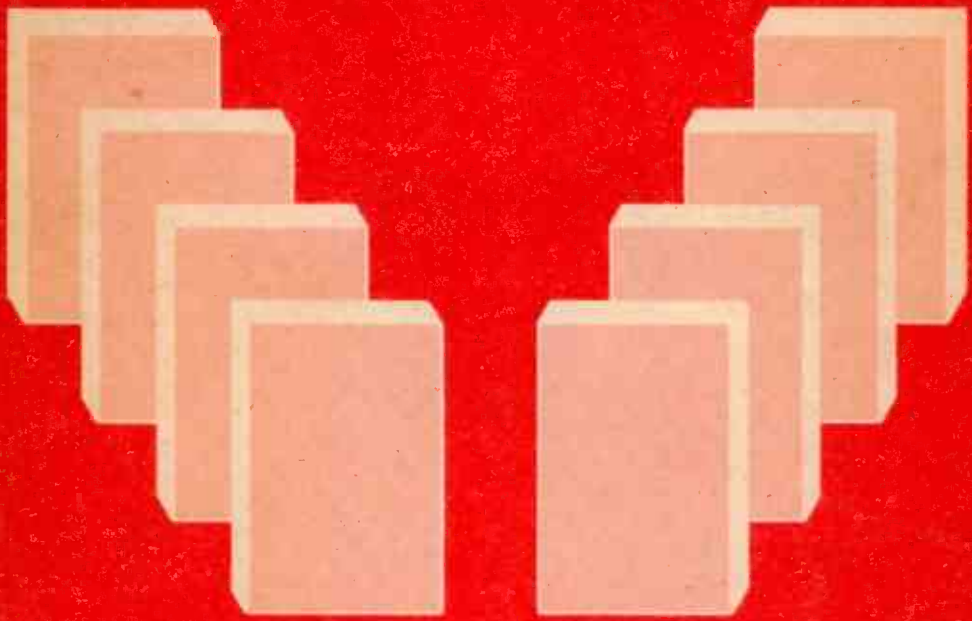
LCD'S: WHAT NEXT?



- Cookbooking: A Definite No No
- Alumni Accomplishments

nri journal
November/December 1979

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nri journal

November/December 1979
Volume 37, No. 5

In this issue, Doug Haggis explores the use of liquid crystals and explains how they work. Colleen Bohr tells us how two alumni make the most of their NRI training. And Mike Curry cautions us to rely on test instruments when making car repairs.

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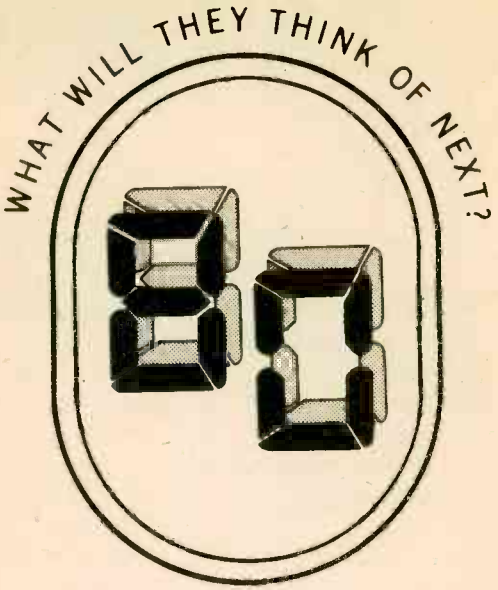
LIQUID CRYSTALS



By
Doug Haggis

Imagine for a moment a television thin enough that you could hang it on your wall just as you would an oil painting. Or, how about a set with a pop-up lid, and the lid itself is the TV screen? Just think, you could take either of these TVs to the beach or the golf course, and even in the brightest sunlight the picture would be glare-free. Impossible? Not quite.

Although you cannot yet buy these sets, the prototypes recently unveiled by Matsushita (Panasonic) and Hitachi do look promising for future production. It will be a few more years before these TVs are commercially available, but the technology exists today – the technology of the liquid crystal display (LCD).

Liquid crystals have been around for quite some time in digital displays. It is likely that you own or have seen a watch or calculator having a liquid crystal display. The liquid crystal display is distinguished from its counterpart, the LED (light-emitting diode), in that the LCD is black and white, rather than bright red, and is not washed out by bright sunlight.

A LIQUID CRYSTAL?

Although liquid crystals are not the easiest things in the world to understand, they do operate in a logical manner. Liquid crystals are chemically produced organic compounds which have properties that make them seem to behave like both ordinary liquids and crystal solids at the same time. The molecules of a liquid crystal compound are in the form of long, cigar-shaped rods that possess what are known as "dipole" characteristics. That is, they have two poles: positive and negative.

Opposite poles attract (just as in two magnets), so a liquid crystal rod

in an electric field will align itself with that field polarity. Picture how iron filings are caught in a magnetic field and position themselves along the lines of magnetic force. The same thing happens to the liquid crystal rod whenever an electric charge is applied. By applying the right charge, the crystal rods can be aligned or positioned any way you want.

In the unenergized state, when no electric field is present, the rods tend to align themselves in such a way that light passing through the crystal is "twisted" or rotated. If the crystal thickness is carefully held to a very small size, the amount of rotation can be precisely determined. For most displays using liquid crystals, an exact 90 degree twist or rotation is needed, as we'll see shortly.

The fact that the liquid crystal responds to an electric field gives it one of its most valuable properties – low power consumption. In use, the LCD behaves very much like a capacitor that is charged and discharged, consuming very little power in the process. A typical watch display may require perhaps 100 nanowatts (0.1 microwatt), giving a very long life to the tiny battery that powers the watch.

Liquid crystals do not generate light, but by arranging them in an electric field they can transmit or reflect light from outside sources. Depending on the application, the principle is as simple as that of the venetian blind.

THE LIQUID CRYSTAL CELL STRUCTURE

Liquid crystal displays found in watches and calculators use a field-effect liquid crystal cell. This type of cell, as shown in Fig.1, consists of two glass plates, each having a transparent conductive coating between which the liquid crystal material is sandwiched. The thin film of transparent electrical conductor is screened

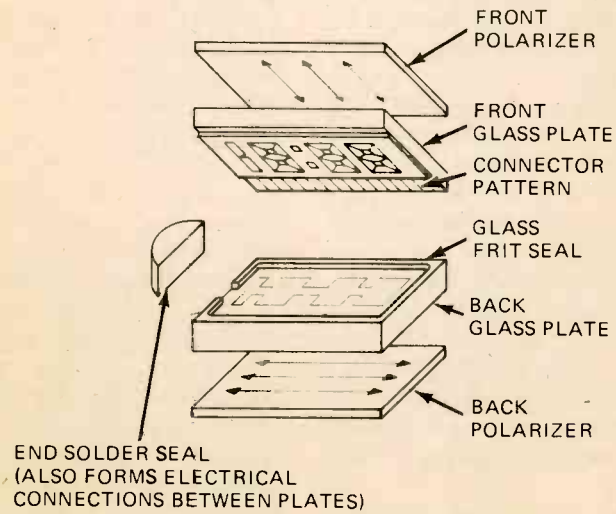


FIGURE 1. LIQUID CRYSTAL CELL STRUCTURE.

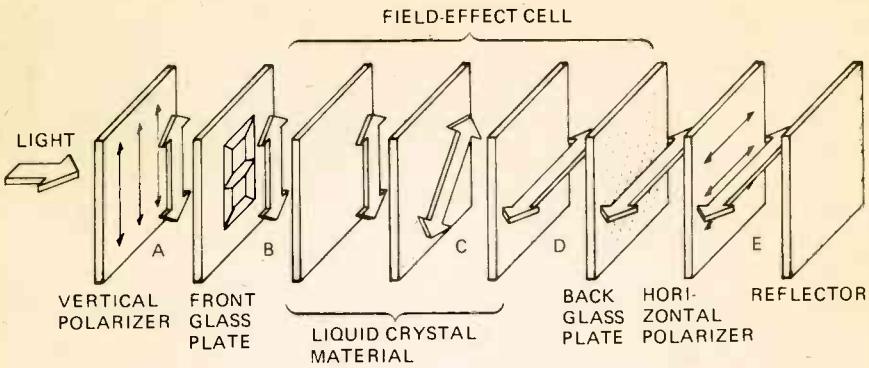


FIGURE 2. UNENERGIZED REFLECTIVE LCD.

on the inside of the front, or top glass plate. This conductive coating is patterned to produce a series of seven-segment characters. The back or bottom glass plate is also screened with a transparent conductor forming a seven-segment character display matching that on the front glass plate. The seven-segment characters on the back glass plate, however, will form a closed seven-segment character, to be used as a common electrode. Leads are then connected to the individual segments on the front glass plate to form characters. Another lead is connected to the digits on the rear glass plate to form what is called the "back plane."

The screened sides of both the back and front glass plates are coated with a transparent dielectric material that produces the desired alignment of the liquid crystal molecules. Next, the two glass plates are fused to a glass frit seal, leaving a gap of approximately 0.050 inch between the plates. This gap is filled with the liquid crystal material. A light polarizing material is applied to the outside surfaces of the front and back plates to polarize the light passing through the cell.

There are three types of field-effect liquid crystal displays commonly used today: reflective, transmissive, and transreflective. The reflective LCD makes use of a vertical polarizer, a horizonal polarizer, and a reflector, as shown in Fig.2. With no voltage (charge) applied, the preparation of the liquid crystal cell plates produces a uniform alignment of the crystal molecules. If the front and back plates are mounted at right angles to one another, according to the way in which the crystal molecules line up, a 90 degree rotation, or twist, occurs. Vertically polarized light entering the front of the cell (A) follows the rotation of the crystal alignment as it passes through the cell, as shown by sections B, C, and D. Having been rotated 90 degrees, the polarized light passes through the horizontal polarizer to the reflector (E). The light is then returned through the cell, again rotating 90 degrees, and passes out of the LCD through the front vertical polarizer.

When voltage is applied across one or more of the character segments, as shown in Fig.3, the crystal molecules in the area of the segments align themselves with the electric field. Therefore, rotation does *not* occur in the area of the energized pattern. The vertically polarized light conforming to the image produced by these elements cannot pass through the horizontal polarizer; rather, the light is absorbed

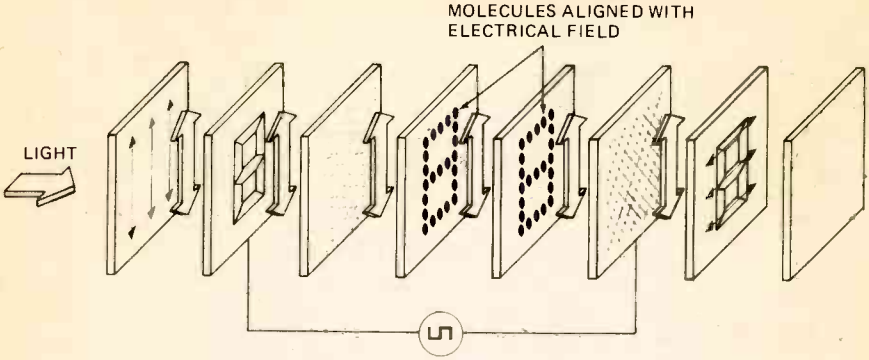


FIGURE 3. ENERGIZED REFLECTIVE LCD.

by it. The energized portion of the display, therefore, appears as a dark or black image against a light background (reflector), creating a high degree of contrast in all but very low light levels. The reflective LCD requires front lighting; that is, the light source must enter through the front glass plate.

In the transmissive LCD, shown in Fig.4, a vertical polarizer and horizontal polarizer are also used. This type of LCD operation requires that the light source enter through the rear or back glass plate.

When no voltage is applied to the cell, light passes through the rear horizontal polarizer, is twisted by the cell, and then passes out through the vertical polarizer at the front of the display. When voltage is applied to the cell, the twist (crystal rod alignment) is destroyed in the region of the energized pattern. The horizontal polarized light emitted by the source is absorbed by the vertical polarizer, forming the black-on-light image of the energized pattern.

The transreflective LCD makes use of a polarizer and a transreflector. The transreflector acts like a one-way mirror. That is, it operates either by reflection of light from the front or by back lighting from the rear. With

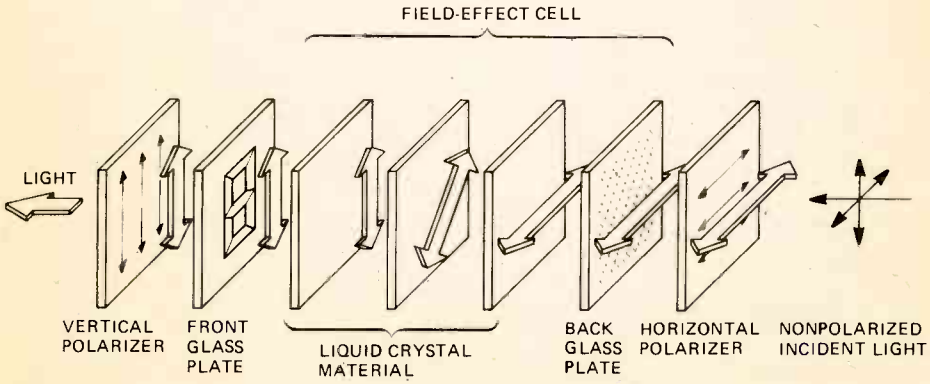


FIGURE 4. UNENERGIZED TRANSMISSIVE LCD.

back lighting, the transreflective display performs like the transmissive display. With front lighting (reflection), the transreflective display performs like the reflective LCD.

PROBLEMS

Despite the many attractive features of liquid crystal displays, they also have some undesirable characteristics. First of all, LCDs respond slowly. This is because it is the physical realignment of the crystal's molecular structure in response to changes in an electric field that gives the crystal its desirable properties. It takes a significant amount of time for the molecules to twist and untwist in response to the applied electric field. For this reason, it is not possible to multiplex LCD digits as is commonly done with LED displays. The slow response also poses a problem when using LCDs for TV pictures.

Second, LCDs are very temperature-sensitive. With the compounds being used today, LCDs operate reliably over a very narrow temperature range – about 65°F to 100°F. At higher temperatures, the LCDs lose their field-effect properties. At lower temperatures, the crystal response time increases, and the display may actually appear to "freeze" with all elements apparently on at once.

THE FUTURE

Today, most watch and calculator LCDs use a display having not more than 120 operational liquid crystal segments. The Hitachi LCD TV screen mentioned earlier makes use of about 9000 individual liquid crystal segments. Matsushita's LCD screen uses over 56,000 individual liquid crystal segments. The segments are arranged as dots, similar to newspaper print. By turning each of the dots on and off (producing dark and light areas) in a specific sequence, the display can be used to produce pictures.

LCD is still an infant of technology, and the biggest step remains to be taken. And, with the LCD TV right around the corner, who can guess what the future will be?

About the Author

As Senior Technical Editor and product development engineer, Doug has been instrumental in the development of NRI's newest, most advanced, fully programmable 25 inch color TV – one of the most sophisticated television receivers especially "designed for learning."

Doug moved to the Washington area in 1970. He has been with NRI since 1976, and is currently working towards his electronics engineering degree at a local university. Doug is a firm believer that hard work and the NRI method of "hands-on training" can prove invaluable in the making of a successful service technician.

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Alumni Accomplishments

This issue, we'll look at two more alumni who have succeeded in their chosen fields with the help of their NRI training. Both men found that home study provided advantages that traditional schools could not offer. Primarily, home study allowed them to continue at their present jobs while being trained in their field of interest. A common sentiment in both success stories is that education never stops and the need for continuing education is especially acute in technical fields where changes occur every day.

GRAD MAKES GOOD

Michael Ihrie, from Kendalville, Indiana, enrolled in NRI's Servicing Electrical Appliances course in 1973. He had completed two years of college, one year at Ball State University and another at Indiana State University. However, Michael found that the traditional college education was too broad for his interests – it did not train him for a "practical" job. Dissatisfied, Michael left college and began working in a factory to support his family.

by Colleen Bohr

MICHAEL IHRIE

Michael knew that the factory was not what he wanted and began looking into home study courses for technical training. According to Michael, home study was the logical choice. "It was the 1973/1974 recession, and I couldn't afford to go back to school full-time. For me, home study was the most economical way to get training. I could hold down a steady job while getting the education I needed to do more with my life."

Michael had some electronics background and enjoyed tinkering with appliances at home, but he did not have the training to turn his interest into a career. After looking at other home study courses, Michael chose NRI because "it offered more and the material was straightforward and easy to understand."

After finishing the course in Appliance Servicing, Michael was qualified to do warranty service. Soon, major appliance companies began sending representatives to Michael so that he could begin warranty service on their appliances. In addition, Michael did repair work for local dealers who sold appliances but had no one to do field service for them. One of Michael's contacts steered him to his present job building test equipment for appliance controls under the official title of Engineering Service Technician. "NRI put me in a good position to know people. You might say it got me in the right place at the right time."

According to Michael, "NRI changed my outlook as far as 'higher education' is concerned. . . . NRI is not a 'matchbook cover' school at all. The information and training at NRI are equal to or, I feel, better than a college." Michael found that many of the technicians he meets are also NRI graduates. From his own experience, Michael found that "the NRI diploma carries quite a bit of weight. It gives you the credentials to get started."

Michael's advice to NRI students is to "stick to it. You've got to finish the course. Even after you finish the course, don't stop there because the field is constantly changing." Following his own advice, Michael is planning to take NRI's Microcomputer course because his company is expanding into the microwave oven field.

Michael cautions NRI students not to expect job offers as soon as they finish the course. "People don't come pounding your door down the minute you get your NRI diploma. The job opportunities in electronics are there, but you have to find them. However, with my NRI training, I found work sooner than I thought I would. NRI helped me get out of the factory and into a career that I enjoy."

CHARLES GOBEIL: REFRIGERATION SPECIALIST

Last November, as he was finishing up his NRI course in Air Conditioning, Refrigeration, and Heating, Charles Gobeil of St. Paul, Minnesota opened up his own business servicing air-condi-

tioning and refrigeration equipment of all types. Today, without any advertising other than word of mouth and business cards, Charles' business is swamped with work. He says his success is the result of his NRI training, vocational/technical school training, initiative, and hard work.

Charles first became interested in refrigeration because it involved a knowledge of many fields and offered a variety of components to work on. Through a night course at a local vocational/technical school, Charles already knew something about electricity, but he wanted a course that dealt specifically with refrigeration. It was at his night course that Charles first heard about NRI. A friend asked Charles for help with an NRI course, and brought his NRI books to class. Charles looked over the books and found them to be informative and understandable. At that point, he says he began considering home study as a viable alternative to traditional schooling.

Because he had to support his family, Charles could not afford to give up his job as a building maintenance man to go to school full-time. For this reason, he sent away for brochures from five different home study schools. Charles was impressed with NRI's brochure "because it gave an outline of the course and it seemed that NRI was truly interested in educating students. In other words, it struck me as being more professional than the other schools I looked at."

Within five months after enrolling with NRI, Charles had completed the course and had started his own business. At first, Charles kept his other job and visited restaurants and bars to tell them of his services. Gradually, by word of mouth, he began picking up jobs and he acquired a phone answering service so that he wouldn't miss calls. Soon, Charles built up enough work to go into the business full-time. Since then, Charles has taken other refrigeration courses in night school. "NRI provided me with an excellent base to build on with experience and further education. I now service just about everything that deals with refrigeration — computer rooms, restaurants, bars, and residential equipment."

CHARLES GOBEIL

Charles has some advice for NRI students. "Continue your education. There's always something new being developed and you have to keep up with the field .... Visit a wholesaler. You can pick up technical information there and actually see what various systems look like .... Also, a good place to get initial experience in servicing is to go to a used appliance store. There are usually about six or seven of these in most big cities. Go in and tell them you'll fix the appliances they have laying around for a small fee. That way, you'll get experience with different brands and you can take your time tearing apart the appliances and looking at them. You can find out the weaknesses of various brands and which brands to stay away from. This can be helpful if you plan on selling equipment .... Finally, go out on some service calls with someone who works in the trade or visit their shop. Their experience can really help you."

Both Michael and Charles demonstrate what can be achieved if interest and ambition are combined with the proper training. Because NRI offered them the opportunity to pursue their career goals without having to give up their present jobs, they received quality training without severe financial loss.

We hope that learning about the accomplishments of Michael Ihrie and Charles Gobeil will serve as encouragement and inspiration to others.

Is the success of Michael Ihrie and Charles Gobeil unusual, or do other NRI students and graduates experience similar rewards for their hard work and training? We hope to find out by looking at other NRI students and graduates in future issues of the *Journal*. If you have an interesting story to tell, or if you know another successful NRI student or graduate, please drop a line to Managing Editor, *NRI Journal*, McGraw-Hill CEC, 3939 Wisconsin Avenue, Washington, D.C. 20016.

And There Are Others . . .

Spiros Angelopoulos, of Astoria, New York, is a recent graduate of NRI's Master course in Color TV Servicing. Although he currently repairs TVs and stereos on a part-time basis, he plans to go into business full-time before the end of the year. According to Spiros, "I recommend NRI to anyone wanting good, 'down to earth' training . . . . NRI is a good school — I would not hesitate to say perhaps the best of its kind."

Winston A. Bynoe, of Timberlake, North Carolina, is a graduate of NRI's Servicing Electrical Appliances course. He, too, has found that his NRI training is valuable to his career: "What I found to be most impressive about NRI is their honest, open, and upbuilding approach. I have developed a part-time business that has supplemented my income. Also, on my full-time job, it has helped me to become a more valuable, useful employee."

Allen W. Davis, of Cheverly, Maryland, graduated in 1976 from NRI's Computer Electronics course. He attributes his current success to his NRI training: "My NRI training is totally responsible for my success in electronics. . . . As my NRI training progressed, so did my confidence, ability, and pay. Subsequent employment has allowed me an equal measure of success as a digital/industrial, commercial/ rf-af technician, and as an electronics instructor."

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Ham News

Ted Beach K4MKX

I had forgotten how quickly the time approaches to prepare the Ham News column for the *Journal,* especially since we switched to a bimonthly schedule! The latest edition is just going out to you all, and here I am writing the November/December column. Oh well, this just means I'll have to get used to relating "news" that is a few months stale – I'm just now beginning to get cards and notes concerning things that were mentioned in the Summer issue. We'll just have to resign ourselves to not having things that are particularly up-to-date appear in these pages!

I had an opportunity the other day to try out a new general coverage receiver that looks like quite a neat rig. I was browsing around in a local Radio Shack store and spotted the receiver behind the counter on a shelf. I asked the clerk if I could try it out and he said, "Go right ahead."

He dug out the manual (no schematic or real technical information), and after reading the specifications, I was quite impressed. It covers the range from 10 kHz to 30 MHz continuously and uses triple conversion! The manual says it has a six-element ceramic filter with a 6 kHz bandwidth at -6 dB and 20 kHz at -70 dB. That's a shape factor of 3.33 and should give very good SSB reception. I don't know what the three intermediate frequencies are, but the first i-f is somewhere around 50 MHz – this would give image frequency that's out of sight.

The clerk said he thought there was an antenna connected to the receiver. Looking at the back, I saw a piece of speaker wire connected to one antenna terminal (it also had a coaxial antenna connector), and the wire wandered off down the shelf about 10 feet and stopped. Some antenna.

Anyway, I turned the rig on and set the frequency to the 20 meter band. This involves setting a band switch that

Fritz	KA2AQL	–	Mt. Vernon NY
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Andy	KA4EIG	N	Tavernier FL
Robert	KA4JVP	N	Burns TN
Bill	KA4KCP	N	Brookville IN
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Bill	WD4ODN	A*	Ft. Mitchell KY
Harley	KA6HIE	N	Nipomo CA
Bob	KA7CUL	G*	Tucson AZ
Arthur	KAØFQQ	N	Moorefield NE
Ed	N4BHQ	T	Charles Heights SC
Harold	N5ANO	–	Abilene TX
Glen	WB8EYT	–	Canton OH
George	WD8SEA	G	Fairfield OH
Steve	KA9AOG	T*	Elkhart IN
David	DA9AMA	G	Beardstown IL
Rich	AI9O	E*	Roselle IL
Lyn	WDØHFR	G*	Holdrege NE
Frank	WL7AHD	N	Whale Pass AK
Bob	DA2QE	–	West Berlin

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selects one of six preselector ranges, setting a MEGAHERTZ dial to the desired MHz (14), and tuning the KILOHERTZ knob. The received frequency is displayed by five LED digits. Once you have found a station, you can peak it up by tweaking the preselector dial.

Even with the real neat "antenna" that was connected to it, I managed to hear several European amateurs in just a few minutes of tuning. Then I switched and tried to bring in WWV at 10 MHz and what do you know? At 10.000 MHz, there it was! Not very loud, but definitely Q5 copy. CHU at 7.333 MHz was also readable.

Not having too much time to really investigate the receiver, I did manage to tune across the entire spectrum, which takes a bit of doing, and was quite surprised *not* to hear numerous birdies all over the place. Normally, in a receiver of this type, I would expect to hear them all over the dial.

I would like very much to see how the receiver performs when connected to a good, long wire antenna with an antenna tuner. Unfortunately, the $379.95 asking price is not presently in my discretionary funds budget (I still like to eat!), so I probably won't get the opportunity. However, if you get the chance to try one out, do so. Drop in to your local Radio Shack and ask to try their DX-300 receiver. It looks great.

The NRI Get Togethers seem to be working to some extent. I can't say from firsthand knowledge since I'm still QRT with a dead transceiver, but we've had a couple of notes already that comment on some local rag chews at the scheduled times, and several people have said they'll try to check in. Just in case everything does go as planned, we'll continue to print the schedule in these pages for this year and next. Maybe one of these days I'll find the time to debug the rig and get in there with you.

NRI "GET TOGETHER" SCHEDULE FOR 1979 – 1980

	75/80	15	40	75/80	15	40
NOVEMBER			6	13	20	27
DECEMBER	4	11	18			
JANUARY	1	8	15	22	29	
FEBRUARY			5	12	19	25

TIMES:
CW 8:30 - 9:00 PM EST
SSB 9:00 - 9:30 PM EST
*+5 kHz in case of QRM or QRN

FREQUENCIES:	CW*	SSB*
15 Meters	21.150	21.400
40 Meters	7.130	7.280
75/80 Meters	3.730	3.980

Even the two meter rig is out of commission. The Wilson has a set of dead nicads, and someone ripped off my mobile antenna and amplifier. I hope they destroy their CB rig when they try them out! I think the nicads gave up from lack of exercise. I can't remember the last time I turned the thing on. After all, even with repeaters, one doesn't do too much with just a rubber duck and 2 watts.

Enough of my woes. Let's look at the bright side of things and see who we've heard from since last time.

Frank, KA2EIO, writes that he attended some classes sponsored by the Jersey Shore Amateur Radio Society (JARS, of course) and was able to pass his General test on July 6, upgrading from Novice. Since April, Frank has worked all U.S. districts and twelve countries. All this on cw using a Swan 270B transceiver. Nice going, Frank.

KA4EIG may have his General ticket by now. Back in August, Andy wrote saying he had just finished his NRI course and was ready to sit for the General test so that he could use all the capabilities of his neat Heath station (SB104A, SB644A, SB221, SB614, and SB634). Up to that point, all those transmitting goodies in the Heath station had not been used except to receive, because Andy had decided long ago to wait until he had finished his course and had a General Class license to light off the transmitter into the Butternut vertical. Such restraint. I know I could not resist, Andy, and I hope you have that General by now.

KA4KCP explains that the "4" call was issued at his permanent QTH in Kentucky. Upon retiring next July, that is where he plans to live. No confusion, Bill. These days it's quite common to hear "displaced" calls since the FCC isn't issuing new ones when one moves to another call district. My congratulations on your coming retirement, and I hope you have lots of fun chasing DX with your TS820 from Mt. Olivet.

WD4LAH writes that he shared his NRI lessons with his son (aged 15), and they both got Novice licenses in 1977. They had a ball chasing WAS and DX, and both were upgraded to General this spring. Since then, they have both remained quite busy getting involved in lots of contests and handling traffic. José and his son (also José) share a Yaesu FT-101E with amplifier, remote VFO, and digital display. There is also a Yaesu scope and phone patch in their shack. For antennas, they use a Hy Gain tribander on a 95 foot tower, a sloper on 40 and 80, and a long wire for 160.

WD4ODN tells us that he had written before when he got his first license, but apparently we never got the letter. Sorry, Bill. Anyway, congratulations on the Advanced, and we hope you were successful in your quest for Extra in September.

KA6HIE, Harley, writes that the Novice test was a snap because of his NRI course. Harley was copying 10 wpm at the time, so he should soon be ready for the General exam.

N4BHQ is another whose correspondence seems to have gone astray. Ed writes (once again) that he passed the Technician exam in November of 1977 and received the ticket in January. He has a Yaesu FT-101E for the low bands and is planning to use the NRI two meter rig he is building on vhf. Fine business, Ed, and my apologies for not getting your name into print sooner than I did.

N5ANO writes that apparently 15 was in fair shape for the August 7 Get Together. Harold called CQ NRI a couple of times and snagged WB2LTS, Manny, in Long Island. He also heard from Al, K1AV, from Portland, Maine, and Jerry, WE4GAT, from Greenville, South Carolina. After a while, they were joined by WD4PXP (not an NRI student or graduate), Larry, in Henderson, Tennessee. About that time, the bottom started dropping out of the band and Harold finished off the QSO with Bob, N5ARM, in Kenner, Louisiana. Bob is a 1971 NRI graduate. Very fine, all of you. Sure hope we'll get some more good reports soon. Thanks, Harold.

WB8EYT is one of two people who wrote me at the home QTH, much to my surprise. (I can't remember who the other person was.) Thanks, Glen. I don't know how well your HW8 and inverted vee will do on the Get Togethers, but do give it a try one of these days.

WD8SEA phoned me at the office some time in August, and I forgot to take notes on what we talked about. I scratched down some things, but unfortunately I can't read them now. The only decipherable scribblings are that George got his General ticket in January of this year. Oh, well.

I don't think I'll ever get used to seeing calls like AI90 in print. However, Rich is very proud of that particular call, and justifiably so. That Extra ticket was gotten despite a busy working schedule and having to deal with many problems along the way. Rich also managed to pick up a First Class Radiotelephone license, and passed the Technician and Advanced amateur licenses – all in a period of two years. Congratulations, Rich, you certainly stuck in there and got your reward!

KA9AOG writes that since he recently got his Technician license, he was planning to try for his Advanced license in the fall, if his college studies permitted. Steve uses a Heath 2036A on two meters along with a Regency 2A. On the low bands, Steve is using an old Hallicrafters SR160 and a dipole antenna.

WDØHFR has also recently upgraded to General and says he missed Advanced by three questions! Better luck next time, Lyn. He managed to contact N5ARM on the August 14 Get Together, but the band conditions were such that the Triton IV couldn't cut the mustard for a real solid QSO. However, next time things may be better for a good long chat.

Frank, WL7AHD, doesn't find a great deal of time to operate from Alaska because he works 14 hours a day, six days a week. However, if anyone would like to make a schedule to contact Alaska, Frank says he would be happy to set one up. He works 10, 15, and 40 with his TS820 and is available after 7:30 PM, PDT, most days. Drop him a line if you need Alaska.

Frank Burden
Pouch B
Ketchikan, AK 99901

Robert L. Chilcote
USAFSB Berlin, Box 15
APO New York 09742

DA2QE says that he will try to check in on the 15 meter Get Togethers as time permits, so you all can get a West Berlin contact. Bob has worked lots of Novices and would also be willing to set up schedules for anyone needing Germany. You can write him at:

That looks like all we have for this time. Please be sure to keep writing. We always like to know what the NRI amateurs are up to out there. See you next year – 1980.

Very 73 – Ted K4MKX

About the Author...

Ted Beach has been with NRI for 18 years, and has been an active radio amateur for more than 25 years. He started writing Ham News shortly after NRI introduced the Amateur License courses in the late 1960's. Then we were most anxious to let everyone know about our new program and were trying to solicit NRI amateurs to help out as volunteer examiners for hopeful Novices.

In addition to being the technical editor of the NRI Journal, Ted sees that the material in all NRI electronics courses (lessons and kits) is technically correct before it goes out to our students. This means that he has been involved with industrial electronics, color television, amateur radio, computers, CB, and most recently, microcomputers. As you might imagine, Ted stays pretty busy most of the time!

1	Conditional Class License eliminated. Novice power limit upped to 250 W.	June 25, 1976
2	Technicians given Novice privileges.	July 23, 1976
3	No new distinctive Novice call signs, although Novice may sign "/N."	October 1, 1976
4	No requirement to sign "portable" or "mobile" except foreign operators using reciprocal licenses.	November 26, 1976
5	First "comprehensive" CW exam given in Washington, D.C. office. No solid copy for one minute requirement.	January 1, 1977
6	Court case "temporarily" suspends all license fees.	January 1, 1977
7	New interim licenses issued upon upgrade of license class at an FCC office.	March 1, 1977
8	Secondary station license eliminated.	March 3, 1977
9	97.95(a)(2) deleted. No notification of new address required.	March 9, 1977
10	New emission purity standards. All spurious emissions down 40 dB for transmitters operating below 30 MHz, down 60 dB for transmitters of 25 watts or more operating between 30 MHz and 235 MHz (97.73).	April 15, 1977
11	Code sending test deleted from Commission-administrated examination.	August 26, 1977
12	97.95(b)(2) rescinded. Maritime Mobil in Region 2 may use all amateur frequencies. In foreign waters, Maritime Mobil may use only frequencies authorized by regional government.	September 12, 1977
13	Call sign restructured, making special calls available to various class license holders.	March 24, 1978
14	Ban on commercial 10 meter linear amplifiers.	April 28, 1978
15	Novice license term extended to five years, renewable. Technicians given full privileges above 50 MHz.	May 15, 1978

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Alumni News

Harry Taylor

IT'S TIME FOR THE 1980 NRIAA NOMINATIONS . . .

Another year has gone by and we are now ready to elect officers for 1980. We will nominate one candidate for President and four candidates for Vice President. These nominations must be received at NRI by December 15, 1979. The nominees will be announced in the next issue of the *Journal*.

In considering whom to nominate, keep in mind the restriction on the reelection of incumbent and past officers as set forth in Article 6, Section 2 of the constitution:

"The President shall not be eligible for reelection until after expiration of at least eight years following his last term of office and further may be a candidate for Vice President only after expiration of at least one year following his term of office as President. Vice Presidents may not serve more than two consecutive terms; when reelected for a second consecutive term they shall not thereafter be candidates for Vice President until after expiration of at least three years following their second term of office."

In past years, we have made suggestions as to possible candidates for

office. This year, however, we are going to leave it entirely up to you. In fact, if you feel qualified for any of the positions, you are welcome to nominate yourself.

Below you will find a 1980 nomination ballot and you will notice that the polls close December 15, 1979. Read on and you'll learn the latest news from our local Alumni Chapters.

1980 NOMINATION BALLOT

(Polls Close December 15)

Harry C. Taylor
Executive Secretary
NRI Alumni Association
3939 Wisconsin Avenue
Washington, D.C. 20016

I am submitting this nomination ballot for my choice of candidates for the coming election. The persons below are those whom I would like to see elected officers for 1980.

My choice for President is _____

City _____ State _____

My choices for four Vice Presidents are

1 _____ City _____ State _____

2 _____ City _____ State _____

3 _____ City _____ State _____

4 _____ City _____ State _____

Your signature _____

Your student number _____

Your address _____

_____

DETROIT CHAPTER

The September meeting was our first meeting after summer vacation. We held a very lively discussion on various problems in consumer electronic equipment. The members spoke about some of the servicing problems they had encountered and how they solved them. This information exchange is extremely valuable when we encounter a tough problem that one of the other members has experienced.

We were especially pleased to see Donald Hughs, who travels a great distance from Ontario, Canada to attend our meetings. Donald told us about some of the servicing problems he had encountered, and we found them very enlightening.

FLINT/SAGINAW VALLEY CHAPTER

At the August 8 meeting, Andy Jobbagy demonstrated the forerunner of modern modular TV construction – a 1962 Motorola set using plug-in RC networks. The devices were about the size of an octal-base vacuum tube, with pins at the bottom for electrical connections and physical support. Andy illustrated the circuit diagrams and numbering systems of these modules.

Next, we observed and discussed three common picture tube failures. It was pointed out that to profit from your work, you must be sure of the defect before you change a picture tube. Interpreting symptoms correctly, therefore, is very important.

We are continuing to discuss, analyze, and service microwave ovens. This is a lucrative field in our area. One problem we face now is where to obtain replacement parts.

At our August 22 meeting, we discussed safety measures that we should

DIRECTORY OF ALUMNI CHAPTERS

DETROIT CHAPTER meets at 8 p.m. on the first Friday of each month at St. Andrews Hall, 431 E. Congress Street, Detroit. Chairman: James Kelly, 1140 Livernois, Detroit. Telephone 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 Road, Flint. Chairman: Dale Keys. Telephone (313) 639-6688. Shop phone (313) 694-6773.

NEW YORK CITY CHAPTER meets at 8:30 p.m. the first Thursday of each month at 1669 45th Street, Brooklyn. Chairman: Sam Antman, 1669 45th Street, Brooklyn.

NORTH JERSEY CHAPTER meets at 8 p.m. on the second Friday of each month at the Players Club, located on Washington Square in Kearney, N.J. For information, contact Paul Howard, 950 Carteret Avenue, Union, N.J. 07083. Telephone (201) 964-8492.

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, Pa. Telephone 583-7165.

PITTSBURGH CHAPTER meets at 8 p.m. on the first Thursday of each month at the home of Jim Wheeler, 1436 Riverview Drive, Verona, Pa. 15147. Chairman: George McElwain, 100 Glenfield Drive, Pittsburgh, Pa. 15235.

SAN ANTONIO CHAPTER meets at 7 p.m. on the fourth Thursday of each month at the Alamo Heights Christian Church Scout House, 350 Primrose St., 6500 block of N. New Braunfels Street, (three blocks north of Austin Hwy.), 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 Street, 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.

TORONTO CHAPTER meets at McGraw-Hill CEC, 330 Progress Ave., Scarborough, Ontario. For information, contact Stewart J. Kenmuir at (416) 293-1911.

practice when working on microwave ovens. Basically, we agreed that you should not wear any metal when working on them -- no rings, watches, necklaces, metal-frame eyeglasses, etc. Microwave energy reaching metallic objects heats up these objects and can cause burns. A more important rule is never expose yourself or anyone to microwave radiation. Never operate the oven unless all shields, waveguides, and panels are in place.

We will continue to discuss and work on televisions, microwave ovens, other appliances, and cable TV signal processing equipment.

NEW YORK CITY CHAPTER

We were pleased to welcome three guests to the July meeting, which was led by our chairman, Sam Atman. The minutes of the previous meeting and the treasurer's report were read and approved.

One of the guests was Paul Howard of the North Jersey Chapter. Paul has been working with us to arrange a joint dinner meeting between our two Alumni Chapters. He stated that the dinner should be held at a hotel or motel convenient to both Chapters and that the cost per person would be about $12. The meeting will be held later in the Fall, with spouses and other special guests invited. If you are interested, you can contact the New York City or North Jersey Chapter or the Executive Secretary at NRI.

This was followed by a film on transistors, which was an informative lesson on transistor basics. A film on circuits will be shown at a later meeting.

Later, we discussed practical TV servicing problems. The set being discussed had weak sound, audio buzz, and fold-over on the right side. Adjusting the audio detector improved the sound, but did not restore normal volume. We will continue to look for the defect common to both the sound and video defects.

NORTH JERSEY CHAPTER

Capacitors were purchased over the summer break to aid in our trouble-shooting sessions. Paul Howard wrote letters to a number of manufacturers and sources of electronic equipment and supplies. As a result, catalogs were distributed to the members from Sylvania ECG, Workman Products, Projector Recorder Belt Company, Hayden Publishing, and Sencore. Literature was added to the Chapter's reference library from Motorola, Sencore, Mallory, RCA, Tech Spray, and Ampower Instruments.

Bob Morello was elected chapter librarian to catalog and maintain our reference library. Joe Crusco and Franklin Lucas were chosen to serve as a membership and welcoming committee. Jack Lapides, who services TV receivers part-time, was welcomed into membership of the Chapter.

Franklin Lucas, who has been a member of our Chapter since its second meeting (after its founding as the Hackensack Chapter), was presented with a certificate of appreciation for his many years of service to the Chapter. Franklin has been an officer of the Chapter in various capacities for eleven terms.

Purnell Williams brought in a Philco B423JWH with raster, but no video or sound. Purnell, Ben Nemeckay, Frank Czirok, and several others traced the trouble to a defective second i-f amplifier transistor. Troubleshooting in two CONAR receivers revealed a defective series-pass transistor in the 125 volt power supply in a set belonging to Sam Britt. Bob Schadewald, Jack Lapides, and Purnell Williams helped Paul Howard locate a bad agc inverter.

Being able to substitute i-f boards again helped us to isolate this problem.

PITTSBURGH CHAPTER

The topic of our August meeting was the servicing of color TV sets. We worked on two sets. The first, a GE, had a direct short in the horizontal output circuit. The second, an RCA XL-100, had an abnormally high voltage that could not be adjusted.

George McElwain used the shorted GE set to demonstrate the procedure for locating short circuits. It had a dead short that would blow the fuse in the set the moment power was applied. This gave no opportunity to measure circuit current. George connected a 100 watt lamp bulb across the fuse terminals and plugged in the power cord. Then, by disconnecting the circuits one at a time, we could see the effect on the bulb intensity. The bulb glowed at full intensity at first, indicating a direct short. When he disconnected the horizontal output transistor, the bulb dimmed. He then replaced the transistor and three associated capacitors, replaced the fuse, and checked out the operation of the set. The problem was solved.

SPRINGFIELD, MA CHAPTER

We covered a number of topics of interest at our September meeting. Under "old business," we discussed the annual picnic, which was held in June. All of the members enjoyed the outing.

John Park showed slides taken on his vacation in Japan this year. You might say that he shared his vacation with us. In addition to the beautiful scenery he found there, he also found the costs of goods commonly found in this country to be extremely high there.

Al Dorman spoke about servicing two-way radio equipment – CB, police, fire, and commercial units. In addition to giving us information on the types of problems and their solutions, he indicated that the demand for this type of work is increasing at a faster rate than is the demand for TV servicing in our area.

Joseph Gaze, who has been with the telephone company for many years, talked about modern telephone equipment – its capabilities, compactness, and versatility. He mentioned that electronic central station switching equipment takes up only a small fraction of the space required for the mechanical equipment it replaces. We hope to learn more about this through Joe's future presentations.

About the Author...

Harry Taylor has been on the NRI staff for over 15 years. He began as a technical writer and, over the years, he wrote or edited lessons and kit manuals in nearly every NRI course.

Harry has had a sincere interest in NRI students and graduates throughout his association with the school. He is currently responsible for the Graduate Services Department and, therefore, interacts daily with members of the Alumni Association and other graduates of NRI.

Harry says that his greatest satisfaction comes from finding solutions to problems NRI graduates run into. He also enjoys meeting graduates when they visit McGraw-Hill CEC and during his travels around the country to the Alumni Chapters.

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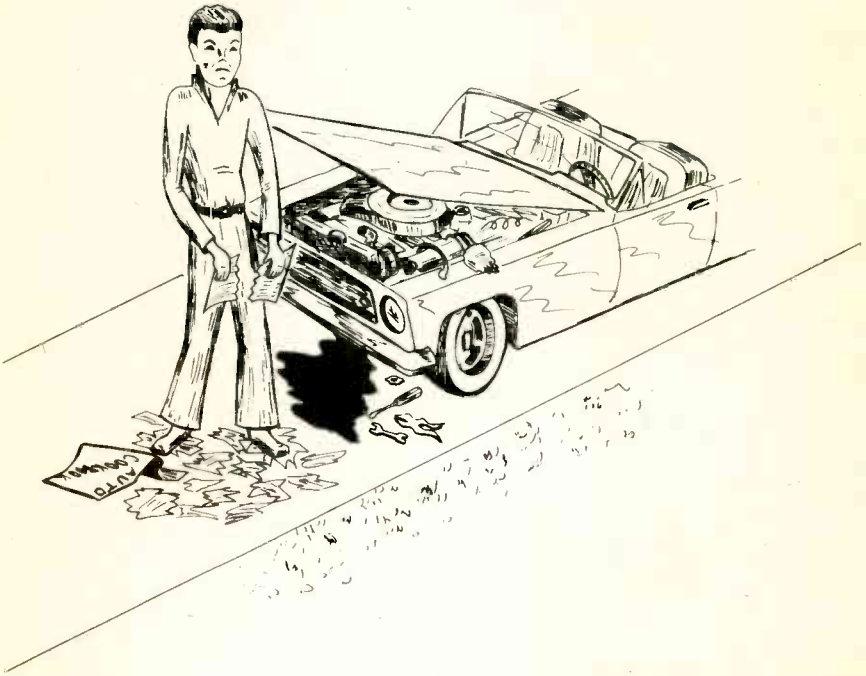

by Mike Curry

I have been spending some time lately on my latest acquisition, a 1972 Colt station wagon, shown in Fig.1. This vehicle was acquired in the interests of one of my minor hobbies, which is to purchase used vehicles at a very reasonable price, repair them at some equally reasonable cost, then sell them at better than Blue Book rate. Except for the unkind name of "Junkman," which my neighbors and my wife persist in calling me, I have found this to be a satisfying pastime.

Be that as it may, I ran into some trouble with the Colt. The gentleman from whom I purchased it was selling it "as is" for $300. After driving it around the block, I concluded that it needed a carburetor rebuild, transmission band adjustments, and new shock absorbers. What with the inflated price nowadays on small cars, I figured I could produce a $500 net profit.

Before you smile and predict that I bought a blown engine for $300, let me assure you that I was 100 percent correct in my original analysis. By the time the Colt was ready for resale, all that I had done was to rebuild the carburetor, adjust the valves and transmission, replace the shocks, do a custom tuneup, and clean up the car in general. (For those of you who don't know, a custom tuneup is when you tune the engine to best running performance, and not necessarily to specifications.)

FIGURE 1. 1972 DODGE COLT STATION WAGON.

What happened? Well, one of the things that I am always trying to communicate to NRI students is: "DON'T COOKBOOK!" Immediately second to this directive is: "Don't do the same thing for the third time without thinking long and hard about what else might be wrong." There are a lot of other things that go hand-in-hand with these ideas, like "Trust your test instruments every time," and "Don't fool with more than one thing at once," but let's look into the first two.

The time-wasting habit of cookbooking comes from looking things up "in the manual." Take the case of your average Saturday mechanic, Joe Shadetree. His next-door neighbor comes over with a complaint that the family station wagon is stalling out at stoplights. Well, Joe breaks open his new copy of Chilton's Troubleshooting Manual, and pages through it until he finds a section on "engine stalls." Skillfully moving his finger across the page, the first entry that Joe encounters under the heading is "Idle speed set too low." Confidently, Joe starts up the wagon, puts it in gear, hooks up a tachometer, and sure enough the idle is down by 75 to 100 rpm. Without hesitation, Joe turns the carburetor idle speed up half a turn, and assures his neighbor that "the service station boys didn't have it set right." Two days later, the neighbor is back, complaining that now the car engine races in "Park," misses badly when it's hot, and still stalls at stoplights. Not to worry. Joe is ready for the next item on the troubleshooting chart – "Idle mixture incorrectly adjusted." Another two days after this adjustment, and Joe's neighbor is back again, beginning to get a little hot by now, saying that the car still races in "Park," misses a lot worse when it's hot, has a tendency to overheat, and still stalls at stoplights.

We can leave Joe while he's adjusting the timing to compensate for the overheating. What is he doing wrong? He's cookbooking – he's looking up the trouble in a list of troubles, then running down through the procedures that are given for correcting the problem.

This is not to say that the lists of possible trouble areas are wrong, but

that they should be looked upon as reminders, and not absolute cures. A good mechanic should use his test instruments to figure out what is actually wrong, and then correct the basic problem, as well as others that might have developed as a result of the first. For example, if you discover that an exceedingly rich fuel mixture has been the cause of poor performance and black exhaust, don't stop after repairing the carburetor. Change the crankcase oil, because it may be contaminated with gasoline.

Since I began this discussion by talking about my Colt wagon, perhaps I should use my own mistakes as further illustration of the points I have brought up. After rebuilding the carburetor and remounting it on the intake manifold, I proceeded to start the engine. Not wanting to grind away on the starter to fill the float bowl, I had pre-filled the float chamber, and primed the intake with a few squirts of gas. The engine started right up, then ran for a grand total of 15 seconds before stalling. After many seconds of starter time, the engine caught once more, taking about 30 seconds of busy work with the accelerator pedal. This time, I got out and walked around to see what was happening.

This carburetor, shown in Fig.2, is a Mikunishi Solex, and it has a handy little sight glass on the front of the float bowl so that you can check the float level without removing the bowl cover. The sight glass showed that the bowl was full to the top, instead of halfway as it should be. Chuckling lightheartedly at my mistake, I unscrewed the bowl cover and made an educated guess at the correct setting. Starting up the engine again, I could barely get it to run at all. This time the sight glass showed little, if any, gasoline in the bowl. So, I made another adjustment. This back-and-forth, adjust-the-float business went on for quite awhile. I was hypnotized by the sight glass, and the neighbors were being greatly entertained.

This was the sort of thing that I am always warning other people not to do. You get an idea fixed in your mind, and you monkey around with things until you practically have an engine running backward before you finally stop and

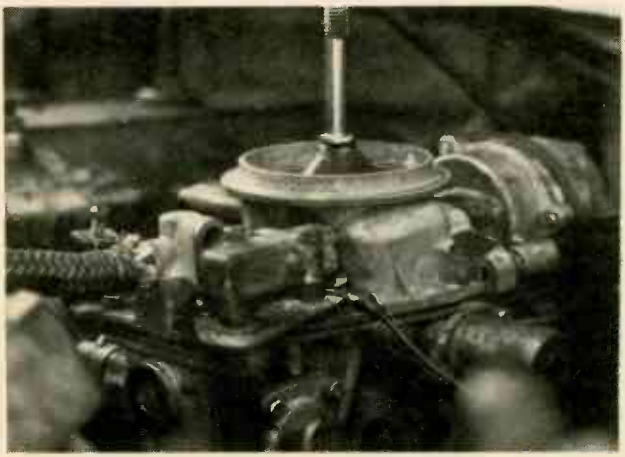

FIGURE 2. MIKUNISHI SOLEX CARBURETOR WITH SIGHT GLASS.

think. Well, I finally stopped, *thought*, and *then* got out a vacuum gauge. With the engine running kind of "so-so," I had 10 inches of vacuum instead of 18. Now, add this up: The engine surges when running, the float will not adjust, and the carburetor had been removed and reinstalled. That means a vacuum leak, and I should have known it within two minutes after starting the engine. Very embarrassing!

The point that I have attempted to make here is that you cannot depend upon hit-or-miss methods and "gut feeling" when it comes to performing competent troubleshooting. Of course, depending upon your familiarity with a particular engine, you might frequently know exactly what is causing a problem, but don't rely on this as a basic approach. If you are confronting an unfamiliar engine with an unknown trouble, you must set up a technique for tackling it. Here are a few things to keep in mind:

1. Know how to use your test equipment. Learn what the instrument readings *mean*.
2. Know the specifications on the engine and its related subsystems. This calls for a service manual of some kind.
3. Know what you are doing. Read the instructions before beginning a test or repair procedure.
4. Make sure that you have *all* the test equipment and tools necessary for the job you are undertaking.
5. Analyze – don't cookbook.

This point must be emphasized: USE YOUR TEST EQUIPMENT TO ISOLATE THE TROUBLE. Vacuum gauges, tachometers, timing lights, voltmeters, and all the rest have specific purposes, and they provide you with the information that your eyes and ears cannot. Break down the trouble area to a subsystem – carburetion, ignition, compression, and so on. Then go to work on the problem area. Keep this up until you find the real trouble.

You are probably thinking that I am going to come to an end here, without telling what was wrong on the Colt carburetion. Well, the carburetor mounting nuts each took a full turn before the manifold vacuum came up to 18 inches, and the float level settled down right on the mark. Since I would never be so stupid as to leave the nuts loose in the first place, I wonder who is sneaking around my neighborhood loosening the nuts on carburetors?

The Author

Mike Curry, former NRI Senior Small-Engine Instructor, poses with his next project, a 1969 Opel Kadett.

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Honors Program Awards

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

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John A. Babich, Jackson Heights NY
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Larry E. Corbin, Mt. Sterling IL
Rodney R. Crowe, Royalton MN
Thomas M. Evans, Eagle Point OR
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William A. Forsberg, Loomis WA
Heinz Gaenssle, New Hudson MI
Charles Gibbs, Olympia WA
James Edward Going, Amsterdam NY
Bernie Martin Gonzales, Fresno CA
Howard A. Graham, Morgantown WV
Roger R. Gustafson, Cherry Valley IL
Alec G. Hunter, Regina SK CANADA
William J. Hurd, Elkhorn NE
Ricky L. Neal, Cool Ridge WV
Ernest Louis Perino, FPO San Francisco
James O. Pugh, Merced CA
Michael C. Reed, Oreana IL
Larry A. Royer, Monmouth IL
William Kennedy Schad, Fayetteville AR
John W. Schindler, Phoenixville PA
Edward Charles Schleis, Denmark WI
Clifford S. Shipley, Aldan PA
Harley W. Smallwood, Cantonment FL
Marvin I. Staudinger, Chugiak AK
James C. Tedder, O'Fallon IL
Ed Wisniewski, Bethesda MD
Edwin A. Young, Jr., Laurel DE

WITH HIGH HONORS

John J. Adinolfi, Pensacola FL
James Eric Allen, Jr., Williston ND
Ralph Frank Allen, Salt Lake City UT
Keith P. Anstine, Quincy WA
Matthew Arrel, Dayton OH
Sam F. Ballarano, Baldwin NY
Richard E. Baltrotsky, Damascus MD
Yusuf H. Bandukwala, Houston TX
Henry Jay Baringer, Enterprise AL
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Lewis F. Baskall, Jr., Denver CO
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Rhett Becker, Bloomington MN
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CONAR

B&K Model 470 Tester/Rejuvenator

POSITIVE GOOD/BAD TESTS

Unlike other testers and restorers, the 470 gives you definite "yes" or "no" answers to tube condition.

AUTOMATIC RESTORATION TIMING

The cathode of the individual tube governs restoration duration, so you can't possibly make a costly timing error that will cause cathode stripping.

CRT INFORMATION SERVICE

Covers all B&K-Precision testers — specify model number. Each new chart complete in itself; lists common crt's plus new types as data becomes available. Issued twice a year.

$250

STOCK NO. 470BK

SPECIFICATIONS

Tests Performed: emission, leakage, tracking (color tubes), life. **Restoring Functions:** shorts removal, gun cleaning, and balancing cathode rejuvenation. **Meters:** (one 4-1/2" D'Arsonval movement). Indications — emission (0-2 mA), restoring current (0-2 scale), heater voltage (0-15), G1 bias (30-100 V), leakage. **Accessories:** Adapters included. CR1 — 90° in-line RCA; 110° color; CR2 — 70° color; CR3 — 90° RCA button-base, large Trinitron; CR4 — 90° GE in-line button-base and special 90° button adapter; CR5 — small Trinitron; CR6 — 110° B/W RCA button-base.

B&K Model DP-50 Digital Probe

$60

STOCK NO. 50BK

Simplify and speed debugging of digital circuits . . . Analyze digital circuits for design changes . . . Trace a pulse throughout a circuit . . . Demonstrate logic state changes and digital circuit operation for classroom use . . . Troubleshoot microprocessors . . . Troubleshoot digital control circuits . . . Use in MRO applications.

- Multi-family, compatible with TTL, DTL, RTL, HTL, CMOS, MOS, and HiNIL
- Displays dc to 50 MHz
- Displays pulse presence and logic states
- Memory mode to "freeze" pulse display
- Pulse mode "stretches" short pulses
- 2 megohm input impedance
- Input overload protected
- Typically detects pulses to 10 nanoseconds

SPECIFICATIONS

INPUT CHARACTERISTICS — Maximum Input Frequency Displayed: 50 MHz. **Minimum Detectable Input Pulse Width:** 20 ns (10 ns typical). **Duty Cycle:** LED intensity is directly proportional to duty cycle observed, up to 50 MHz (and a 10:1 ratio). **Pulse Standard Mode:** Will detect and stretch any input pulse. **Memory Mode:** Will detect and latch any input pulse. **LOGIC THRESHOLDS — TTL/DTL:** Logic One: 2.4 V; Logic Zero: 0.8 V. **CMOS:** Logic One: 70% of supply voltage; Logic Zero: 30% of supply voltage. **Input Overload Protection:** ±50 VDC. **Input Impedance:** 2 megohms in all modes.

CB SERVICING NOTEBOOK

NAME Harold Kinley

DATE November 1979

SUBJECT Case Histories

The various CB case histories I'm going to relate represent a typical day's work for me as a moonlighting CB repair technician. As you'll see, CB isn't dead and, surprisingly enough in these days of inexpensive rigs, people still want to repair their rigs. I guess they become attached to their old rigs and can't do without them. At any rate, I manage to stay busy!

GEMTRONICS GTX-36

The customer with this radio said that by wiggling the microphone plug the transmitter would key. He also said that the radio didn't "get out" very well. The first thing I noticed about the radio was that the microphone plug was wrapped with several layers of tape. This type of plug is known to give lots of trouble.

I replaced the plug on the microphone with a 4-pin female type, which has a ring that threads onto the jack that mates with the plug. This type of plug is quite good because it can't be pulled out of the jack without first unscrewing the ring.

Since I had changed the plug on the microphone, I also had to change the jack on the radio to match the plug. The replacement jack I planned to use was slightly too large to fit into the hole left by the original jack, but by using a rat-tail file I was able to enlarge the hole. The front panel of this radio is plastic, so it was fairly easy to enlarge the hole and then screw in the new jack.

With the radio on Channel 23, I keyed the microphone to check the transmitter. The rf wattmeter showed 1 watt of rf power. When I switched to Channel 1, the power meter read 4-1/2 watts! Switching through all the channels while watching the power meter, I found that the rf power was low only on Channels 21, 22, and 23. The other channels seemed OK.

I then checked the receiver response on Channels 21, 22, and 23. With a 1 μV modulated signal feeding the input of the receiver and the set on Channel 1, I adjusted the volume control for exactly 1/2 watt on the audio power meter. Then I switched the set and signal generator to Channel 23. The audio output dropped more than 3 dB. Also, the "S" meter reading was lower on Channel 23 than on Channel 1. I began to suspect that a bad crystal was the problem. But first I thought I would try tuning the synthesizer oscillator transformer to see what effect it would have. I was able to bring up the output on Channels 21, 22, and 23 to 4 watts, but the tuning was very sharp and critical. On the other channels, the tuning was much smoother and far less critical.

Since Channels 21, 22, and 23 were affected, I had to find the crystal that was common to all three channels. This turned out to be a 37.850 MHz crystal. It seems that the higher frequency crystals give far more trouble than the lower frequency crystals. I guess that this has something to do with the way the crystals are cut. Anyway, I looked through my stock of replacement crystals and found a 37.850 MHz crystal. I replaced the one in the set with the one from my stock and checked the results. With the new crystal installed, the frequency was about 3 kHz high on Channels 21, 22, and 23, so I couldn't leave the crystal in there. Before removing it, I decided to recheck the synthesizer tuning again. This time, it tuned very smoothly on Channels 21, 22, and 23. The output was 4 watts. Everything looked great except the frequency!

I then remembered that I had an old Gemtronics GTX-23 CB set that I had already cannibalized. The GTX-23 is very similar to the Gemtronics GTX-36, so a crystal from one should work equally well in the other. I checked the junker to see if the 37.850 MHz crystal was still in it. It was! I installed this crystal in the GTX-36 and found that it worked very well. The frequency was around 400 Hz high (which is OK), the synthesizer tuning was good, and the power output was normal now.

I then made sure that I had the synthesizer tuned to the proper point. I tuned it while watching the rf meter. On one side of the peak the dropoff was gradual, and on the other side the dropoff was sharp. This is normal. I then tuned the synthesizer just below

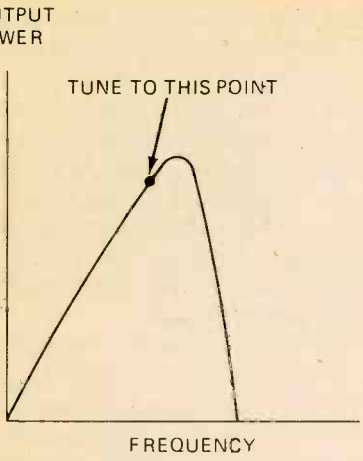

FIGURE 1. PROPER POINT FOR TUNING THE SYNTHESIS OSCILLATOR COIL IN GEMTRONICS GTX-36.

the peak on the side of the gradual dropoff, as indicated in Fig.1.

Next, I checked the transmitter operation on all channels for proper output and frequency. There was about 1/2 watt difference in power from Channels 1 to 23, Channel 23 being 4 watts and Channel 1 being 4-1/2 watts. I switched to Channel 13 and performed a quick "peak" alignment on the transmitter stages from the xmit mixer output to the xmit driver output. While watching the power meter I carefully tuned each coil for peak indication on the meter.

These coils were all sealed with wax, so before I could tune them I had to use my soldering iron to carefully heat the wax enough to allow the tuning slug to be moved freely. It is easy to break a slug, so I've learned (the hard way) never to force a slug to turn against its will! If the slug will not turn freely, heat the wax very carefully so as not to damage the coil or transformer. When the wax softens, the slug will turn easily.

Even with the transmitter tuned properly, the modulation didn't seem just right. There was plenty of audio output from the receiver, so the audio stages used in the receive mode must be working properly. Next I tried adjusting the amc (automatic modulation control). Adjusting this control helped some, but still the modulation wasn't just right. This seemed to narrow the trouble down to one of three places: the modulation input to the final stage, the microphone audio amplifier stage, or the microphone itself.

Since I had a Gemtronics GTX-23 on the shelf awaiting pickup, I decided to borrow the microphone from it to substitute for the one on this GTX-36. The modulation was now much, much better. As a matter of fact, the set was now overmodulating heavily. I readjusted the amc to compensate for this. Apparently, the trouble was in the microphone. I thought that the cartridge might be defective, so I substituted a new one for it. This still didn't cure the trouble.

Next, I checked the switch contacts through which the audio passes from the cartridge to the cord. The contact resistance was low, which is the way it should be. Then I checked for shorts in the cord by checking the resistance from the audio wire to the shield. The resistance should have been infinity. Instead it showed 500 ohms, which varied as the cord was twisted and wiggled. I thought the trouble might be in the new plug that I had installed, so I removed the plug to have a look. Everything looked OK. I temporarily disconnected the audio "hot" lead from the plug to recheck the resistance from this lead to the shield. The low resistance was still present, so this cleared the plug of suspicion. The trouble had to be in the cord itself.

I replaced the cord and the trouble disappeared. The modulation was good

and a complete performance check revealed that the set was working fine now. Although I had spent considerable time and effort repairing this set, I was able to keep the cost reasonable by using a used microphone cord and a crystal from a junked set, all with the customer's knowledge. Otherwise the repair cost would have been prohibitive.

BON SONIC CB 23

The owner of this set did not bring it into the shop himself; a friend brought it in for him. The friend did not state the nature of the complaint, but just said that the owner wanted it repaired. My first step was to hook the set up on the workbench to see exactly what the set would (or would not) do. Upon applying power to the set the channel selector lamp and the meter lamp lit up, and the ammeter on the bench supply showed that the set was drawing about 200 milliamperes. I pushed the microphone button to check for power output, but there was none – not a trace on the meter. I checked for power on all channels and there was no power output on any channel.

To check the receiver I fed a strong modulated signal into the set, but there was no sound at all from the speaker nor any indication at all on the receiver "S" meter. I figured there must be *something* on the set that would work, so I switched the set to the "PA" position and connected the audio power meter to the "PA" jack on the rear of the set. I whistled loudly into the microphone while watching for an indication on the audio meter. There was absolutely no indication on the meter. Apparently the only things working were the lamps!

At this point I reached for the Sams CB index to locate the manual on this set. To my dismay, I could find no listing under Bon Sonic. Oh well, more fun circuit tracing without a diagram!

I located some burned foil on the circuit board, which appeared to be in the vicinity of what was probably the polarity protection diode. An ohmmeter check revealed that the diode was shorted. This is what caused the foil to burn up. Replacing the diode and bridging the open in the foil restored proper supply voltages.

The radio would now receive on all channels except 1, 2, 3, and 4. However, when the set was jarred accidentally the receiver quit working. Tapping the circuit board lightly would make the receiver start and stop again. A careful visual inspection revealed that one lead of the detector-agc diode had not been properly soldered to the board. A little solder cured this intermittent.

Now the only remaining symptoms were no reception on Channels 1, 2, 3, and 4 and no transmission on any channel (no rf output). I decided to troubleshoot the transmitter. To find out exactly where the rf signal was stopping in the transmitter, I used my rf probe in conjunction with my vom. I first checked for rf at the base of the rf driver transistor. There was a good reading there. Next I checked at the collector of the same transistor and found the same rf voltage reading as on the base. This was a cause for suspicion, since the transistor apparently wasn't amplifying the rf signal at all. I removed the transistor and checked it on my transistor tester. There turned out to be a base-collector short.

Replacing the transistor cured the transmitter troubles on all channels except 1, 2, 3, and 4. I poked around the crystal synthesizer switch and found that a 37.600 MHz crystal was used on these four channels. I took a look through my spare crystal assortment and found a replacement. After removing the original crystal and installing

the replacement, the set still did not work on these channels. I then removed the crystal I had substituted and re-installed the original.

Since the crystal is connected to the base of the oscillator transistor through the channel switch, I decided to use my ohmmeter and check for continuity between the crystal and the base of the transistor. There was no continuity! Next I decided to check between the switch contacts for continuity. When I moved the ohmmeter probe around, I noticed one wire was completely loose from the switch terminal, but was lying against the terminal in such a way as to look completely innocent! Resoldering the wire to the switch terminal restored the four missing channels. This completed the repairs, but before replacing the cover I made a complete performance check on the set. Everything else checked OK now.

GEMTRONICS GTX-2300 BASE STATION

The owner of this set said that it had been completely dead since lightning had run into the set through the power line. He wanted the set restored to first-class condition.

I hooked the set up on the workbench to check the symptoms. As the customer had said, the set was completely dead; not even the dial light or the meter light would come on. Now, one doesn't have to be a trouble-shooting wizard to know that when a set is as dead as this one the power supply becomes the prime suspect. With this in mind, I pulled out the service manual on this set and studied the power supply section of the schematic. As you can see from Fig.2, there are two different plugs for the set. One plug is for operation on 120 volts ac and the other plug is for operation from a 12 volt dc supply such as a storage battery. When the set operates on a 12 volt dc supply, the power oscillator is used to develop an alternating voltage across one of the primary windings of the power transformer. This ac voltage is induced into the secondary and then rectified and doubled by the voltage-doubler arrangement to supply the high voltage required by the vacuum tubes. When the set is operated on a 120 volt ac power source, the power oscillator is not used because the supply voltage is already in a form that can be used by the transformer. That is, it is already the ac voltage that is required to operate a transformer.

Now, the trouble with this set seemed to be in the power supply because of the "dead" nature of the radio. I removed the top and bottom covers from the set and referred to the schematic for my next move. The schematic showed a fuse in the primary of the power transformer. This is labeled F2 on the schematic. In the set the fuse is soldered directly into the circuit. The fuse has a lead attached to each end, and it was definitely blown. The next thing I did was to temporarily connect another fuse into the circuit by using jumper wires with alligator clips on each end. Upon applying power to the set the fuse immediately blew.

The next step (it should have been my first step!) was to locate the short circuit causing the fuse to blow. After looking at the schematic a bit more, I decided to check the two power oscillator transistors, TR1 and TR2. An ohmmeter check showed a dead short in both directions between the emitter and collector of both transistors. I removed both of them from the circuit and double-checked them on my transistor tester. The transistor tester confirmed that both transistors had emitter-to-collector shorts. This effectively placed a direct short across the transformer

winding that connects between the two collectors of the power oscillator transistors. I also checked the two bias diodes, D8 and D9. They were both OK. After replacing the two transistors, I temporarily connected another fuse into the circuit and reapplied power. This time the dial light and the meter light lit up and the fuse held. This was far enough for the moment! I had to back up and figure out how I was going to connect the fuse into the circuit permanently. Since I didn't have any fuses with leads attached, I decided to install an in-line fuse holder in the circuit.

To get on with the radio testing I applied power to the set and waited a few minutes for the tubes to warm up. Then I fed a weak modulated signal (0.8 μV at 30% modulation by 1 kHz tone) into the set. I peaked the three 455 kHz i-f transformers by ear. While peaking these transformers I was listening not just for the loudest volume, but also for the cleanest sound. (That is the setting that produces the loudest volume with the least distortion.) After this "peaking," the radio sounded good. A sensitivity check showed a sensitivity of 0.7 μV at 10 dB S+N/N ratio, which is good for this set. Next I checked the receiver operation, which was excellent over the entire band.

Transmitter testing came next. I turned the channel selector to Channel 13 and keyed the transmitter. The

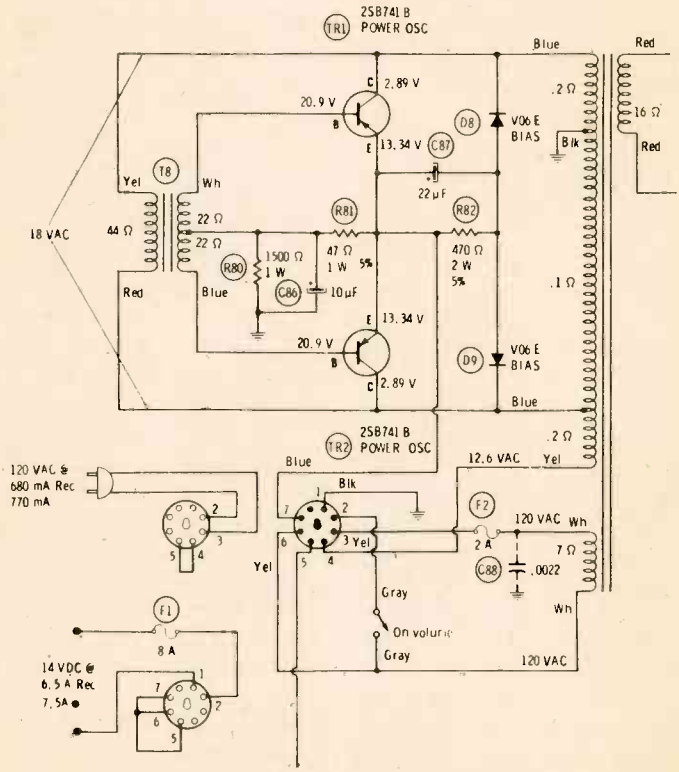

FIGURE 2. GTX-2300 POWER SUPPLY.

wattmeter indicated about 3 watts. I whistled into the microphone to observe the modulation envelope on the scope. I didn't like what I saw. Instead of being rounded, the peaks of the modulation waveform were clipped off, resulting in a flat-topped waveform like the one in Fig.3(A). I first suspected that the modulator wasn't delivering enough peak power, but then why was the envelope modulated to 100% on the negative peaks? If the modulator was weak, the waveform should have looked like Fig.3(B). It appeared that the transmitter just wasn't able to deliver the peak rf power required at the peak of the modulation cycle.

Since the final amplifier tube is the one that has to work the hardest in the transmitter, I decided to replace it and check the results. After burning my fingers in the process of changing the tube, I attended my wounds while waiting for the new tube to heat up. After a few minutes I keyed the transmitter and carefully adjusted the output tuning capacitors, CV4 and CV5, shown in Fig.4. The output power rose to 3-1/2 watts. I whistled into the microphone while looking at the scope. This time I liked what I saw. The waveform was no longer clipped, but was rounded as in Fig.3(C).

Apparently the old tube was "flat," and it was saturating before the peak of the modulating voltage was reached. As you know, when the plate current saturation point is reached, a further increase in plate voltage will produce no more output power. A "flat" tube has a much lower saturating point than a good tube. This explains the flat top of the modulation envelope.

My next step was to check the power output across the band from Channel 1 to 23. The power on Channel 23 was about 0.3 watt lower than that on Channel 1. Retuning capacitors CV4 and CV5 equalized the power between

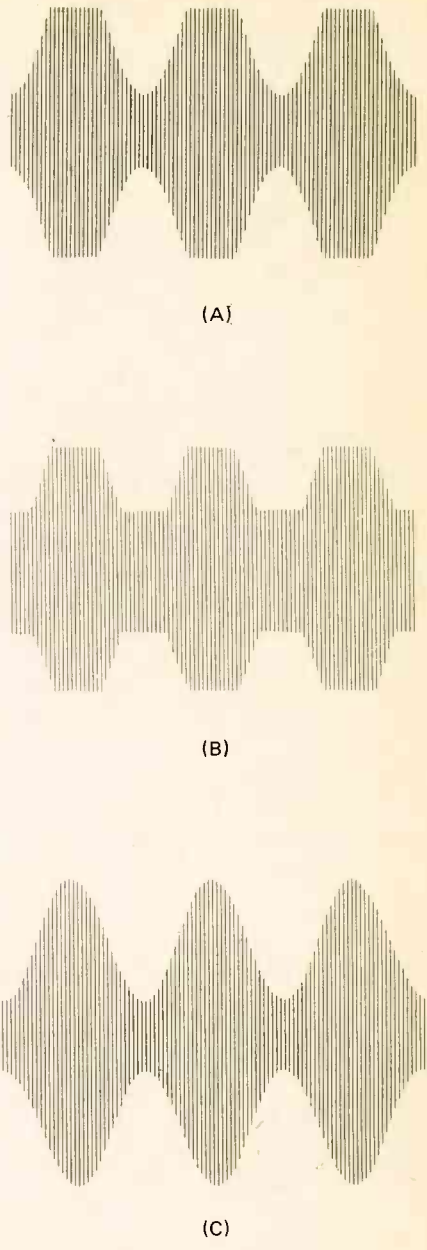

FIGURE 3. (A) NEGATIVE PEAKS OK, (B) BOTH PEAKS CLIPPED, AND (C) NORMAL MODULATION.

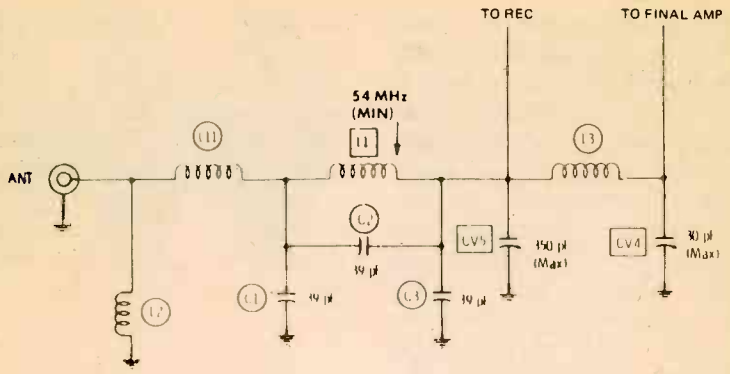

FIGURE 4. RF OUTPUT NETWORK OF GTX2300.

channels 1 and 23. I had to switch back and forth between these channels several times while adjusting the two capacitors to get the power balanced. Then the power in the mid-band range, channel 13, was a little higher. This is normal and to be expected. The last thing I did before replacing the covers was to check the transmitter frequency on all channels. All the channel frequencies were within 250 Hz, well within the allowable 1350 Hz. This completed the repairs on this model, so I headed for the sofa for a well-earned rest!

TEABERRY MODEL BIG "T"

The customer's complaint on this set was that the signal was breaking up during transmit. When I got around to checking the set I found that the transmitter output power would rise and fall as the microphone cord dangled. The problem seemed to be a break in the cord near the plug, since flexing the cord near the plug had the greatest effect. The way I normally repair such breaks is to cut the cord beyond the break and reconnect to the plug. This shortens the cord somewhat, but most of the time the break will be near the microphone head or the plug, so only 2 or 3 inches of cord is lost in the repair. The other alternative is to replace the entire cord, which means you will have to work on both ends. This is considerably more expensive to the customer. However, if the cord shows considerable wear or if the insulation is cracked and brittle, replacing the cord may be the best bet. If the microphone itself also looks bad, you might suggest replacing the entire mike and cord assembly.

In this case I removed the plug from the cord. My usual procedure in such a case is to pull each conductor individually. If one is broken not far into the cord, the conductor will usually pull out very easily. Then by looking at the length of the piece of conductor which pulled out, you can tell how much to cut off the cord. When I pulled on the red conductor in this cord the wires slid right out of the insulation. The break was in the keying wire about 1-1/2 inches from the end. I cut the cord about 2 inches above the end and reconnected it to the plug. This cured the intermittent keying condition.

On the microphone itself, there was a piece of tape wrapped around the bottom of the keying button. I wondered why it was there, so I removed it to find out. As I was removing the

tape, the plastic keying button fell out of the side of the microphone! After disassembling the microphone, I found that the pin that held the keying button in place was missing. I was able to fashion a replacement pin out of a paper clip. It worked just fine!

With these problems out of the way, I continued on to performance testing of the radio. The next problem that I encountered was very poor receiver sensitivity. The receiver required 20 μV for 10 dB S+N/N ratio. Usually (but not always) this is caused by a problem in the rf amplifier stage, so that is where I started checking first. Figure 5 shows the rf amplifier of this rig. Using my hand-held signal injector, I touched the probe tip to the gate of TR1, which is an FET transistor. The sound from the speaker was very faint. Next I touched the probe to the drain of TR1. This time the sound from the speaker was much louder. It looked as though TR1 wasn't amplifying the rf signal. Next I took some voltage measurements around TR1. At the source I measured 1.1 volts. The gate also was at 1.1 volts. The voltage on the drain was 8.5 volts. These voltages were out of line with what the schematic calls for. Because the same voltage was measured on the gate and source, I suspected a short there.

I removed the transistor and measured the resistance between the source and gate. The resistance was 6 ohms, either way the ohmmeter leads were connected. I was fortunate to have a replacement for this FET in stock. I installed the replacement in the set and applied power to check the results. The speaker was blasting because I still had the 20 μV feeding the receiver input. I hastily turned the signal generator attenuator to around 1 μV. The signal was still coming through at the 1 μV level, so the new FET fixed the trouble. I tweaked the rf input and output transformers for peak performance. These are labeled T1 and T2 on the schematic. The sensitivity was now 0.5 μV for 10 dB S+N/N ratio, quite a bit better than the 20 μV level required before! Continuing on with the performance testing, the only other problem I found was that the channel selector switch was dirty. It was very touchy. I sprayed it with contact cleaner and rotated the switch in each direction several times. Further performance testing revealed no more problems, so I buttoned up the set and headed for the refrigerator! This kind of repair always makes me hungry!

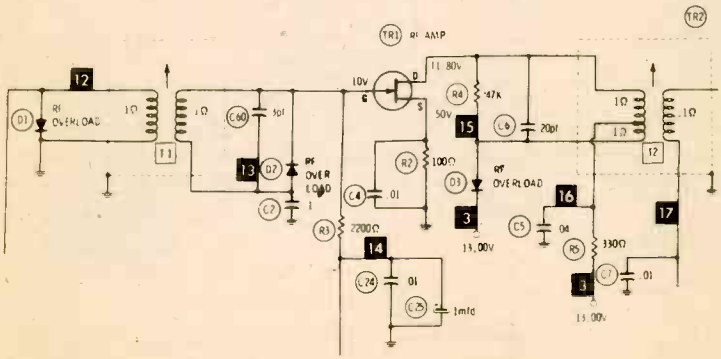

FIGURE 5. RF AMPLIFIER OF TEABERRY BIG "T."

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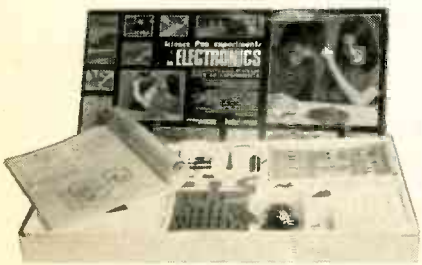

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